Final Model Review Report for the Wetland Value Assessment Models

Prepared by
Battelle Memorial Institute

Prepared for
Department of the Army
U.S. Army Corps of Engineers
Ecosystem Planning Center of Expertise
Mississippi Valley Division

Contract No. W911NF-07-D-0001
Task Control Number: 09032
Delivery Order: 0594

August 31, 2010
FINAL REPORT
for the
Model Review of the
Wetland Value Assessment Community Index Models

Submitted to:
Department of the Army
U.S. Army Corps of Engineers
Ecosystem Planning Center of Expertise
Mississippi Valley Division

Contract Number: W911NF-07-D-0001
Task Control Number: 09057
Delivery Order Number: 0605

Prepared by:
Battelle
505 King Avenue
Columbus, OH 43201

August 31, 2010
EXECUTIVE SUMMARY

An independent external peer review of the Wetland Value Assessment (WVA) Community Index models was conducted for the United States Army Corps of Engineers (USACE) Ecosystem Planning Center of Expertise (ECO-PCX) under Contract Number W911NF-07-D-0001, Task Control Number 09-032 to support efforts for restoration and mitigation of wetlands and other coastal habitats under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA). The WVA method was originally developed for wetland restoration and planning projects in coastal Louisiana and east Texas, and is a tool used to evaluate potential changes in ecosystem benefits. It directly applies the Habitat Evaluation Procedures (HEP), which was developed by the U.S. Fish and Wildlife Service (USFWS) and other agencies to evaluate the impacts of development projects on fish and wildlife resources and is now also used to evaluate the benefits of ecosystem restoration projects. While HEP more traditionally uses species-specific models, the WVA uses a community-level approach.

The WVA models are community-based models developed for several types of wetlands and other habitats found in coastal Louisiana, including fresh-intermediate, brackish, and saline marshes; barrier islands and headlands; swamp; bottomland hardwood wetlands; and forested coastal ridges (e.g., coastal chenier/ridges). They are planning models that were originally developed for use in determining habitat benefits for proposed projects submitted for funding under CWPPRA. The WVA models are currently being used for the Barataria Basin Shoreline Restoration Integrated Feasibility Study and are intended for use on current and future USACE projects (such as Louisiana Coastal Area [LCA] projects).

Although the WVA models were developed for use in Louisiana coastal habitats, these habitats extend into eastern Texas, as shown on U.S. Environmental Protection Agency (EPA) maps of the ecoregions of Texas. In particular, the models may be used on the habitats in the coastal areas of Orange, Jefferson, Chambers, Liberty, and Galveston Counties from Sabine Pass to the eastern edge of Galveston Bay for barrier headlands; coastal cheniers/ridges; saline, brackish, and fresh-intermediate marshes; bottomland hardwood wetlands; and cypress-tupelo swamp. Extensive marsh, swamp, and bottomland hardwood habitat can be found along the Trinity River in Chambers and Liberty Counties and the lower Neches and Sabine Rivers in Jefferson and Orange Counties.

The USACE Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of USACE planning models and to assure that high quality methods and tools are available so that informed decisions on investments in the Nation’s water resources infrastructure and natural environment can be made. The main objective of the PMIP is to carry out “a process to review, improve and validate analytical tools and models for USACE Civil Works business programs” (USACE EC 1105-2-407, May 2005). In accordance with the Planning Models Improvement Program: Model Certification (EC 1105-2-407, May 2005), certification is required for all planning models developed and/or used by USACE. The objective of model certification
is to ensure that models used by USACE are technically and theoretically sound, computationally accurate, and in compliance with USACE planning policy. USACE’s ECO-PCX proposed to conduct an Intermediate Level review of the WVA models based on their anticipated widespread use for projects under LCA authority and in applicable areas in Texas.

As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering peer review panels for USACE, Battelle was engaged to conduct the model quality assurance review for the WVA Models. Independent, objective peer review is regarded as a critical element in ensuring technical quality, system quality, and usability of the models. To accomplish the model review, six subject matter experts (i.e., peer reviewers) were selected by Battelle. The peer reviewers were provided with electronic versions of the WVA Community Index Models documents and associated spreadsheets along with a charge that solicited their comments on specific aspects of the document and model spreadsheets. The charge questions solicited comments regarding key technical quality, system quality (limited), and usability criteria that are critical for model certification as described in the USACE Protocols for Certification of Planning Models (July 2007). There was no communication between the peer reviewers and the model developers during the peer review of the documents and models.

Approximately 600 individual comments were received from the peer reviewers in response to the charge questions. Following the individual reviews of the model documentation and spreadsheets by the peer reviewers, a peer review teleconference was conducted to review comments on the key model review criteria, discuss charge questions for which there were conflicting responses, and reach agreement on the Final Panel Comments to be provided to USACE. The findings of the models’ independent external peer review regarding their technical quality, system quality and usability are documented in specific sections of this report, and Final Panel Comments are provided in Appendix B.

This Final Report for the Model Review of the WVA Models describes the model review process, describes the peer review panel members and their selection, and summarizes the findings and Final Panel Comments of the peer reviewers. This report was subject to USACE review; however no comments on the draft report were received from USACE. The results of the peer review as presented in this final report will be taken into consideration for certifying or revising the WVA Models.

Overall, the peer reviewers agreed that the concept and application of the models are sound for planning efforts. Models are simple representations of complex systems and, as such, must balance complexity and reality with simplicity and usability. For the WVA models, this goal has been achieved. The HEP method, which is equivalent to the WVA method, has a long history of being applied to these situations. The models seem to sufficiently capture the habitats being modeled and do not have any irreparable deficiencies.

However, there were some issues identified with the models’ documentation, application, variables, and some potentially serious errors in spreadsheet calculations and formulas. These are issues are summarized in the bullets below.

- One of the biggest concerns of the peer review panel is that the development and application of the models is not well-documented. The models are well-established and
use widely accepted protocols (HEP); however, whether they are “based on well-established contemporary theory” (USACE Protocols for Certification of Planning Models, July 2007) could not be determined. The theoretical development of each model was weak and generally not well documented from the literature or other sources. For the most part, model assumptions are not explicitly stated in the model documents. Stating the assumptions for the WVA/HEP method and Habitat Suitability Index (HSI) models would improve confidence in the results and provide model users with guidance on how the models are to be applied.

- The peer reviewers found that the application of the models is not thoroughly described, and there are concerns regarding how future conditions can be projected based on the limited data presented. Many of the variable measurements appear to be subjective, and a lack of detailed protocols will lead to extensive application of best professional judgment and inconsistencies in results between projects and project teams. Furthermore, documentation problems were identified in the model spreadsheets that could limit the usability and accuracy of the models.

- By necessity, models are simplified representations of complex systems. As such, only a limited number of variables can be included in models before they become unnecessarily complex. However, several external components were identified that could impact the quality of the ecosystems being modeled but were not included in the models, and the peer reviewers suggested that additional variables to reflect sea level changes (all models) and more local and direct human disturbance (some models) be included. Although the variables in the models will certainly respond to these external stressors, it was strongly suggested that they might be included in the models as important variables. Furthermore, risk and uncertainty associated with the models capturing, responding to, and predicting the impacts of extreme environmental conditions (e.g., severe weather) were not considered.

The HSI model output typically ranges from 0.0 (no habitat value) to 1.0 (optimal habitat), while the WVA models contain variables that can inexplicably only have Suitability Index (SI) values ranging from 0.1 to 1.0, meaning that it is impossible for any habitat to have no value for fish and wildlife. Also, the inclusion of policy goals for the construction of marsh vegetation cover variables is not appropriate for ecological goals. In some cases, optimal conditions were defined as “no habitat loss” rather than conditions that are most suitable for fish and wildlife to thrive. (e.g., One-hundred percent emergent vegetation coverage in marshes is not optimal for foraging and breeding by fish and wildlife, nor is it realistic, as tidal wetlands necessarily have natural tidal creeks; however, the marsh models stipulated 100% emergent vegetation coverage as optimal.) The decision to use policy over science to assign SI values to variables may limit the ability of the models to accurately assess the value of the ecosystems being represented. Lastly, HSI model output is theoretically linked to or represents some characteristic of the population or community being represented (i.e., a performance measure), and no performance measures are defined for the WVA models. An example of a performance measure would be species richness per unit area, based on the assumption that species richness is directly correlated with habitat quality.
Peer review of the technical quality, system quality, and usability of the WVA models determined that the models appear to be generally technically sound, but the models contain several problems in their calculations/formulas. These were classified as formula calculation errors, specification errors, or error message problems. Specification errors are difficult to separate from formula errors because it is not always clear whether the specification or the calculation is incorrect. Correction of these problems is critical to ensuring reliable and accurate model outputs. Incorporating validation into the model spreadsheets is recommended to prevent the use of non-sensible data or data being entered in the incorrect format.

The reviewers strongly suggest incorporating the recommended resolutions into the model documentation and model spreadsheets before allowing widespread use of the models for planning purposes. The models will be better able to achieve their stated purpose if suggested revisions are made. In their current condition, they are highly subjective and may not be able to accurately predict future conditions.
### Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXECUTIVE SUMMARY</td>
<td>iii</td>
</tr>
<tr>
<td>ACRONYMS</td>
<td>ix</td>
</tr>
<tr>
<td>1.0 Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Model Purpose</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Model Assessment</td>
<td>2</td>
</tr>
<tr>
<td>1.3 Contribution to Planning Effort</td>
<td>4</td>
</tr>
<tr>
<td>1.4 Report Organization</td>
<td>4</td>
</tr>
<tr>
<td>2.0 Model Description</td>
<td>7</td>
</tr>
<tr>
<td>2.1 Model Applicability</td>
<td>7</td>
</tr>
<tr>
<td>2.2 Model Summary</td>
<td>7</td>
</tr>
<tr>
<td>2.3 Model Components</td>
<td>8</td>
</tr>
<tr>
<td>3.0 Model Evaluation</td>
<td>19</td>
</tr>
<tr>
<td>3.1 Model Review Approach</td>
<td>19</td>
</tr>
<tr>
<td>3.2 Assessment Criteria</td>
<td>23</td>
</tr>
<tr>
<td>3.2.1 Technical Quality</td>
<td>23</td>
</tr>
<tr>
<td>3.2.2 System Quality</td>
<td>23</td>
</tr>
<tr>
<td>3.2.3 Usability</td>
<td>24</td>
</tr>
<tr>
<td>3.3 Approach to Model Testing</td>
<td>24</td>
</tr>
<tr>
<td>3.4 Technical Quality Assessment</td>
<td>24</td>
</tr>
<tr>
<td>3.4.1 Review of Theory and External Model Components</td>
<td>24</td>
</tr>
<tr>
<td>3.4.2 Review of Representation of the System</td>
<td>26</td>
</tr>
<tr>
<td>3.4.3 Review of Analytical Requirements</td>
<td>28</td>
</tr>
<tr>
<td>3.4.4 Review of Model Assumptions</td>
<td>29</td>
</tr>
<tr>
<td>3.4.5 Review Ability to Evaluate Risk and Uncertainty</td>
<td>32</td>
</tr>
<tr>
<td>3.4.6 Review Ability to Calculate Benefits for Total Project Life</td>
<td>33</td>
</tr>
<tr>
<td>3.4.7 Review of Model Calculations/Formulas</td>
<td>34</td>
</tr>
<tr>
<td>3.5 System Quality</td>
<td>37</td>
</tr>
<tr>
<td>3.5.1 Review of Supporting Software</td>
<td>37</td>
</tr>
<tr>
<td>3.5.2 Review of Programming Accuracy</td>
<td>37</td>
</tr>
<tr>
<td>3.5.3 Review of Model Testing and Validation</td>
<td>37</td>
</tr>
<tr>
<td>3.6 Usability</td>
<td>40</td>
</tr>
<tr>
<td>3.6.1 Review of Data Availability</td>
<td>40</td>
</tr>
<tr>
<td>3.6.2 Review of Results</td>
<td>45</td>
</tr>
<tr>
<td>3.6.3 Review of Model Documentation</td>
<td>47</td>
</tr>
<tr>
<td>3.7 Model Assessment Summary</td>
<td>51</td>
</tr>
<tr>
<td>4.0 Conclusions</td>
<td>53</td>
</tr>
<tr>
<td>5.0 References</td>
<td>55</td>
</tr>
</tbody>
</table>

**Appendix A:** Biographic Information for Model Peer Review Panel Experts  
**Appendix B:** Final Panel Comments

1. Starting the SI curves for all variables at 0.1 is problematic because even habitat with no ecological value appears to have some ecological value.
2. Justification for assigning variable weights needs to be provided.
3. The number of target years should be increased to improve the predictive ability of the models given that changes are often non-linear.
4. In the spreadsheet for the marsh model, open water and emergent marsh AAHUs are incorrectly combined and should be added rather than taking the arithmetic mean.
5. Off-site, indirect impacts and human disturbances should be addressed by the models.
6. Sea level is an important driver and relative sea level rise and climate change should be included in the models.
7. Validation of the models based on performance measures needs to be described and documented.
8. The model documentation should clearly state the basis for the model assumptions, the theoretical basis of the models and how the science is applied, and how the models were developed to eliminate the appearance of subjectivity.
9. The methods for data collection are unclear and not well-documented, therefore data quality is uncertain.
10. For some model variables, policy decisions appear to supersede the biology of the relationships for developing the Suitability Index (SI) curves.
11. The spreadsheets for the models as created are likely to lead to errors in maintenance and use.
12. Several inaccuracies were identified in the model spreadsheets that should be corrected.
13. The usability of the spreadsheets is limited because of the spreadsheets’ user interface and user documentation.
14. Data validation needs to be built into the spreadsheets.
15. The WVA method should be expanded to handle risk and uncertainty.
16. The WVA method should be updated, taking into account new GIS data, LIDAR, and other new data sources as well model formats/presentation (visualization tools, HGM).
17. Development and documentation of a more precise approach to measurement of some variables could be improved.
18. The use of the geometric mean may be more appropriate than the arithmetic mean to derive some HSIs. Provide scientific basis for the decision.
19. A performance measure should be stipulated to identify the measurable community characteristics to which the HSIs are related.
20. The geographic boundaries/domain of the models are unclear.
21. An explicit statement should be provided regarding the minimum area to which the models can be applied.
22. Additional error checks should be incorporated into the model spreadsheets.

Attachment A: Work Plan
ACRONYMS

AAG  American Association of Geographers
AAHU  average annual habitat units
CECW  Civil Engineers Civil Works
CEM  conceptual ecological model
COI  conflict of interest
CWPPRA Coastal Wetlands Planning, Protection, and Restoration Act
DBH  diameter at breast height
ECO-PCX Ecosystem Planning Center of Expertise (USACE)
EngWG Engineering Work Group
EnvWG Environmental Work Group (USFWS)
EPA  United States Environmental Protection Agency
FEMA Federal Emergency Management Agency
FWOP Future Without-Project
FWP Future With-Project
GIS  geographic information systems
ha  hectares
HEP  Habitat Evaluation Procedure
HSI  Habitat Suitability Index
HU  habitat units
IEPR  independent external peer review
LCA  Louisiana Coastal Area
LDNR Louisiana Department of Natural Resources
LIDAR Light Detecting and Ranging
NMFS  National Marine Fisheries Service
NRCS National Resource Conservation Service
NWI  National Wetlands Inventory
PMIP Planning Models Improvement Program (USACE)
ppt  parts per thousand
SAV submerged aquatic vegetation
SI  Suitability Index
SLR  sea level rise
SOW Statement of Work
TY  target year
USACE United States Army Corps of Engineers
USFWS United States Fish and Wildlife Service
USGS United States Geological Survey
WVA Wetland Value Assessment
This page intentionally left blank
1.0 INTRODUCTION

A review of the Wetland Value Assessment (WVA) Models was conducted for the United States Army Corps of Engineers (USACE) Ecosystem Planning Center of Expertise (ECO-PCX) under Contract Number W911NF-07-D-0001, Task Control Number 09-032 to support efforts for restoration and mitigation coastal wetlands and other coastal habitats in Louisiana and east Texas. The WVA method was originally developed for wetland restoration and planning projects funded under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA), and is a tool that is used to evaluate potential changes in ecosystem benefits. The WVA method is a direct application of the Habitat Evaluation Procedures (HEP), which was developed by the U.S. Fish and Wildlife Service (USFWS) and other agencies to evaluate the impacts of development projects on fish and wildlife resources and is now also used to evaluate the benefits of ecosystem restoration projects. Because the WVA method is a direct application of HEP, the WVA method will hereafter be called WVA/HEP method. While HEP more traditionally uses species-specific models, the WVA/HEP uses a community-level approach.

The WVA models are community-based models developed for several types of coastal wetlands and other coastal habitats found in Louisiana, including fresh-intermediate, brackish, and saline marshes; barrier islands and headlands; swamp; bottomland hardwood wetlands; and forested coastal ridges (e.g., coastal cheniers). They are planning models that were originally developed for use in determining habitat benefits for project proposals submitted for funding under CWPPRA. The WVA models are currently being used for the Barataria Basin Shoreline Restoration Integrated Feasibility Study and are intended for use on current and future USACE projects (such as Louisiana Coastal Area [LCA] projects).

Although the WVA models were developed for use in Louisiana coastal habitats, these habitats extend into eastern Texas, as shown on U.S. Environmental Protection Agency (USEPA) maps of the ecoregions of Texas. In particular, the models may be used on the habitats in the coastal areas of Orange, Jefferson, Chambers, Liberty, and Galveston Counties from Sabine Pass to the eastern edge of Galveston Bay for barrier headlands; coastal cheniers/ridges; saline, brackish, and fresh-intermediate marshes; bottomland hardwood wetlands; and cypress-tupelo swamp. Extensive marsh, swamp, and bottomland hardwood habitat can be found along the Trinity River in Chambers and Liberty Counties and the lower Neches and Sabine Rivers in Jefferson and Orange Counties.

1.1 Model Purpose

As described in the WVA Methodology Introduction (USFWS 2006a), the WVA models have been developed for determining the suitability of Louisiana coastal habitats for 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 common fish and wildlife species. The models should also apply to similar habitats in Texas, as described above.

Developed from a quantitative habitat-based assessment method, the WVA models quantify changes in fish and wildlife habitat quality and quantity that are expected to result from a
proposed habitat restoration project, although they could be applied equally well to created habitats used to mitigate impacts associated with Civil Works projects. The results of the WVA models, 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/HEP method provides an estimate of the number of acres benefited or enhanced by the project and the net acres of habitat protected or restored.

Project evaluations involve data collection to determine baseline habitat conditions and predict habitat conditions for future with-project (FWP) and future without-project (FWOP) scenarios. The WVA models were designed to be applied, to the greatest extent possible, using only existing or readily obtainable data. They have proven to be an efficient and cost-effective tool for evaluating proposed restoration projects.

1.2 Model Assessment

The USACE Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of USACE planning models and to assure that high quality methods and tools are available so that informed decisions on investments in the Nation’s water resources infrastructure and natural environment can be made. The main objective of the PMIP is to carry out “a process to review, improve and validate analytical tools and models for USACE Civil Works business programs” (USACE EC 1105-2-407, May 2005). In accordance with the Planning Models Improvement Program: Model Certification (EC 1105-2-407, May 2005), certification is required for all planning models developed for and/or used by USACE. The objective of a model quality assurance review is to ensure that models used by USACE are technically and theoretically sound, computationally accurate, and in compliance with USACE planning policy. Model assessments are conducted in accordance with the USACE Protocols for Certification of Planning Models (July 2007).

The following outlines the basic steps of the USACE model certification process which are designed to guide the model review. Model development is a multi-step, iterative process, with the number of steps and iterations being dependent upon the complexity of the model. In general, these steps occur in four fundamental stages.

- **Stage 1 (Requirements Stage)** involves identifying the need for a specific analytical capability and the options for tools to meet the need.
- **Stage 2 (Development Stage)** involves the development of software programming code or a spreadsheet and testing by the model developer.
- **Stage 3 (Model Testing Stage)** involves a beta test of the model by selected users whose objective is to validate the model and ensure that it is usable in real-world applications.
- **Stage 4 (Implementation Stage)** involves providing training, user support, maintenance and continuous evaluation of the model.

The certification procedure depends on the stage of model development. The process may include the following steps.
1. Peer reviewers determine whether project needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.

2. Peer reviewers evaluate the technical quality of the models (review of model documentation), including whether:
   a. The model is based on well-established contemporary theory.
   b. The model is a realistic representation of the actual system.
   c. Analytical requirements of the model are properly identified and the model addresses and properly incorporates the analytical requirements.
   d. Assumptions are clearly identified, valid, and support the analytical requirements.
   e. USACE policies and procedures related to the model are clearly identified, and the model properly incorporates USACE policies and accepted procedures.
   f. Formulas used in the model are correct and model computations are appropriate and done correctly.

3. Peer reviewers evaluate system quality (review by running test data sets or reviewing the results of beta tests) to determine whether:
   a. The rationale for selection of supporting software tool/programming language and hardware platform is adequately described, and supporting software tool/programming language is appropriate for the model.
   b. The supporting software and hardware are readily available.
   c. The programming was done correctly.
   d. The model has been tested and validated, and all critical errors have been corrected.
   e. Data can be readily imported from/into other software analysis tools, if applicable.

4. Peer reviewers evaluate the usability of the model to:
   a. Examine the data required by the model and determine the availability of the required data.
   b. Examine how easily model results are understood.
   c. Evaluate how useful the information in the results is for supporting project objectives.
   d. Evaluate the ability to export results into project reports.
   e. Determine whether training is readily available.
   f. Determine whether user documentation is available, user friendly and complete.
   g. Determine whether adequate technical support is available for the model.
   h. Determine whether the software/hardware platform is available to all or most users.
   i. Determine whether the model is easily accessible.
   j. Determine whether the model is transparent and allows for easy verification of calculations and outputs.

The WVA models are at Stage 3 in the development process. These models have already been applied to several coastal restoration projects in Louisiana and eastern Texas, and are being assessed for quality and applicability. This review of the WVA models focused primarily on the
technical quality of the models as well as their usability. The review of system quality was limited, as the models are spreadsheet-based and there is no new software program to evaluate.

The level of effort for a model review depends on the complexity of the model(s) developed, the risks associated with planning decisions made using the models, and the stage of model development. The WVA models have undergone an Intermediate Level Review, based on the models’ intermediate level of complexity relative to other planning models. The Intermediate Level Review included an Independent External Peer Review (IEPR) of the models. Although model reviews have been conducted external to USACE, it is ultimately USACE’s decision whether to certify planning models for use on other projects or in other geographic areas.

1.3 Contribution to Planning Effort

USACE has primary responsibility for the construction of Federally-authorized wetland and coastal habitat planning, protection, and restoration projects, including projects in coastal Louisiana and Texas. The WVA models are planning models that were originally developed for determining habitat benefits of proposed projects submitted for funding under CWPPRA. The WVA models are currently being used for the Barataria Basin Shoreline Restoration Integrated Feasibility Study and are intended for use on current and future USACE projects (such as LCA projects).

These models are intended for use on projects that aim to restore and mitigate important coastal habitats and ecological services. The WVA models were developed to evaluate proposed project alternatives based on ecosystem benefit changes in eight different coastal ecosystems. These models and the methods used to assess changes in coastal ecosystems and impacts to fish and wildlife resources were developed by the USFWS Environmental Work Group (EnvWG) assembled under the Planning and Evaluation Subcommittee of the CWPPRA Technical Committee. The EnvWG includes members from each agency represented on the CWPPRA Task Force and members of the Academic Assistance Subcommittee.

Proposed project alternatives are evaluated by comparing changes in ecosystem benefits from current conditions to projected future conditions when habitat restoration or mitigation alternatives are put in place (with-project conditions) and without habitat restoration or mitigation efforts (without-project conditions). This approach characterizes baseline ecological conditions, forecasts changes in fundamental ecosystem processes that could occur under with-project and without-project conditions, and assesses the ability of proposed restoration or mitigation measures to offset ecosystem impacts. The forecast is based on projected changes in both quantity (acres) and quality (community habitat suitability) of coastal ecosystems.

1.4 Report Organization

This report is organized into the following sections:

Section 2.0 Model Description — Describes the applicability of the model for planning projects and summarizes the model inputs and components.
Section 3.0 Model Evaluation — Describes the criteria used to assess technical quality, system quality, and usability; summarizes the approach to the model review; and describes the results of the model assessment.

Section 4.0 Conclusions — Summarizes the overall conclusions of the model review.

Section 5.0 References — Lists the references used for this model assessment.

Appendix A – Contains biographic information on the expert peer review panel members selected to perform the review of the model certification assessment criteria.

Appendix B – Contains the Final Panel Comment forms that contain the key comments from the model review as well as each comment’s basis, significance, and recommendations for resolution.

Attachment A – This is the Final Work Plan for the Model Review of the WVA Models, which contains the final charge guidance and questions to the peer reviewers to guide the review of the models and model documentation.
This page intentionally left blank
2.0 MODEL DESCRIPTION

2.1 Model Applicability

The WVA models are USFWS Habitat Suitability Index (HSI) models and, as such, they are designed to capture changes in ecosystem quality over time. The user must identify Target Years (TY) for anticipating changes in habitat area and/or quality within the project area. Changes are evaluated with respect to baseline conditions (TY = 0) before proposed changes occur. Additional TYs would be points in time over the life of the project for which change would be projected. The models quantify the effects of ecosystem changes at selected target years due to projected habitat loss, mitigation, or restoration.

The variety of habitats and communities in coastal Louisiana and parts of eastern Texas include barrier islands and headlands; coastal cheniers/ridges; saline, brackish, and fresh-intermediate marshes; bottomland hardwood wetlands; and cypress-tupelo swamp. Models were developed for each of these communities to evaluate ecosystem changes in habitat quality. These models were specifically developed for the CWPPRA, and are only applicable to coastal Louisiana and similar parts of eastern Texas.

2.2 Model Summary

As explained in the CWPPRA WVA Methodology Introduction (USFWS 2006a):

The WVA operates under the assumption that optimal conditions for fish and wildlife habitat within a given coastal 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. Each model consists of 1) a list of variables that are considered important in characterizing fish and wildlife habitat, 2) a Suitability Index 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 Indices for each of the component variables into a single value for habitat quality; that single value is referred to as the HSI. The output of each model (the HSI) is assumed to have a linear relationship with the suitability of coastal ecosystems in providing fish and wildlife habitat.

HSI scores are multiplied by the area of the selected habitat to derive Habitat Units then annualized over the project life to obtain Average Annual Habitat Units or AAHUs. Each WVA model contains habitat variables which are assumed to reflect habitat quality and ability to support a diverse wildlife community.

The CWPPRA WVA Methodology Introduction also explains (USFWS 2006a):

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 common fish and wildlife species utilizing a given habitat type. Earlier attempts to capture other wetland functions and values such as storm-surge protection, flood water storage, water quality functions, and nutrient import/export were abandoned due to the difficulty in defining unified model relationships and meaningful model outputs for such a variety of wetland benefits. However, the ability of a Louisiana coastal wetland to provide those functions and values may be generally assumed to be positively correlated with fish and wildlife habitat quality as predicted through the WVA.

Project evaluations involve data collection to determine baseline habitat conditions, and prediction of habitat conditions for FWP and FWOP scenarios.

2.3 Model Components

Habitat variables were selected for the WVA models based on three criteria:

1. The variable had to represent a condition that is important for characterizing fish and wildlife habitat quality in the type of coastal habitat under consideration.
2. Variable values had to be easily estimated and predicted based on existing or readily obtainable data (e.g., aerial photography, habitat classification data, water quality monitoring stations, interviews with knowledgeable individuals, etc.).
3. The variable had to be sensitive to the types of changes expected to occur with typical habitat restoration projects proposed under CWPPRA.

An SI curve was developed for each model to assign the variable a value from 0.1 to 1.0, with 1.0 denoting the highest quality for a variable.

Coastal Marsh Community Models

Three types of coastal marsh communities were modeled: fresh-intermediate, brackish, and saline marshes. The variables selected for characterizing fish and wildlife habitat quality were based on species-specific HSI models for species known to occur in Louisiana coastal habitats. As discussed in the Coastal Marsh Community Models documentation (USFWS 2007), each of the models contains six variables, which are summarized below using excerpts from the documentation.

$V_1$ – Percent of wetland area covered by emergent vegetation. Persistent emergent vegetation plays an important role in coastal wetlands by providing foraging, resting, and breeding habitat for a variety of fish and wildlife species. It also provides a source of detritus and energy for lower trophic level organisms that form the basis of the food chain. An area with no emergent vegetation (i.e., shallow open water) is assumed to have minimal habitat suitability in terms of this variable, and is assigned an SI of 0.1. Optimal vegetative coverage is assumed to occur at 100 percent (SI=1.0). That assumption is dictated primarily by the constraint of not having graph relationships conflict with the CWPPRA's purpose of long-term creation, restoration, protection, or enhancement of vegetated wetlands. Biologically optimal habitat conditions occur at marsh cover values between 60 and 80 percent, and sub-optimal habitat conditions outside that range.
$V_2$ – Percent open water area covered by aquatic vegetation. Fresh and intermediate marshes often support diverse communities of floating-leaved and submerged aquatic plants that provide important food and cover to a wide variety of fish and wildlife species. A fresh/intermediate open water area with no aquatic vegetation is assumed to have low suitability (SI=0.1). Optimal conditions (SI=1.0) are assumed to occur when 100 percent of the open water is dominated by aquatic vegetation. Again, that assumption is dictated by CWPPRA’s purpose of long-term creation, restoration, protection, or enhancement of vegetated wetlands. Biologically optimal conditions actually occur at a lower percent cover, and habitat suitability declines as coverage nears 100 percent because of the potential for mats of aquatic vegetation to hinder fish and wildlife utilization, adversely affect water quality by reducing photosynthesis by phytoplankton and other plant forms due to shading, and contribute to oxygen depletion spurred by warm-season decay of large quantities of aquatic vegetation.

$V_3$ – Marsh edge and interspersion. This variable accounts for the relative juxtaposition of marsh and open water for a given marsh:open water ratio, and is measured by comparing the project area to sample illustrations in the model documentation depicting different degrees of interspersion. Interspersion is assumed to be especially important to the suitability of an area as foraging and nursery habitat for freshwater and estuarine fish and shellfish. The marsh/open water interface represents an ecotone where prey species often concentrate, and where post-larval and juvenile organisms can find cover. Isolated marsh ponds are often more productive in terms of aquatic vegetation than are larger ponds due to decreased turbidity, and, thus, may provide more suitable waterfowl habitat.

A relatively high degree of interspersion in the form of stream courses and tidal channels (Interspersion Class 1) is assumed to be optimal (SI=1.0). Areas exhibiting a high degree of marsh cover are also ranked as optimal, even though interspersion may be low, to avoid conflicts with the premises underlying the SI graph for variable $V_1$ and prevent areas of relatively healthy, solid marsh, or projects designed to create marsh, from being penalized with respect to interspersion. Numerous small marsh ponds (Interspersion Class 2) offer a high degree of interspersion, but are also usually indicative of the beginnings of marsh break-up and degradation. Interspersion Class 2 is therefore assigned a more moderate SI of 0.6. Large ponds and other open water areas with little surrounding marsh (Interspersion Classes 3 and 4) offer lower interspersion values and usually indicate advanced stages of marsh loss. These are assigned SIs of 0.4 and 0.2, respectively. The lowest expression of Interspersion Class 5, characterized by very small marsh islands and less then 5% emergent marsh or areas made up entirely of open water, has the lowest value and is assigned an SI=0.1.

$V_4$ - Percent of open water area $\leq$ 1.5 feet deep in relation to marsh surface. Shallow water areas are assumed to be more biologically productive than deeper water because there is a reduction in sunlight, oxygen, and temperature with increasing water depth. Shallower water also provides greater bottom accessibility for foraging for some species of waterfowl and wading birds. Some deeper water is desirable because it provides drought a refuge for fish, alligators and other marsh life.
The SI curves for this variable differ slightly between the models. Optimal open water conditions in a fresh/intermediate marsh are assumed to occur when 80 to 90 percent of the open water area is less than or equal to 1.5 feet deep. An SI of 0.6 is assigned to areas where all of the open water is less than or equal to 1.5 feet deep. Because brackish marsh generally exhibits deeper open water areas than fresh marsh due to tidal scouring, the SI graph is constructed with lower percentages of shallow water receiving higher SI values, and optimal open water conditions are assumed to occur when 70 to 80 percent of the open water area is less than or equal to 1.5 feet deep. The SI graph for the Saline Marsh Community Model is similar to that for brackish marsh, where optimal conditions are assumed to occur when 70 to 80 percent of the open water area is less than or equal to 1.5 feet deep. However, at 100 percent shallow water, the saline graph yields an SI= 0.5 rather than 0.6 as for the brackish and fresh-intermediate models. The model documents state that this “reflects the increased abundance of tidal channels and generally deeper water conditions prevailing in a saline marsh due to increased tidal influences, and the importance of those tidal channels to estuarine organisms” (USFWS 2007).

V5 - Salinity. The SI curves for the salinity variable also vary between different coastal marsh habitats. “It is assumed that periods of high salinity are most detrimental in a fresh/intermediate marsh when they occur during the growing season (defined as March through November, based on dates of first and last frost contained in Natural Resource Conservation Service soil surveys for coastal Louisiana)” (USFWS 2007). For this reason, mean salinity during the growing season is used as the salinity parameter for the Fresh/Intermediate Marsh Community Model. Conditions in a fresh marsh are assumed to be optimal when mean salinity during the growing season is 0.5 parts per thousand (ppt) or less. Optimal conditions in intermediate marsh are assumed to occur when mean salinity during the growing season is 2.5 ppt or less.

The average annual salinity is used as the salinity parameter for the Brackish and Saline Marsh Community Models. For a brackish marsh, optimal conditions are assumed to occur when salinities are between 0 ppt and 10 ppt, even though the EnvWG acknowledges that average annual salinities below 5 ppt will effectively define a marsh as fresh or intermediate, not brackish. The SI graph makes allowances for lower salinities to account for occasions when there is a trend of decreasing salinities through time toward a more intermediate condition, assuming that lower salinities are not detrimental to a brackish marsh. Average annual salinities greater than 10 ppt are assumed to be progressively more harmful to brackish marsh vegetation. Average annual salinities greater than 16 ppt are not considered in the Brackish Marsh Community Model and are considered to represent saline conditions.

For the Saline Marsh Community Model, optimal salinity conditions are assumed to occur between 0 ppt and 21 ppt, even though average annual salinities below 10 ppt will effectively define a marsh as brackish, not saline. As with the SI curve for a brackish marsh, the Suitability Index (SI) graph makes allowances for lower salinities to account for occasions when there is a trend of decreasing salinities through time toward a more brackish condition, assuming that lower salinities are not detrimental to a saline marsh. Average annual salinities greater than 21 ppt are assumed to be slightly stressful to saline marsh vegetation.

V6 - Aquatic organism access. Access by aquatic organisms such as fish and shellfish is considered to be a critical component in assessing the quality of a given marsh system. Marshes
with a relatively high degree of access also exhibit a relatively high degree of hydrologic connectivity with adjacent systems and may contribute more to nutrient exchange than marshes exhibiting a lesser degree of access. The SI for $V_6$ is determined based on two things: 1) the interaction between the percentage of the project area wetlands considered to be accessible by aquatic organisms during normal tidal fluctuations and 2) the type of man-made structures (if any) across identified points of ingress/egress (bayous, canals, etc.). Access ratings for man-made structures were determined by consensus among EnvWG members as support from scientific research was not identified. Optimal conditions (SI=1.0) are assumed to exist when all of the study area is accessible and the access points are entirely open and unobstructed.

Regarding habitats with limited access, “A fresh marsh with no access is assigned an SI=0.3, reflecting the assumption that, while fresh marshes are important to some species of estuarine-dependent fishes and shellfish, such a marsh lacking access continues to provide benefits to a wide variety of other wildlife and fish species, and is not without habitat value. An intermediate marsh with no access is assigned an SI=0.2, reflecting that intermediate marshes are somewhat more important to estuarine-dependent organisms than fresh marshes” (USFWS 2007). Because brackish marshes are assumed to be important habitat for estuarine-dependent fish and shellfish, a brackish marsh providing no access is assigned an SI of 0.1. The SI graph for aquatic organism access in the Saline Marsh Community Model is the same as that in the Brackish Marsh Community Model.

**Barrier Island Community Model**

Barrier islands consist of several different habitats including surf zones, beaches, dunes, supratidal marshes (*i.e.*, swale), intertidal marshes, ponds, lagoons, tidal creeks, unvegetated flats, and subtidal habitats. “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” (USFWS 2002a). Seven variables based on the quality of component habitats were selected for the Barrier Island Community Model. The following descriptions of each variable are excerpted from USFWS (2002a).

$V_1$ - Percent of the total subaerial area that is classified as dune habitat. Dune habitat is defined as subaerial habitat $\geq 5$ ft. NAVD88 and includes foredunes, dunes, and reardunes. Although dune habitat occurs at elevations below 5 ft. NAVD88, lower-elevation dunes are more frequently overwashed and ephemeral, which reduces their habitat value. Lower-elevation dunes often consist of vegetation more commonly associated with swale habitat and lack a high percentage of atypical dune species.

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 visual estimates of habitat distribution on the islands, and 3) field knowledge of the model developers.

$V_2$ - Percent of the total subaerial area that is classified as supratidal habitat. 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.
As with $V_1$, SI 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 visual estimates of habitat distribution on the islands, and 3) field knowledge of the model developers.

$V_3$ - Percent of the total subaerial area that is classified as intertidal habitat. Intertidal habitat occurs from 0.0 ft. NAVD88 to 1.9 ft. NAVD88, and includes intertidal marshes, mudflats, beaches, and any other habitats within that elevation range on the gulfside and bayside of the barrier island.

Again, SI 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 visual estimates of habitat distribution on the islands, and 3) field knowledge of the model developers.

$V_4$ - Percent vegetative cover of dune, supratidal, and intertidal habitats. Suitability Index graph relationships for this variable were determined by: 1) reviewing vegetative cover transects of existing barrier islands along the Louisiana coast, 2) field investigations which provided visual estimates of vegetative cover, and 3) field knowledge of the model developers.

$V_5$ - Percent vegetative cover by woody species. This variable is intended to capture the habitat value of areas vegetated by woody species and is defined as the percent of the subaerial vegetated area consisting of at least two woody species. The SI is divided by two for islands with only one woody species.

The SI graph for this variable was described as being based on the best professional judgment and personal field knowledge of those involved in model development. The EnvWG agreed that cover by woody species should be a small percentage (10% to 20%) of the vegetative cover on an island.

$V_6$ - 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 provided in the documentation for the Barrier Island Community Model 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. However, interspersion can also be indicative of degradation of back-barrier marshes from subsidence.

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 interspersion is characterized by 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 result in 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 and 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). The lowest degree of interspersion, Class 5, consists of no emergent, intertidal land and is assumed to be of lowest quality (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.

\[ V_7 \] - Beach/surf zone features. This variable is intended to capture the habitat value of the beach/surf zone, and the SI 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 SI value for each beach zone feature was based on the best professional judgment and field knowledge of the model developers.

**Barrier Headland Community Model**

The SI values assigned to barrier island variables are not relevant for barrier headland communities. Therefore, a separate model with the same variables but with different SI classifications was developed for assessing changes in barrier headland communities. The five most important variables for barrier headland and SI curve values are presented in the CWPPRA WVA Methodology Coastal Headland Community Model documentation (USFWS 2002b) and excerpted below.

\[ V_1 \] - Percent of the total project area that is classified as dune habitat. Dune habitat is defined as subaerial habitat \( \geq 5 \) ft. NAVD88 and includes foredune, dune, and reardune habitat. Although dune habitat occurs at elevations below 5 ft. NAVD88, lower-elevation dunes are more frequently overwashed and ephemeral, reducing 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.

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 estimates of habitat distribution on the islands, and 3) field knowledge of the model developers.
\( V_2 \) - Percent of the total project area that is classified as supratidal habitat. 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.

As with \( V_1 \), SI 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 visual estimates of habitat distribution on the islands, and 3) field knowledge of the model developers.

\( V_3 \) - Percent vegetative cover of dune and supratidal habitats. Again, SI graph relationships for this variable were determined by: 1) reviewing vegetative cover transects of existing barrier islands along the Louisiana coast for common dune and supratidal species, 2) field investigations which provided visual estimates of vegetative cover, and 3) field knowledge of the model developers.

\( V_4 \) - Percent vegetative cover by woody species. This variable is intended to capture the habitat value of areas vegetated by woody species and is defined as the percent of the subaerial vegetated area consisting of at least two woody species. The SI is divided by two for islands with only one woody species. The SI graph for this variable was described as being based on the best professional judgment and personal field knowledge of the model developers.

\( V_5 \) - Beach/surf zone features. This variable is intended to capture the habitat value of the beach/surf zone, and the SI 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 SI value for each beach zone feature was based on the best professional judgment and field knowledge of the model developers.

**Swamp Community Model**

The CWPPRA Swamp Community Model evolved from the Louisiana Department of Natural Resources (LDNR) Swamp Community Model. After using the LDNR model for several years, the USFWS EnvWG determined that several of the model variables were not being impacted and concluded that model sensitivity and project benefits were being compromised. Therefore, the apparently non-responsive variables were eliminated for the CWPPRA version of the model. Four variables remained after the model was modified, and these are described in the CWPPRA WVA Swamp Community Model documentation (USFWS 2008) and excerpted below.

\( V_1 \) - Stand structure. The most limiting factor to wildlife species that utilize tupelo-cypress swamps is the presence of a varied stand structure to provide resting, foraging, breeding, nesting, and nursery habitat and the medium for invertebrate production. This medium can exist as herbaceous vegetation, scrub-shrub/midstory cover, or overstory canopy, and optimal habitat contains a combination of all three. This variable assigns the lowest suitability to sites with a limited amount of all three stand structure components, the highest suitability to sites with a significant amount of all three stand structure components, and mid-range suitability to various combinations when one or two stand structure components are present.
V₂ - Stand maturity. “Because of man's historical conversion of swamp, the loss of swamp to saltwater intrusion, historical and ongoing timber harvesting, and a reduced tree growth rate in the subsiding coastal zone, swamps with mature sizeable trees are a unique but ecologically important feature. Older trees provide important wildlife requisites such as snags and nesting cavities and the medium for invertebrate production. Additionally, as the stronger trees establish themselves in the canopy, weaker trees are out-competed and eventually die, forming additional snags and downed treetops that would not be present in younger stands” (USFWS 2008).

The SI graph for this variable assumes that snags, cavities, downed treetops, and invertebrate production are present in suitable amounts when the average diameter-at-breast height (DBH) of canopy-dominant and canopy-codominant trees is above 16 inches for baldcypress and above 12 inches for tupelogum and other species, and stands with those characteristics are considered optimal for this variable (SI = 1.0). Another important consideration for this variable is stand density, measured in terms of basal area, as it reflects the number of trees available for nesting, foraging, and other habitat functions.

V₃ - Water regime. This variable considers the duration and amount of water flow/exchange during flooding. The optimal water regime is assumed to be seasonal flooding with abundant and consistent riverine/tidal input and water flow-through (SI=1.0). Seasonal flooding with periodic drying cycles is assumed to contribute to increased nutrient cycling (primarily through oxidation and decomposition of accumulated detritus), increased vertical structure complexity (due to growth of other plants on the swamp floor), and increased recruitment of dominant overstory trees. Furthermore, the full functions of a swamp in providing fish and wildlife habitat are assumed to be maximized. Temporary flooding is also assumed to be desirable; however, habitat suitability is assumed to decrease as water exchange between the swamp and adjacent systems is reduced. The combination of permanently flooded conditions and no water exchange is assumed to be the least desirable (SI=0.1), as those conditions can produce poor water quality during warm weather, reducing fish use and crawfish production.

V₄ - Mean high salinity during the growing season. Mean high salinity during the growing season (March 1 to October 31) is defined as the average of the upper 33 percent of salinity measurements taken during the specified period of record. Although bald cypress is able to tolerate higher salinities than other swamp species, species such as tupelogum and many herbaceous species are salinity-sensitive. Optimal conditions are assumed to occur at mean high salinities less than 1.0 ppt, and habitat suitability is assumed to decrease rapidly at mean high salinities in excess of 1.0 ppt.

**Louisiana Department of Natural Resources Fresh Swamp Community Model**

This is the original Swamp Community Model developed by LDNR (LDNR 1994). The six variables selected for this model are those that were believed to be the most important for characterizing fish and wildlife habitat quality of Louisiana freshwater swamps. The descriptions of these variables are excerpted below.

V₁ – Stand Structure. This variable is the same as that described for the CWPPRA WVA Swamp Model described above.
**V₂ – Stand Maturity.** This variable is also the same as that described for the CWPPRA WVA Swamp Model described above.

**V₃ – Hydrology.** The primary assumption for this variable was that a natural flooding regime with seasonal flooding or semi-permanent flooding is optimal (SI=1.0). Permanent flooding with a high degree of water exchange is optimal for fish spawning and nursery habitat, but is only of moderate value to wildlife, and an SI of 0.8 was assigned to such conditions. Permanently flooded habitat with limited water exchange produces low quality conditions during warm weather and was assigned an SI of 0.4. This is one of the variables that was determined to be insensitive to with-project and without-project projections and was eliminated from the CWPPRA Swamp Community Model.

**V₄ – Size of Contiguous Forested Area.** Because larger forested areas are less common and afford habitat for species that are considered to be “specialists,” larger forested tracts are considered to have greater ecological value. Forested areas greater than greater than 500 acres in size were considered to be optimal. Again, this is one of the variables that was determined to be insensitive to with-project and without-project projections and was eliminated from the CWPPRA Swamp Community Model.

**V₅ – Suitability and Traversability of Surrounding Land Uses.** Because many wildlife species that inhabit fresh swamps will commonly use adjacent areas for temporary refuge, resting cover or foraging, adjacent land uses that afford wildlife movement between adjacent swamp patches are more desirable. Because planning projects typical protect, mitigate or restore wetlands, this variable was determined to be insensitive to with-project and without-project projections and was eliminated from the CWPPRA Swamp Community Model, as stated above.

**V₆ – Disturbance.** Human-induces disturbances can displace individuals, modify wildlife home ranges, impact reproduction, and cause stress in animal populations. The effect of disturbance is a factor of the type of disturbance and distance from the disturbance. Human disturbance was considered to be “insignificant” if the disturbance was greater than 500 feet from the habitat (SI=1.0). An SI of 0.01 was assigned when the disturbance was within 50 feet of the site and “constant or major.” This variable was also eliminated from the CWPPRA WVA Swamp Community Model, as stated above.

**Coastal Chenier/Ridge Community Model**

Songbird breeding habitat quality was the focus for the Coastal Chenier/Ridge Community Model variables. Three variables were selected for this model as described in the CWPPRA WVA Coastal Chenier/Ridge Community Model (USFWS 2002c) and excerpted below.

**V₁ – Percent tree canopy cover.** Neotropical migratory landbirds preferentially use stopover sites exhibiting high structural and floristic diversity (Moore et al.1995 as cited in USFWS 2002c). To achieve the desired vertical plant diversity (i.e., a mix of trees, tree saplings, shrubs, vines, and herbaceous plants), a moderately closed tree canopy would be preferred to over a totally closed canopy (Hunter, pers. comm.; Barrow, pers. comm.; Woodrey, pers. comm. as cited in USFWS
2002c). Tree canopy coverage ranging from 65 - 85% is assumed to provide optimal conditions to allow for establishment of midstory trees, shrubs, vines, and herbaceous plants, provided that the site is not grazed.

\( V_2 \) – Percent shrub/midstory cover. Shrub-scrub habitats provide important foraging and resting areas for migrant landbirds (Moore et al. 1995 as cited in USFWS 2002c), and shrub-scrub habitats are presumed to be important to migratory passerine birds as refuges from raptor predators (Moore et al. 1990 as cited in USFWS 2002c). Shrub/midstory canopy coverage ranging from 35 - 65% is assumed to represent optimal conditions (SI=1.0).

\( V_3 \) – Native woody species diversity. A wide variety of fruits, flowers, nectars, and animals, primarily invertebrates, are consumed by migrant landbirds (Moore et al. 1995, Fontenot 1999, Barrow, pers. comm. as cited in USFWS 2002c). Vegetation provides birds with foraging opportunities and constraints depending upon the structure of individual plants, aggregations of plants, and the arthropods that these plants host (Robinson and Holmes 1984 as cited in USFWS 2002c), and the resulting foraging conditions define the diversity of bird species in the habitat. It is assumed that a variety of native shrubs, midstory trees, woody vines and overstory trees will provide sufficiently diverse foraging and resting habitat to enable spring and fall transient birds to continue their migration. However, it is assumed that the presence of \( \exists >10 \) species of native trees, shrubs, and woody vines is assumed to represent optimal conditions. It is also assumed that the parameters defining optimal conditions for variables \( V_1 \) and \( V_2 \) will moderate the potential for variable \( V_3 \) to exert a false reading of habitat value for migrant landbirds, should the diversity of plant species be confined only to trees, shrubs, or woody vines.

Although many of the same variables occur throughout the WVA models, the SI value assigned to the variables will vary because optimal habitat conditions vary between habitats. The importance of variables also varies between habitats.
This page intentionally left blank
3.0 MODEL EVALUATION

USACE requires that planning models be reviewed and certified. The purpose of the review is to evaluate the technical quality, system quality, and usability of the planning models. The results of the model review will be used by USACE to determine whether to certify the model for inclusion in the toolbox of USACE planning models. The ECO-PCX conducted an Intermediate Level review of these regional models based on their anticipated wide use for projects under LCA authority and in applicable areas in Texas. As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering external peer review panels for USACE, Battelle was engaged to conduct the model quality assurance review for the WVA models.

3.1 Model Review Approach

Independent, objective peer review is regarded as a critical element in ensuring technical quality, system quality, and usability of the models. Details of the review process and charge guidance are provided in the Final Work Plan for the Model Review for the Wetland Value Assessment Models (Attachment A). The review consisted of nine tasks, including:

Task 1 – Participate in Kick-off Meeting (three teleconference meetings)
Task 2 – Prepare Work Plan
Task 3 – Prepare and Finalize Charge to Model Reviewers
Task 4 – Identify Candidate Model Reviewers and Select and Finalize Contracts with Candidate Model Reviewers
Task 5 – Conduct Model Assessment
Task 6 – Meeting to Discuss Findings
Task 7 – Prepare Draft Report for Model Review
Task 8 – Meeting to Discuss Model Review Findings
Task 9 – Prepare Final Report for Model Review

Battelle participated in a teleconference meeting with USACE Headquarters Civil Works (CECW) representatives, representatives from the USACE ECO-PCX, and the Model Proponents (Task 1). The purpose of the meeting was to brief Battelle on the USACE’s specific goals and objectives for the model review. Battelle prepared a draft and final work plan, which included charge questions and guidance to the external peer review panel, based on the goals and objectives discussed as well as the USACE Statement of Work (SOW) (Tasks 2 and 3).

To accomplish the model quality assurance review, Battelle selected six subject matter experts (i.e., peer reviewers) based on background, years of experience, and lack of actual or perceived conflicts of interest (COI) (Task 4). These experts were approved by the USACE ECO-PCX (Task 4). The peer review panel included:

- A HEP expert with experience conducting ecosystem output evaluations,
- A planning expert with experience in evaluating and comparing alternative plans for ecosystem restoration,
• A hydraulic engineer with engineering experience related to ecosystem restoration in coastal areas,
• A coastal wetlands ecologist with regional experience
• A coastal ecosystems ecologist with regional experience, and,
• A software programming and spreadsheet auditing expert with experience auditing, testing and debugging spreadsheets.

Information on the experts selected for the peer review panel is summarized in Table 1, and a short biography for each panel member is provided in Appendix A.

Table 1. Experts Selected for the WVA Model Review Panel

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Location</th>
<th>Education</th>
<th>PE</th>
<th>Exp (yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat Evaluation Procedures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dean Stauffer</td>
<td>Virginia Tech</td>
<td>VA</td>
<td>Ph.D., forestry, wildlife, &amp; range science</td>
<td></td>
<td>34</td>
</tr>
<tr>
<td>Planner</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Samuel Brody</td>
<td>Texas A&amp;M</td>
<td>TX</td>
<td>Ph.D., environmental planning</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Hydraulic Engineer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Billy Edge</td>
<td>Texas A&amp;M</td>
<td>TX</td>
<td>Ph.D., civil engineering</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>Ecologist, Coastal Wetlands</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daniel Childers</td>
<td>Arizona State Univ.</td>
<td>AZ</td>
<td>Ph.D., marine science</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Ecologist, Coastal Ecosystems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>James Webb</td>
<td>Independent</td>
<td>TX</td>
<td>Ph.D., range science</td>
<td></td>
<td>37</td>
</tr>
<tr>
<td>Software Programmer/Spreadsheet Auditor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raymond Panko</td>
<td>University of Hawaii</td>
<td>HI</td>
<td>Ph.D., communication</td>
<td></td>
<td>29</td>
</tr>
</tbody>
</table>

*PE = Professional Engineer

After the peer reviewers were under subcontract, Battelle conducted a kick-off teleconference to brief the peer review panel on the purpose and approach for the review process. Another kick-off teleconference was convened with Battelle, the peer reviewers, ECO-PCX, and the model developers to provide the peer reviewers an opportunity to be briefed specifically on the models and to ask questions directly of USACE. The peer reviewers were provided with electronic versions of the review documents, along with guidance and a charge that solicited their comments on specific aspects of the documents that were to be reviewed.
The following documents and reference materials (files names are provided in italics) were provided to the peer reviewers for the review. Most of the documents contained CWPPRA WVA Methodology information, including:

1. Introduction (wva_methodology_intro_3-7-06.doc_032708_wpk.pdf)
2. WVA Methodology Procedural Manual (WVA Procedural Manual 3-7-06032708.pdf)
3. Emergent Marsh (Saline Marsh) Community Model (marsh_models__fresh-intermediate__brackish_saline__1-22-07.pdf and saline_marsh_wva_model_spreadsheet_revised_1-22-07.xls)
4. Fresh-Intermediate Marsh Community Model (marsh_models__fresh-intermediate__brackish_saline__1-22-07.pdf and fresh-int_wva_model__spreadsheet_revised_1-22-07.xls)
5. Brackish Community Model (marsh_models__fresh-intermediate__brackish_saline__1-22-07.pdf and brackish_marsh_wva_model_spreadsheet_revised_1-22-07.xls)
6. Barrier Island Community Model (barrier_island_model.pdf and barrier_island_wva_model_spreadsheet.xls)
7. Barrier Headland Community Model (barrier_headland_model.pdf and barrier_headland_wva_model_spreadsheet.xls)
8. Swamp Community Model (Two models are being reviewed – the original model developed by LDNR and the modified CWPPRA model. Information for the original LDNR swamp models are in bottomland_hardwoods_model.pdf and LDNR Swamp WVA Model 8-5-08.xls. Information for the CWPPRA restoration models are in Swamp Model 6-1-08.pdf and Swamp WVA model 7-31-08.XLS.)
10. Forested Coastal Ridge (Coastal Chenier) Community Model (Coastal Chenier Model 8-1-02.pdf and coastal_chenier_wva_model_spreadsheet.xls)

Peer reviewers were asked to review the documentation for the WVA models and supporting worksheets. The following additional documents were provided for reference only and were not to be reviewed (file names are in italics):

1. Draft Engineering Reports for Barataria Basin Barrier Shoreline Restoration:
   b. Caminada Headland Reach (caminada_description_of_alternatives.pdf)
   c. Sabine-Neches (snww_deis_appendices_c-i.pdf)
2. Ecological Modeling Reports for Barataria Basin Barrier Shoreline Restoration:
   d. Shell Island (ecological_modeling_report_for_shell_island_wva_pis.pdf)
   e. Caminada Headland (ecological_modeling_report_for_caminada_wva_pis.pdf)
3. WVA Excel worksheets and land loss spreadsheets for Barataria Basin Shoreline Restoration:
   f. Shell Island Reach (shell_island_wva_analysis_march_2008_032808.xls and shell_island_wva_acreage_summary_2-13-08_032808.xls)


The peer reviewers were asked to review the models and their documentation using guidance and charge questions provided to them. There was no communication between the peer review panel and the model developers during the peer review process. The guidance and charge questions are based on the model assessment criteria discussed in the USACE Protocols for Certification of Planning Models (July 2007). The intent of these questions was to focus the review on the assessment criteria that are critical for the certification of planning models. The process and evaluation criteria for the review are outlined in the Protocols for Certification of Planning Models (USACE 2007) and described in Section 1.2 Model Assessment of this report.

Charge questions were provided to the model review panel in Individual Charge Response Forms to be used by the peer reviewers during their review. Following the panel members’ individual reviews of the WVA models, Individual Charge Response Forms were compiled into a Merged Charge Response Form that contained all of the peer review comments. Approximately 600 individual comments were received.

A panel review teleconference was conducted to discuss key technical comments identified in the Merged Charge Response Form, conflicting comments, and reach agreement on the key findings of the review to be provided to USACE in the Model Review Report. At the conclusion of the teleconference meeting, 22 Final Panel Comments had been developed which identify and discuss the key issues with the models and model documents and present recommendations for resolution. The peer reviewers were also assigned the responsibilities of drafting specific sections of the Model Review Report. The results and conclusions of the peer review are discussed in Sections 3.3 through 4.0 of this report. Final Panel Comments are provided in Appendix B. These Final Panel Comments were taken into consideration for revising the WVA models for application.
3.2 Assessment Criteria

In accordance with the Planning Models Improvement Program: Model Certification (EC 1105-2-407, May 2005), the WVA models were subjected to an independent external peer review. The review was conducted based on guidance in the USACE Protocols for Certification of Planning Models (July 2007). The WVA method is the same as the USFWS HEP method; however, an assessment of the HEP methods was not conducted as part of this review. The current review focused on an assessment of the application of WVA/HEP to the WVA models. As required by USACE (Protocols for the Certification of Planning Models, July 2007), the models were reviewed and assessed for technical quality, system quality, and usability. The review of these three criteria is described in the following sections.

3.2.1 Technical Quality

Analytical tools, including models, used for planning purposes need to be technically sound and based on widely accepted contemporary scientific theory. The study area, and how it responds to the influences that act upon it, must be realistically represented by the components of the models. The architecture of the model calculations must reflect how the system is expected to respond to changes in measured variables based on the application of scientific theory. Formulas and calculation routines that form the mechanics of the models must be accurate and correctly applied, with sound relationships among variables. The models should be able to reflect natural changes as well as the influence of anthropogenic laws, policies and practices. All model assumptions must be valid and should be well-documented. The analytical requirements of the models must be identified, and the model must address these requirements. The models should also produce robust, reproducible results that stand up to the rigorous scrutiny in later stages of the plan formulation process.

3.2.2 System Quality

System quality refers to the quality of the entire system used to develop, use, and support the models, including the software and hardware platform. System quality is assessed by testing the hardware and software components, design verification planning for customer acceptance, third party interoperability, compatibility with various hardware and operating systems such as USB, Windows, and Macintosh, and the development of problem-tracking database. Most of this is done through USACE internal review and tracking. However, some criteria can be evaluated by external peer reviewers. In general, peer review evaluation of system quality can include assessing whether supporting software tools/programming language are appropriate for the models, programming is done correctly, software and hardware are available, the models have been tested and validated, and data can be readily imported into other software analysis tools (if applicable).

In this case, the peer reviewers were not asked to assess software for the models because the models are spreadsheet based. Therefore, the peer reviewers were provided with spreadsheets containing each of the WVA models. The review of the spreadsheets included model testing and validation.
3.2.3 Usability

Usability refers to how easily model users can access and run the models, interpret the model output, and use the model output to support planning decisions. An assessment of model usability includes evaluating the availability of data required to run the models and the ability of the user to learn how to use the model properly and effectively. Model outputs must also be easy to interpret, useful for supporting the purpose of the models, easy to export to project reports, and sufficiently transparent to allow for easy verification of calculations and outputs.

3.3 Approach to Model Testing

Although the peer reviewers were not tasked with testing the use of the WVA models, limited testing was performed by applying the models to sensible and non-sensible test data (i.e., both realistic and impossible variable measures). The testing approach and results are discussed in Section 3.4.3 of this report, as well as in Final Panel Comments 11 through 14 (Appendix B). The peer reviewers’ assessment also included a review of the information available in the model documentation and associated spreadsheets.

3.4 Technical Quality Assessment

The technical quality assessment was based on an assessment of the criteria described in Section 3.1.1. Without knowing all of the relevant USACE policies and procedures, the peer reviewers were unable to determine whether the models properly incorporate USACE policies and procedures. The results of the peer reviewers’ assessment of the other criteria are summarized in the following sections.

3.4.1 Review of Theory and External Model Components

Model certification requires that each model is “based on well-established contemporary theory” (USACE Protocols for Certification of Planning Models, July 2007). Contemporary theory may be based on professional judgment, literature reviews, and/or current and previous research. For the most part, the WVA/HEP method has theoretical underpinnings, as do the HSI models that form the basis of the evaluations. However, in most cases, the underlying theory and assumptions of the method and the models are implied and not explicitly presented.

The HEP approach and HSI models have been well-developed over the years, and have a solid theoretical basis (USFWS 1980). It is generally accepted that when the relationship between an animal population (or community) and its habitat requirements is understood, it is possible to develop models that represent this relationship. The HSI models are developed to represent this relationship in a basic way, recognizing that models are a representation of reality and that the approach is a somewhat simple summary of a complex ecological interaction. The HSI models are not intended to be a complete and in-depth representation of how an animal (or community) relates to its habitat. Rather, the intent is to develop a tool that captures the essence of the relationship and can be used to guide planning and management.

Ideally, HSI models are based on a thorough synthesis of all of the best available data from scientific literature and other sources. The individual variables selected for the HSI model are depicted as SI curves, histograms, or other functional forms to represent habitat quality based on that single variable. Suitability indices are combined to reflect the overall suitability (HSI) based
on field data. Development of the SI relationships and aggregation equations should be documented as completely as possible.

The panel found that the theoretical development of each model was weak and generally not well-documented from the literature or other sources. Most models indicated that the selected variables and SI curves came from “published and unpublished data and studies, consultation with other professionals and researchers outside the EnvWG, and personal knowledge of EnvWG members.” While it is assumed that these individuals are knowledgeable and used appropriate literature and data sources, with the exception of the Coastal Chenier/Ridge Community Model little documentation is provided to support the SI curves and rationale for combining the variables. The models would be enhanced substantially by including the basis for variables selected, the SI curves, and aggregation equations used to combine the models to achieve the HSI value for a data set.

Habitat Suitability Index model output can range from 0.0 (no habitat value) to 1.0 (optimal habitat). Theoretically, this output value is linked to or represents some characteristic of the population or community being represented. This is called the performance measure. For a community model, a typical performance measure might be the number of species present or species/guild diversity. Specifying the performance measures allows the user to better understand what response might be expected in the modeled system as suitability increases or declines. All the WVA HSI models reviewed are lacking clear performance measures. For example, the narrative for the marsh models ambiguously states: “These models were designed to function at a community level and therefore attempt to define an optimal combination of habitat conditions for all fish and wildlife species utilizing coastal marsh ecosystems “(USFWS 2007). It is critical that specific performance measures be stated for this and all models. Once the performance measure is defined and stated, users will know what sort of change to expect in the system as the HSI value changes.

The HSI models implemented in the WVA/HEP method will likely be sensitive to external model components to the extent they can be accurately predicted. By necessity, the number of variables implemented to represent community relationships in the models was limited. Environmental parameters external to the models could also be indirectly captured through their influence on the model variables. However, the extent of their influence on habitat quality is not fully represented. For example:

- Sea level rise (SLR) is not specifically addressed in any model. However, simulating SLR in the future can be expected to impact some model variables such as salinity or cover type areas. Hence, potential effects of SLR may be captured by the models, even though it is not an explicit variable.
- Invasive species are not directly modeled, but could have an effect on some variables, including number of plant species present (Coastal Chenier/Ridge Community Model) or the percent cover of vegetation (Barrier Island Community Model).
- Human disturbance is not directly considered in any model, but to the extent the effect of future disturbance can be predicted for a site, the impacts on relevant habitat components (i.e., vegetative cover) may be assessed.
3.4.2 Review of Representation of the System

By definition, models are abstractions of real-world systems and, as such, they are inherently simpler than the ecosystems they represent. While basic ecological conditions are represented in the models, human disturbance factors, which may impact the analysis, are not consistently or thoroughly incorporated into the evaluation process. A project site should not be considered isolated in space; ecological processes are often impacted by adjacent or surrounding human activities. Land use changes (e.g., increased impervious surface area or increased high intensity uses) should be considered when predicting future ecological conditions at the site level. Similarly, larger-scale drivers that are affected by anthropogenic activities (e.g., climate change, SLR, change in storm frequency/intensity, change in river sediment loads, etc.) should be considered in these models.

It is unclear why some of the WVA models consider human impacts (e.g., Barrier Headland and Fresh Swamp Community Models) while others do not. Projects may be implemented in areas expecting human population growth and development within a twenty-year time horizon that will affect ecological conditions within the project area. Consistent and detailed protocols should be established to effectively incorporate human impacts into the WVA models, and this should be described and justified in the model documentation.

A specific and important (potential) shortcoming in terms of the ability of the model to realistically represent the actual system is the absence of SLR as a variable. To the extent that we can predict SLR, this phenomenon should be factored into the model computations as a potential impact on the quantity and quality of coastal habitat during target years. This is particularly important in Louisiana coastal habitats where: 1) relative SLR (defined as eustatic SLR plus soil elevation changes associated with subsidence, compaction, etc.) is often an order of magnitude greater than eustatic SLR; 2) the flat topography makes coastal habitats vulnerable to small increments of SLR; and, 3) storm impacts often compound the effects of SLR.

Current USACE plan formulation and evaluation policy (USACE 2000) requires SLR effects to be incorporated into the analytical techniques used to support planning recommendations and decisions for every USACE coastal study. Sea level changes can be addressed externally or internally to planning models. The WVA models were not designed to assess the ecological implications of SLR for coastal habitats. Simulating the effects of SLR would be possible but would require that the model user make an a priori assessment of how each of the model variables would be affected by a change in the surge levels. All of the projected measurements for variables in the model would have to be altered, which is problematic because of the large uncertainty as to how each variable may change.

To effectively determine whether the models effectively represent the systems being model, geographic boundaries of the ecosystems being modeled need to be clearly defined. Because models are abstractions of reality, when modeling ecosystems it must be clear what natural systems are being abstracted. Rarely are ecosystem-scale models general enough to be applied to a broad geographic variety of systems. The geographic boundaries of the WVA models reviewed seem somewhat subjective and may be largely based on administrative or political considerations, since only Louisiana and east Texas are included in the geographic range. No maps were used to clearly demarcate the geographic domains of the models. The general model
documentation suggests that many of these WVA models may be applicable in Texas but documentation for many of the specific models generally referred only to Louisiana. A lack of clarity about the geographic domains of the WVA models generates risk in model use if the models are applied to systems for which they are not appropriate.

**Coastal Marsh Community Models**

For V_1 (percent emergent vegetation), it appears that policy rather than science is driving the form of the SI curve. Apparently, a goal of CWPPRA is to create wetlands with 100% marsh cover, which is given the SI value of 1.0. However, as the authors acknowledge optimal habitat conditions for most fish and wildlife likely would be achieved with 60%-80% cover. A tidal wetland with 100% vegetative cover is not physically viable, since a dendritic network of tidal creeks is a critical component of these ecosystems for moving water, nutrients, particulates, energy, and organisms through the system with the tides. If this SI curve remains as it is, the model will have no real biological basis, but becomes a tool to evaluate how closely the project is getting to policy objectives rather than biological objectives.

The SI curve for V_2 (percent cover of submerged aquatic vegetation [SAV] in open water) has a design similar to V_1 and is not reasonable at the high end. An SI value of 1.0 only at 100% cover will severely limit the model. Reviewers suggested setting the optimal cover to 70 or 80% makes more biological sense and should be considered.

The forms of the V_1 and V_2 SI curves will make it extremely difficult to generate an HSI of 1.0 for any set of real field data because they only take a value of 1.0 at 100% cover of emergent vegetation (V_1) or SAV (V_2). As these conditions are not likely to occur naturally, this model could never generate an HSI of 1.0 regardless of the SI values for the other variables, and optimal habitat conditions could never be achieved.

Relative to V_3, the term “interspersion” is not clearly defined. This term can have different meanings and interpretations, and the references in this section to an appendix only made it more difficult to fully understand what is meant by the term. Lack of a consistent application of the term could lead to inconsistent inputs to models, resulting in inconsistent outputs.

The marsh model documentation acknowledges the importance of marsh edge, marsh:open water ratios, and interspersion to aquatic habitat quality. Considerable research has been published on how marsh edge:area ratios relate to shrimp use of intertidal marsh; however, this literature was not cited in the model documentation. Given the availability of the research, it is surprising to see that interspersion Class 1, which has little or no marsh edge and very few tidal creeks, was given an SI of 1.0. The justification appears to be that Class 2 is probably a marsh that has deteriorated from a Class 1 status. Intertidal marshes have an inherent drainage dendrology that is related to tidal range and tidal energy. This creek network is essential to the movement of tidal water and its contents (e.g., animals, nutrients, organic matter, etc.) and thus to the functioning of the marsh ecosystem. As a result, interspersion Class 1 may be considered to have a lower SI than Class 2. The authors were aware of and tried to address the problems associated with healthy versus deteriorating marshes; however, marsh deterioration might be better addressed as a separate variable. Also, the photos of interspersion classes (pages 31 and 32)
need to have measurement scales so that model users can properly visualize the distances and areas. It could be argued that Class 3 is optimal for shrimp and juvenile fish production and red fish access because of the large channels and abundant edge habitat whereas Class 1 (which is presently optimal) provides little shrimp and fish habitat, little habitat for wading birds, almost no gull or tern feeding habitat, no waterfowl habitat, and no alligator habitat.

Additional variables might be considered for the marsh models. Potential variables might include the percent of marsh interior that is permanent marsh pond habitat for fish and waterfowl (sometimes greater than 1.5 feet in depth), number or cover of channels, and an index to marsh access. These variables are supposedly covered in marsh edge and interspersion; however, water which may drain daily from shallow marsh open area due to tidal exchange will not support and maintain aquatic vegetation and cannot be used during ebb tides.

**Barrier Island/Headland Community Models**

It would be useful to modify $V_6$ to include some estimate of the percent area impacted by beach and surf features. As the model now stands, the inference is that the total area being evaluated will be impacted by these features.

In the Barrier Headland Community Model, percent cover of subtidal habitat should be separate from supratidal habitat and dunes. The relative cover of dunes also can be indicative of unstable conditions.

For the Barrier Island Community Model it may be reasonable to consider the volume of the dune cross-section which might address the risk associated with coastal hazards. The larger the dune volume, the less the amount of overwash expected and the greater protection for the intertidal and supratidal habitat quality.

**Coastal Chenier/Ridge Community Model**

In the Chenier/Ridge Community Model, the amount of canopy or midstory cover is not accounted for by species. The species diversity variable ($V_3$) is supposed to capture that, but this may not provide a value that really indicates the true habitat value. The occurrence of undesirable species like Chinese tallow may give improper values to habitat. It may be reasonable to modify $V_3$ (species diversity) to reflect the negative effect of invasive species.

Additional features, such as canopy height, herbaceous cover, presence/density of snags, invasive species, and landscape contextual variables, could be considered for inclusion.

### 3.4.3 Review of Analytical Requirements

A general assumption was made that a “Review of Analytical Requirements” refers to the techniques by which data and information are quantified for the WVA model variables and SI relationships. There are no direct statements in the WVA model documents pertaining to analytical requirements of variables in the models. The only guidance given on analytical requirements are the criteria for variable selection stated in the CWPPRA WVA Methodology Introduction (USFWS 2006a). Based on these criteria, the analytical requirements of the models...
are very simple. The criteria are that the values of each variable and projections had to be easily estimated and needed to be based on existing or readily obtainable data. The variables also had to be sensitive to changes caused by the habitat restoration projects. Neither the above criteria nor the information on variable measurements provide any information on analytical stringency of data. The assumption must be made that the data for each variable are reasonable because they are obtained by reliable data collectors and by fundamental scientific techniques.

The peer reviewers are concerned about the lack of prescribed data collection procedures and analytical requirements because, without consistent protocols that are clearly laid out, it may be difficult to replicate measurements and obtain comparable results across multiple sites, particularly with variation in personnel. Nearly all aspects of the models have some level of subjectivity because there are no guidelines to measure and predict to a specified accuracy. The SI curves also appear very subjective, as they seem to have been derived from a compilation of past experiences of the EnvWG committee with CWPPRA and coastal areas rather than precise analytical requirements and a strong scientific basis.

The WVA process often calls for experts to use professional judgments when estimating variables. Relying on such subjective measures could lead to inconsistent, biased, or inaccurate predictions of future habitat conditions and wide variations in model outcomes from one project team to the next. Every effort should be made to provide guidance that will help ensure that the best unbiased and rigorous estimates can be made for each of the input variables. The quality of the output will be improved as a consequence.

3.4.4 Review of Model Assumptions

When considering the assumptions underlying the WVA models it is important to recognize that the method is actually composed of two components. The core of the method is found in the HSI models. Once data have been collected at a project site, the appropriate HSI models are applied and the WVA/HEP process is used to determine initial Habitat Units (HUs) and to project HUs into the future as habitat changes under the with-project and without-project scenarios. The WVA process is the same as HEP. The dichotomy between HEP and WVA, identified in the introduction to the WVA model documents (USFWS 2006a), is a false one. The authors state that community, rather than single-species, models are being applied and that, hence, WVA represents a modified HEP. However, this does not change the application of the procedures in any way. The WVA method as documented and presented is actually HEP with no modification. As such, the assumptions should be the same.

The development and application of HSI models and the application of WVA/HEP both have explicit and implicit assumptions that should be acknowledged and met to the extent possible. The value and utility of the models and assessment approach will be a function of how well the assumptions have been met. In the documents that were reviewed, relatively little attention was given to explicitly stating the assumptions, but in some cases the underlying assumptions may be inferred. The assumptions for the HSI models and WVA/HEP process are reviewed in the following sections.

Habitat Suitability Index Model assumptions
There are a number of assumptions that are associated with HSI models; the WVA models generally did not acknowledge or otherwise address these assumptions. The primary assumptions related to HSI models include:

1. There is a habitat-imposed limitation to wildlife community structure or diversity. An implicit, if not explicit, assumption of any habitat-based model is that habitat conditions have a direct effect upon the entity being modeled, whether an animal population or a community. Thus, it is assumed that community measures such as population size or community diversity are at some level a function of habitat conditions. It is this limitation that allows development of a model using habitat features that assess the potential of an area to support a population or a community.

2. There is a measurable attribute of the population or community that is linked to (and limited by) the habitat features measured (typically referred to as the performance measure). For single species, performance measures are often considered to be some measure of population density or reproductive output on a per-unit-area basis. In a community model, a typical performance measure might be the number of different species or guilds represented at the site being evaluated.

3. Critical components of the habitat that are limiting to the performance measure have been represented in the model. All models are abstractions of reality, and model development typically seeks to balance complexity and realism with simplicity and utility. The HSI models seek to capture the essence of the relationship between critical habitat characteristics and the performance measure. The assumption is that the selected habitat variables are those that best reflect this relationship. It is not possible to include all habitat variables; rather, the expectation is that the variables selected are adequate to represent the relationship and that by applying the model we can make a better and more consistent assessment of habitat quality than we could through expert opinion alone.

4. The association between the performance measure and each individual variable is accurately captured in a SI relationship. Along with selecting the best and most appropriate variables to reflect habitat quality, it is essential that the functional relationship between habitat suitability and an individual variable be clearly and correctly represented. This relationship may be linear, a histogram, a menu of choices, or a user-defined function. When the individual SI curve/relationship is developed, it is critical that justification be given for the shape and position of the curve. This justification should include citations of relevant peer-reviewed scientific literature, data from past research, and (to a limited degree) the actual data used to support the SI curves.

5. The aggregation equations and weightings that are used to integrate the SI values for the variables should integrate and reflect the ecological relationships between the performance measures and suitability values for each of the individual habitat variables. It is important that the integration of the individual SI values be reflective of the ecology of the relationship. The logic and reasoning for how the variables are combined must be clearly explained, and the rationale for any variable weighting should be clearly stated, along with the logic behind the weighting factors selected. These justifications should be supported by the scientific literature and/or data from past research studies.

For the most part, these assumptions have not been explicitly addressed in any of the WVA models. For some variables in some models, the rationale behind the SI curves is described
generally, but only one model (coastal chenier/ridge) included any reference to primary literature or empirical documentation to support the SI curves and aggregation equations that were developed.

It is recommended that these assumptions be explicitly acknowledged in the model narratives. The model documentation would also be greatly improved and better supported with the inclusion of references to the primary literature and data to support the construction of the SI curves, aggregation equations for HSI determination, and weighting factors used in the aggregation equations.

**WVA/HEP Assumptions**

The basic theory and concepts underlying HEP, being equivalent to the WVA/HEP method, have been well developed. The primary assumptions that underlie application of WVA/HEP method are:

1. Habitat value can be represented with an HSI model.
2. Total value of a site to the species/community of concern can be represented by HUs, defined as HSI multiplied by area.
3. Habitat conditions for the relevant HSI variables can be predicted for future time periods for different scenarios, and future HUs can be estimated.
4. AAHU (HU averaged over the time period of analysis) can be estimated for scenarios representing the site without a project/enhancement and with a project/enhancement. Comparison of the AAHUs allows an evaluation of the benefits or losses associated with each scenario.

These theoretical aspects of WVA/HEP are addressed in the WVA Methodology Introduction (USFWS 2006a). When implementing the WVA/HEP method, users must also accept the following assumptions:

1. The HSI models being used for the assessment are correct. This is an implicit assumption that often is not stated. But, when a WVA/HEP is undertaken, the user assumes that the HSI models selected for application are, in fact, scientifically sound and represent the system being abstracted by the model. It is also assumed that the application of WVA/HEP is appropriate for the situation.
2. Empirical data used to establish the baseline conditions (TY0) are accurate and collected appropriately. For data collection to be correct and consistent among different applications, it is critical that clear and concise guidance be provided for collecting data for each of the variables in the field. Doing so will help ensure the consistency and credibility of the WVA/HEP application. The guidance provided in the Procedural Manual for WVA (USFWS 2006b) is inconsistent. In some cases relatively detailed information is provided for variable estimation/sampling (e.g., loss rate calculation for the marsh community models) but in other cases the recommended approach to variable estimation is quite vague (e.g., the description of V2 [Stand Maturity for the Swamp Community Model] states “typically, plots or transects are conducted”. This does not provide much guidance.)
3. Target year selection for projecting future conditions is appropriate. Target years should be selected to reflect when changes are expected to occur in the habitat for the critical variables in the models being applied. The target year recommendations for TY0, 1, and 20 for without-project conditions and TY0, 1, 3, 5, and 20 for with-project conditions are likely inadequate. The underlying assumption is that habitat change is linear between any two selected target years. This likely is not true for a 15- or 19-year time span. As a result, serious consideration should be given to selecting additional target years within the 20 year period of analysis to better reflect habitat changes. Major events (e.g., hurricanes, river floods) should also trigger additional target year sampling to occur the year after the event. However, it is difficult to predict events such as these with accuracy. To accommodate these perturbations, several different scenarios with and without the event at different target years can be simulated and compared.

4. Future habitat conditions can be predicted with some degree of accuracy. The quality and validity of the WVA/HEP results are in large part a function of the accuracy with which future habitat conditions can be predicted for each of the target years. When habitat conditions are predicted accurately, the HSI output will be accurate, and the resulting HU calculations will be acceptable. Guidance in the CWPPRA WVA Procedural Manual (USFWS 2006b) is generally provided for predicting future conditions for each variable. One possible remedy is to consider using reference areas of known age to provide estimates of habitat conditions at future target years.

For the most part these assumptions related to WVA/HEP are not, but should be, explicitly addressed in the CWPPRA WVA Procedural Manual (USFWS 2006b). It also would be appropriate and is recommended to acknowledge and address these assumptions in any future reports of the results of WVA/HEP applications.

### 3.4.5 Review Ability to Evaluate Risk and Uncertainty

Risk and uncertainty has become an important part of USACE analysis and design procedures in recent years, as noted by Moser (1997). However, there is no discussion of risk and uncertainty in the variables used to calculate the HSI values that ultimately determine the AAHUs used to evaluate management scenarios. Since the project life will be from 20 to 50 years, there is a strong likelihood that tropical and extra tropical storms may impact the area. The upper Gulf coast has a reasonable chance of one or more hurricanes each year. Damages to a project will depend upon the severity, track, and proximity to the site. The WVA models currently do not incorporate probability or consequences of project failure. However, location of coastal habitat in this environment suggests the real possibility of failure in extreme events.

The term “risk” is used in many ways to define hazards, losses, and potential problems. Risk is frequently defined as expected losses in terms of lives or dollars, generally calculated by combining the probability of system failure with the consequences associated with that failure. This can computed on a project life or an annual basis. The performance of a project or system is defined as the probability that specific loads will cause the system to fail, and losses are defined as the adverse impacts of that failure if it occurs. In simplified mathematical terms:

\[
\text{Risk} = \text{Probability of Failure} \times \text{Consequences of Failure}
\]
For any location along the upper Gulf coast and extending landward for several miles, a hurricane could cause extensive flood, wave, and wind damages. Wind damages could extend hundreds of kilometers from the coast. There are many methods and tools available to determine the probability of failure. 1) Historical data can be used for a specific area; 2) surge and water levels computed for the Federal Emergency Management Agency (FEMA) flood mapping purposes can define frequency-indexed forcing events; or 3) more detailed joint probability methods can be used such as those used to redesign the levees of New Orleans. The latter can be used with a typical random walk method using hundreds of realizations of possible yearly storm possibilities. Each storm occurrence in the sequence would produce some impact or damage to the site, with the years without storms yielding no damages. Performing 200 random sequences of 50 years would provide the basis for determining the parameters for the above equation and lead to the risk to a particular alternative. Lastly, the acceptable level of risk for habitat restoration projects would need to be established.

The potential for storms to affect an area should be considered in the context of a probabilistic event. While risk and uncertainty is not covered in the referenced documents, there should be a discussion of the process for determining the risk of using specific variables to calculate AAHUs.

### 3.4.6 Review Ability to Calculate Benefits for Total Project Life

The ability to calculate benefits for total project life varies somewhat in how the benefits are evaluated or considered. The stated purpose of the WVA method is to provide and compare an “estimate of the number of acres benefited or enhanced by the project and the net acres of habitat protected/restored” (USFWS 2006a). The benefit of a project can be quantified by comparing AAHUs between the FWOP and FWP scenarios. The difference in AAHUs between the two scenarios represents the net benefit attributable to the project in terms of habitat quantity and quality. Based on this stated purpose, the benefits in the models are defined as increases in AAHUs. The AAHU benefits should be properly reflected if the variables are properly measured and future values of variables are projected accurately. For the most part, an increase in AAHUs likely allows adequate comparison of benefits of FWOP to FWP. The procedure may be somewhat simplistic but adequate for the intended purpose.

As discussed in Section 3.3.2, the WVA models tend to adopt simplicity and utility over complexity and detail, and as such they are by definition not very realistic representations of the actual ecosystems. In all of the models, the primary target was fish and wildlife habitat. The models, if properly implemented, should adequately track benefits related to fish and wildlife. The assumption seems to be that actual ecosystem functions and values will be captured anyway. Variables that were selected have to be sensitive to the types of changes that are expected to result from typical habitat restoration projects proposed under CWPPRA. These variables work only if available data are of suitable quality and appropriate expertise is employed. The requisite quality of measurements has not been documented, which may ultimately impact the ability of a user to calculate benefits with the highest possible accuracy.

The entire protocol and models are biased towards measuring the benefits of a restoration project. From a more ecologically-based viewpoint, the ability to calculate benefits for total project life is related to a performance measure issue. There is ambiguity as to what exact
system is being represented for each model, which is reflected in the lack of specified performance measures. Performance measures define what community trait(s) is/are linked to model outputs and what is changing in the community as the HSI value increases. To simply demonstrate that the community is “better” isn’t sufficient. Specific model output values should be correlated with values of performance measures such as species richness, guild diversity, or other community metrics. Until the benefits are defined clearly, whether the full range of ecosystem benefits is covered cannot be assessed. It is critical that the performance measure for each model be stated explicitly so that the users are aware of specifically what the calculated benefits reflect.

These models probably work adequately for fish and wildlife-associated benefits, but other benefits (e.g., those related to hydrology) likely will not be well-represented. The exact ecosystem benefits linked to model output are not clear. Multiple benefits (e.g., flood attenuation, water quality, and species richness) are left out of the model, but a full range of ecosystem services is not intended for inclusion in the model.

In most cases suggested, it may not be appropriate to project future conditions for only a few time periods, such as using TY0, TY1, and TY20 for future without-project, and TY0, TY1, TY3, TY5, and TY20 for FWP scenarios. An implicit assumption in the process is that any change in habitat conditions between target years is linear. For many variables used this may not be reasonable, and it is worth considering whether additional target years should be recommended to more fully capture the change in habitat. At the minimum, it may be reasonable to include a TY10 and TY15 in all calculations. Alternatively, depending on the variables in the model being assessed, target years should be selected to reflect when major changes in the variables would be expected. As more target years are included, it can be expected that the benefits accrued or lost will be more accurately estimated.

Without the ability to incorporate risk and uncertainty (see Section 3.3.5), the long term computations are lacking validity. For example, there needs to be consideration of loss of habitat during hurricane events as well as chronic erosion.

### 3.4.7 Review of Model Calculations/Formulas

The models contain several problems in their calculations and formulas. The severity of problems identified was defined as follows:

- **Very serious:** the error is likely to lead to a substantially incorrect final number or that the model will not compute an answer
- **Serious:** there is a reasonable possibility that the error will lead to a somewhat incorrect final number or there is a lower possibility that the model will lead to a substantially incorrect number
- **Minor:** the likelihood of leading to substantially incorrect number is low, but the error should be corrected
- **Substantially:** the margin of error is likely to be larger than 10%
- **Potentially:** whether there is an error is uncertain or incorrect final numbers could be calculated if the model is not used very carefully.
These problems are classified primarily as formula calculation errors, specification errors, and error message problems. Specification errors are difficult to separate from formula errors because it is not always clear whether the specification or the calculation is incorrect. The most important errors are cited in this section. Final Panel Comment 12 (see Appendix B) explains these problems and discusses some less serious problems.

The code inspection process, which was performed on the spreadsheet models, typically detects 60% to 80% of the errors in a model. This suggests that one or two serious errors might remain in the model if the following problems are resolved. If two or more people conduct separate code inspections, most remaining errors will likely be detected.

**Formula Calculation Errors**

*Coastal Marsh Models*

**AAHU Calculation [Potentially Very Serious Problem].** The Coastal Marsh Community HSI models appropriately recognize that the contribution of open water and marsh cover to habitat quality can be different, and separate HSI values are calculated for marsh and open water. These HSI values are then multiplied by their respective areas of open water or marsh, HUs are determined for each target year being evaluated, and ultimately AAHUs are determined for the period of analysis. To determine the total HUs or AAHUs for the area being assessed, the user would next combine the contributions from marsh and open water by adding the HUs or AAHUs together. However, the Benefit Assessment section of the Coastal Marsh Community Models documentation (page 9) provides weighted formulas to calculate the average AAHUs. Averaging these two values in any form is incorrect, because it results in model output of fewer AAHUs than are being evaluated. This is a serious flaw in this model and renders the results invalid.

To illustrate this point, assume 200 hectares (ha) were being evaluated 100 ha of which were marsh, and 100 ha of which were open water. Assume the derived HSI for the marsh was 0.6, resulting in 60 HUs for the marsh, and that the HSI for open water was 0.4, resulting in 40 HUs for the open water. (We will simplify the example and assume habitat is consistent over time, and the HU = AAHU.) If this was a freshwater marsh, using the equation on page 9, we would calculate the net AAHUs as \( [(2.1 * 60) + 40]/3.1 \), resulting in 53.55 AAHUs provided by the 200 ha. This value is clearly wrong and is generating HSI values with the potential to be > 1.0. A total of 200 ha was being evaluated, and the total AAHUs provided by the two cover types (marsh and open water) will be 60 + 40 = 100 AAHUs.

It is inappropriate to carry out the weighting when calculating benefits measured by AAHUs. If, in fact, the open water habitats are of lower quality than the marsh, then that should be reflected in the HSI calculation for open water, not when calculating final AAHUs. A way to approach the lower perceived contribution of the open water cover would be to apply a penalty to the open water HSI, proportional to the perceived value. For example, for the freshwater marsh, the weightings would indicate that open water has approximately 50% of the value of emergent marsh (based on the 2.1 weight for emergent marsh). In this case, once the HSI values have been calculated for open water and marsh, the open water HSI could be multiplied by an adjustment factor of 0.5 to derive the final HSI value. These values would then be used to determine HUs,
and once AAHUs are calculated for marsh and open water, they would be added together to
derive the total AAHUs generated by the FWP scenario. This approach appropriately applies the
weighting at the HSI level, not the AAHU level.

Brackish Marsh
AAHU Calculation [Potentially Very Serious Problem]. The cumulative HU total is divided by
50 instead of by 20. This appears to be an error. If so, it will create a major output error for the
AAHU calculation.

Barrier Island
Variable V6, Interspersion [Very Serious Problem]. In the review copy of the model, an error
message appeared even if the values were entered correctly. This could inaccurately lead a
model user to believe that he or she is using the model incorrectly.

Swamp WVA
Variable V2, SI Calculation [Potentially Very Serious Problem]. The HSI calculation does not
include D127, the contribution from the trees.

Swamp LDNR Model
Variable V2, Maturity: Age or Species Composition and DBH [Potentially Serious Problem]. In
the case of age, the SI for V2 can be less than 0.1 while the documentation indicates that SIs
range from 0.1 to 1.0.

Variable V6, Disturbance [Potentially Serious Problem]. If there are several disturbance types,
V6 must be computed for each type, and a weighted SI must be computed. The spreadsheet does
not do this.

AAHU Calculations [Potentially Serious Problem]. The model divides the Cumulative HUs by
50 instead of the usual 20.

Specification Errors

Swamp WVA
Variable V2, Stand Maturity [Very Serious Problem]. The Basal Area calculation for SI is not
defined in the specification. In the spreadsheet, the logic is Basal Area times the Factor selected
from the table below the input and calculation cells in the spreadsheet, although the variable is
labeled as Basal Area.

Swamp LDNR Model
Variable V2, Maturity: Age or Species Composition and DBH [Potentially Serious Problem]. An
ERROR message appears unless the sum of the Cyprus and Tupelo percentages is 100%. There
is nothing in the documentation to justify this.

Fresh-Intermediate Spreadsheet
Incorrect Graph in Specification Document for V5 [Minor Problem]. The specification document
incorrectly shows V5 SIs falling to zero. The documentation indicates that all SIs should range
from 0.1 to 1.0. This is an error in the specification only. The spreadsheet correctly forbids salinity values greater than 5 and 7. The documentation should be changed to avoid later confusion.

Error Message Problems

*Swamp WVA Variable V₃, Water Regime [Serious Problem]*. There is no error message if the user fails to enter a value for V₃. Failing to enter a value will automatically make the HSI for the year equal to zero.

3.5 System Quality

3.5.1 Review of Supporting Software

The model calculations are done in Microsoft® Excel, and this appears to be an appropriate choice. There is no specific modeling software package for the WVA models. Excel makes the logic of calculation flow fairly easy to follow, and it can safely be assumed that most potential model users already have experience using Excel. If the calculations were done in a third-generation programming language, such as C++, the logic would be opaque. Consequently, there probably would have been more errors because of the extra mental effort involved in using a third-generation programming language, which is not optimized for calculations of the type involved in the spreadsheet models. Excel is limited by the processing power of the user’s computer. However, the models are small and should run adequately on the simplest computers, including netbook computers and even hand-held devices that can run Excel.

The models are written to run in Excel 2003, making them readable in Excel 2003 and the newer Excel 2007. Excel 2007 offers some new functionality, but this new functionality is not mandatory for the model. However, at some point, Excel 2003 files will no longer be supported, so a migration date for the models should be considered. If there is to be migration, the use of an Excel file format that does not permit macros, such as XLSX should be used for safety. Also, migration might be a good time to certify the model for use in alternatives to Excel, such as Google docs and Open Office.

3.5.2 Review of Programming Accuracy

There is no programming *per se* in the model, as programming refers to the use of a procedural language such as C++. Rather, the logic of the models is expressed in terms of a non-procedural program (Excel) without the use of Excel’s procedural extension (Visual Basic for Applications). Consequently, there are no programming accuracy concerns. Rather, there are only accuracy concerns for Excel calculations and formulas. These concerns are covered in Section 3.3.7 of this report.

3.5.3 Review of Model Testing and Validation

An important component of any model building and application exercise is to establish the validity of the model and to test it with independent, empirical data. Recognizing that models are intended to be a representation of reality, no model can be a “perfect” predictor of real
conditions. However, it is important to ensure that any model used performs at an acceptable level of accuracy and precision. The level of acceptability can be determined by the user. This can be determined through the validation and testing process.

The HSI models used in the WVA/HEP process can be validated/tested at three different levels. At the first level, the internal structure of the model can be verified to be reasonable and evaluated with “dummy” data sets. At the second level, the model would be applied to externally collected data sets that include some measurement of the performance measure associated with the model along with the habitat variables. The third level of model testing for these models will consist of a rigorous test of the spreadsheets used for model calculations. Based on the review, it appears that the models evaluated have not been rigorously tested at any of these levels.

Validating internal consistency

Several components come into play when verifying the consistency and structure of an HSI model. Each of the selected variables should be well documented and amply supported with information from the scientific literature, other studies, and expert opinion. With the exception of the Coastal Chenier/Ridge Community Model, it is difficult to verify the SI curves developed for the models because of the lack of supporting references and data. While some justification and explanation is provided for the variables selected, additional support from the literature would be useful. In particular, an internal evaluation to verify the model SI curves should have revealed SI relationships that are not biologically reasonable, such as $V_1$ (% emergent marsh) and $V_2$ (% SAV in open water) in the Coastal Marsh Community Models. Both of these SI curves can only take a value of 1.0 when the variable is at 100%. It does not make sense ecologically that optimal habitat to support a community can exist only in such a narrow range. In HSI models, SI curves that have a very narrow range for optimal conditions such as this typically do not perform well. Another internal inconsistency is the fact that no SI curves are allowed to take values < 0.1. Again, this is not biologically realistic because there will be sites that have no habitat value and should appropriately be assigned a value of 0.0. The result for the current models may be HSI values that inflate the true quality of the habitat.

The selection of aggregation equations across the models evaluated was not consistent. Additive functions were used in the Barrier Island and Barrier Headland Community Models; geometric means were used in the Swamp and Coastal Chenier/Ridge Community Models; and a mixture of geometric mean and simple addition used in the Coastal Marsh Community Models. No strong logic was provided for this variation in approaches, and at times weighting factors were incorporated that appeared to be arbitrary.

Verification of HSI model outputs should always be conducted with sample data sets (Stiehl 1995). Test data sets with logical and extreme values for each of the SI variables and that represent high- and low-quality habitat should be developed and then applied to the models. This will allow the developer to assess the model performance and detect variable combinations or components of model structure that may be problematic. The data sets and results of such internal testing should be included as part of the model narrative. There was no evidence that these models had been verified for internal consistency or that sample data sets had been applied.
to assess model behavior.

Testing with empirical data

Ideally, all models would be tested with independent, external data sets. The essential information needed for these independent tests will include a measure of the population/community performance measure reflected by the model along with measurements of the relevant habitat variables. Data should be collected from a diversity of sites with varying levels of the performance measure. Once these data sets are collected, the model output (in this case the HSI values) can be generated and compared to the performance measure. A positive relationship between the performance measure and HSI values recorded across a diversity of sites would indicate a model that performs well. If there is no relationship between the HSI and performance measure, the data can be used to help guide revision of the model.

There is no evidence that any of the HSI models evaluated have been tested with independent, empirical data. All models lack a clearly-identified performance measure, although some measure of community diversity could be inferred as a reasonable performance measure. At this time it appears that the peer review panel can not affirm the models perform as intended based on comparison to real field data.

Testing the Habitat Suitability Index Model Spreadsheets

The spreadsheet models should be tested by comparing each formula against the printed specifications. This has been done for the WVA spreadsheet models during this review to identify specification and calculation disagreements. Errors that were identified represent either a specification error or a calculation error.

For each of the spreadsheet models, each formula was checked against its specification using a five-step process. This check was usually straightforward because most of the specification documents were highly detailed. First, the formula was examined for apparent correctness. Then, each formula was checked by dividing possible inputs into equivalence classes and testing at least one input in each equivalence class to determine if it produced the expected result. The results of this check indicate that most of the formulas were in full agreement with the specifications, but several material errors were found. Final Panel Comment 12 lists these errors (see Appendix B). These errors should be fixed, along with errors in the specification document.

The third step was to test each formula using inappropriate data, such as numbers below or above expected input values (including negative numbers), data in the wrong format (such as text in a numerical input field), and entering percentages with a percentage sign or as a fraction of 100 instead of as a whole number. For the inappropriate data tests, most formulas failed to reject most of the inappropriate input. It is essential to add data validation to every formula. The recommendations for resolution provided in Final Panel Comment 14 discuss how to do this (Appendix B).

Fourth, the models were studied for poor design. Several cases were found where users were required to do calculations that the spreadsheet could have done. Asking users to do calculations
is likely to increase errors. It also makes a specific application of the model impossible to audit because there is no way of knowing how a user calculated the numbers. Final Panel Comment 11 (see Appendix B) discusses models in which unnecessary use calculation effort is done.

Lastly, the model was studied for user interface and documentation issues. Several major problems with the user interface were found. These are discussed in Final Panel Comment 12 (see Appendix B). This comment also notes that in-workbook documentation is completely absent. This lack of documentation for users, maintainers, and customers of the spreadsheets’ results is likely to lead to errors and lost productivity. The written specification documents are not sufficient documentation for users, maintainers, and customers.

Although the model testing protocol did not include fonts and font sizes, the peer review panel noted that several spreadsheets use a variety of different fonts and font sizes for similar information, even within a calculation block. This lack of attention to detail is likely to reduce the confidence of users and maintainers in the validity and quality of the models.

The developers should fix the problems in the models and then generate new tests for each formula in which data in expected equivalence classes, out of bounds data, and inappropriate user inputs are tested against each formula. The results of each test should be documented, preferably in the spreadsheet. Later, when changes are made, developers should do regression testing, in which all cases are rerun. This will allow the tester to determine whether parts of the model that should not have changed still give correct results. These tests can be automated if they are done in Visual Basic for Applications.

### 3.6 Usability

#### 3.6.1 Review of Data Availability

In the procedural manual (USFWS 2006b) the references to available data are brief. There appears to be the assumption that readers and potential users are aware of and know how to obtain the data for the models. The CWPPRA WVA Procedural Manual (USFWS 2006b) and model manuals indicate to some extent what data are available and who will provide the data for project evaluations, but more detailed descriptions of the data type, source, availability, quality and limitations, and time era should be provided, perhaps in a table in the procedures manual or in each model manual. The manual also only addresses available data in Louisiana; there are no procedures for Texas or areas of Southwest LA where there are apparently no U.S. Geologic Survey (USGS) data.

Different types of data are needed for various parts of proposed projects. Initial field investigation data are needed to familiarize the EnvWG and Engineering Work Group (EngWG) with the project area, discuss a benefited area for upcoming project boundary meetings, and determine habitat conditions in the project area. During the initial site visit, participants compile a list of vegetative species for discussion of habitat classification and collect data for the WVA/HEP (e.g., densities of SAV, water depths, salinities, vegetative cover, tree diameter) (USFWS 2006b).

Data are also needed for project boundary determination. The CWPPRA WVA Procedural
Manual (USFWS 2006b) indicates that data to be used in defining project boundaries and defining variable suitability indices are generally available for much of Louisiana. The procedural manual seems to imply that adequate quality data will be available for all projects except for southwestern LA. However, there is no mention of availability of data for eastern parts of Texas. There is great deal of data available from USGS. The suggestion is that, in most cases, the primary data for project boundaries will come from land cover Geographic Information System (GIS) analysis, which should be readily available from USGS or other sources. The WVA model documents are not clear as to whether the USGS data are the only source. It has been suggested by some peer reviewers that not all data sources were considered in model documentation and some suggested data sources may be of low quality compared to other available data. More sources of data have apparently become available since these models were originally developed, and there are a lot of habitat data available that are being overlooked. There are also large amounts of aerial photography, water level measurements, Light Detection and Ranging (LIDAR) data, and other similar data that are not included in discussions of available data.

Field or existing data must be collected to establish baseline values for each variable to describe existing conditions in the project area. Future values for variables without the project and with the project require project sponsors to substantiate their claims with monitoring data, research findings, scientific literature, or examples of project success in other areas. A number of sources of data have at least been partly described in the manuals.

There is substantial concern about the quality and accuracy of some data. The documents do not discuss data quality requirements. There is information available that needs to be included to improve consistency between data sets and provide users with information on the quality of model outputs. It should be suggested that model users obtain sufficient metadata to characterize data quality and to allow for the characterization of model output quality. The source, quality, suitability, availability, time era, and type of the available data need to be described better. For example, GIS data are fraught with spatial errors that are not easily recognized by untrained personnel. The accuracy of data needs to be at least identified in the documentation if not rectified in model implementation. Inaccuracies occur when photography of different resolutions and quality are used to compare time periods, classify different sites, etc. Also, different photographs at different resolutions (pixels per square inch) and quality (black and white photos, true color, and color infrared) and habitat classifications by different personnel can result in different classifications of habitats, thus compromising the validity of the assessment. Calculations based on changes prior to 2000 are probably not accurate due to misclassifications and pre-2005 inaccuracies in drawing shorelines in GIS and photo rectification. Misalignment of photos, misclassification of habitats, and improper alignment of boundaries can be real problems for a model.

**Generally Available Data for All Projects**

Some of the sources of data mentioned or partially described in the manuals are paraphrased below along with some comments, suggestions, and additions needed for ease of obtaining and using the data:
1. The USGS-Baton Rouge Field Station provides baseline and historical habitat classification and land/water data.
   - There is no discussion or clarification of cost, availability, time periods, addresses (email address, contact person or number,) type of data, software needed to use.

2. USACE provides historical land/water data. The model documentation indicates that USACE uses the digitized project boundaries and provides historical land/water data to the project sponsor to calculate historical marsh loss rates. The land/water cookie-cuts include data from six time periods: 1930, 1956-58, 1974, 1983, 1990, and 2000. The land/water data are provided in tabular format to the project sponsor.
   - The source of these data (e.g., branch or office of USACE), contact person or number, type of data, should be given to allow ease of access.
   - At another manual location the data are cited as USACE/USGS habitat and land/water data, which adds confusion as to what or where the data are available.
   - USACE land/water data are not available for extreme southwestern Louisiana. There is no suggestion as to a remedy for lack of data.

3. The manual indicates that the project sponsor should provide the USGS habitat data.
   - There is no indication of how the habitat data should be derived or defended, but presumably data may come from USGS habitat classification maps (with the boundary indicated) or USACE land/water data, or from baseline values that are determined for each variable from site visits and field determinations.

4. USGS/ National Wetlands Inventory (NWI) maps are available for 1956, 1978, 1988/90 for Louisiana
   - No description is given for source of data (e.g., Internet site, USGS in Baton Rouge)
   - It needs to be clarified as to whether the data are hard copy or ArcView shape files, or both

5. 2000 Louisiana Coastal Area habitat classification data. In another location the information is listed as 2000 Louisiana Coastal Area (LCA), which leads to confusion by users as to available sources of data.
   - Habitat data provided by USGS. The source, type of data, office location, contact person or number, availability to whom and type of data (ArcView shape files, hard copy) need to be clarified.

6. 1990 and 2000 land/water data from satellite imagery
   - It is uncertain whether these are habitat classification files or raw photography data.

7. Coast 2050 reports (provide estimated loss rates for swamp by mapping units)
   - Citations vary and need to be clarified so users know where to look. For example, this source appears to be cited as Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1998.
   - There is a question as to whether the Coast 2050 Report is really accurate at project level scales.
   - It is not clear to reviewers whether these are maps, digital data, or hard copy reports.
8. Water Regimes. Suggestions are made as to how to determine water regime: “Data from a nearby water level gage, such as those monitored by the COE or USGS, can also be helpful in determining the flooding duration of the project site. Previous WVAs for other projects in the area can also be helpful. Determining the baseline value for this variable, as well as making future projections, often requires the project planner to examine conditions outside of the project area. Navigation channels, flood protection levees, forced drainage systems, and drainage canals outside of the project area should be investigated to determine their effect on the hydrology of the project area.” (USFWS 2006b)

- The project planner is given some guidance but ultimately he is left to his own devices as to how to and where to find the proper data.

9. Engineering tools. Some engineering tools/models are briefly mentioned as available for habitat evaluations. The source and ease of use are not discussed. Data quality is limited by how well the person using the tool can use it. These tools also have limited availability.

- Coastal Engineering Manual (CEM) was not listed as an available tool. The CEM should be included in the list of engineering tools.
- Delft3D is mentioned, and this is considered to be a powerful tool. Yet, it requires a large learning curve and is not likely to be generally useful.
- Genesis (Generalized Model for Simulating Shoreline Change) and Sbeach models are generally easier to use but are not always germane.
- Others models (e.g., DNRBS, NMLONG) predict shoreline position by modeling the movement of sand due to waves over several years.

- The manuals should provide some information on availability. Some literature that is available on barrier island modeling includes Coastal Planning and Engineering 2001, Dean 1997, Herbich 2000a, Herbich 2000b, List et al. 1997, and Tait 2000 (as cited in USFWS 2006b). Desktop PC versions of some of these models are available.
- Several agencies including the National Marine Fisheries Service (NMFS), EPA, Natural Resources Conservation Service (NRCS), and LDNR have used many of the coastal engineering methods previously discussed. Their expertise should be used when assessing projects via the barrier island/headland habitat model.

10. For coastal ridge habitats located along the gulf shoreline, erosion data could be obtained from the U.S. Geological Surveys Louisiana Barrier Island Erosion Study-Atlas of Shoreline Changes in Louisiana from 1853 to 1989 and the Atlas of Sea-Floor Changes from 1878 to 1989. For chenier/ridges located within interior areas, USGS habitat data or USACE land loss data may be helpful.

- There is no information as to whether the data are available in digital/GIS form or whether the atlases are readily available.

**Data Needs That Are Specific For Project Sites and Habitat Variables Within Sites**

More consistent identification of data availability and protocols for expert assessments are needed since the quality of available data and use of data at different resolutions may
compromise the validity of the assessments. Each site needs to be evaluated to determine whether adequate and proper data are available. Some clarification is needed as to when efforts should be made to obtain data that are specific for a project site and habitats within the site. Some data need to be taken during field visits. The need to collect field measurements is indicated for some variables in some models, but the method is left up to individual selection. Some of the variables can be determined by remotely sensed data, but some must be determined in the field since they change nearly continuously or classification from photos is not realistic. Measurements of some variables (e.g., canopy cover, DBH of trees, ground cover) will need to be made onsite for individual sites. Consistent techniques probably should be specified for measuring each variable. Land surveys by certified land surveyors and data collection can provide meaningful data for individual projects. In some cases there were discrepancies between the procedural manual (USFWS 2006b) and the model documentation as to how data are to be taken and measured. This should be rectified because consistent/repeatable data are less available when it is unclear how data are to be collected.

Specific Variable Measurement Problems That Affect Consistent Measurements Of Variables

$V_4$, Mean High Salinity During the Growing Season in the Swamp Model - The baseline (TY0) value for this variable is usually obtained from salinity monitoring data collected along the coast. Salinity data can be obtained from a number of sources: Louisiana Department of Wildlife and Fisheries; Louisiana Department of Health and Hospitals; USGS and USACE monitoring stations; LDNR monitoring stations used for monitoring CWPPRA projects; field trip data; or data from landowners/land managers. Determining the baseline value from long-term data is preferred to using data from a field investigation which provides a one-time observation of salinity in the project area. Members of the American Association of Geographers (AAG) have been very helpful in providing project planners with salinity data. Monitoring data from freshwater diversion projects (e.g., Caernarvon, West Point a la Hache) can also be helpful in determining future without-project conditions for diversion projects into swamp habitat. Modeling conducted for various projects and USACE feasibility studies can also be helpful. Precise locations of data (websites, office locations, or telephone numbers) should be provided.

$V_1$ (Stand Structure) and $V_2$ (Stand Maturity) in the Swamp Model – The manual indicates that baseline (TY0) value for this variable is usually determined during field investigations of the project area. The manual indicates that typically plots or transects are conducted by the project sponsor or by a group during the EnvWG field trip. The manual further states that video flights of the candidate projects may assist in determining vegetative coverage. There is no information provided about sources of video data or techniques to analyze the video and develop cover estimates.

The manual states that a tree growth spreadsheet developed by USFWS and USACE biologists can be used to assist with tree growth projections. That spreadsheet was developed to project the growth of several swamp and bottomland hardwood species. Another reference to assist with tree growth projections is the U.S. Department of Agriculture’s Silvics of North America. That publication contains growth information for several swamp species. The availability is uncertain since there is no information on how to obtain these documents.
Baseline habitat classification and land loss data – Shoreline erosion rates should be determined by the USGS using aerial photography and GIS software. There is concern about the time period photography was taken, how measurements are taken, and whether storms are accounted for between start and end measurements. Typically, measurements are taken perpendicular to the shoreline for two or more time periods, and an average of those measurements is calculated to determine the shoreline erosion rate. Anomalies (e.g., points along the shoreline) which could skew the average should be removed from the measurements. Aerial photography from at least two time periods is needed. It needs to be determined whether normal conditions existed between time periods. Storm effects between the two time periods can skew data tremendously. One has to determine whether the photography is available and determine when storms occurred and affected that site.

\( V_2 \) Percent Open Water Covered by Submerged Aquatic Vegetation of the Marsh Model – The baseline (TY0) value for this variable is usually determined by ocular estimate during field investigations or from the personal knowledge of project planners, landowners, or land managers in the project area. Raking along pond bottoms can also provide an indication of SAV densities. Video flights of the candidate projects are conducted each year and may assist in determining SAV coverage. Methods of ocular measurements are undefined.

\( V_2 \) Percent Shrub/Midstory Cover of the Barrier Island and Headland Models - The baseline (TY0) value for this variable should be determined during field investigations of the project area. Plots or transects conducted in the project area should be designed to provide the best estimate of midstory cover. Video flights of the candidate projects are conducted each year and may assist in determining canopy cover of shrub/midstory species. No specific methods are given. Different techniques by different personnel at different projects could lead to wide variations in data.

\( V_3 \) Native Woody Species Diversity - The baseline (TY0) value for this variable should be determined during field investigations of the project area. Plots or transects conducted in the project area should be designed to provide the best estimate of the number of woody species present. No specific methods are given. Different techniques by different personnel at different projects could lead to wide variations in data.

**Conclusions and Recommendations**

References to available data are brief but there are descriptions of some available data in the manuals. The manuals only address available data in Louisiana; there are no procedures for Texas or areas of southwest Louisiana where there apparently are no USGS data. It is assumed that readers and potential users are aware of and know how to obtain and use the data for the models. More detailed descriptions of the data type, source, availability, quality and limitations, and time era of data probably should be provided to users.

**3.6.2 Review of Results**

The results of models are used for comparisons of changes in AAHUs for with-project and without-project scenarios. The AAHUs of FWP and FWOP scenarios are compared to determine
benefits of a project. The results are intended to quantify “changes in fish and wildlife habitat quality and quantity that are expected to result from a proposed habitat restoration project. The results of the WVA/HEP, measured in 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/HEP method provides an estimate of the number of acres benefited or enhanced by the project and the net acres of habitat protected/restored.” (USFWS 2006b)

Results (differences in AAHUs) will generally be fairly well understood and likely very clear for those who understand the system; but results seem likely to be very simple and intuitive. Based on differences in AAHUs, the planners must determine whether project objectives are reasonable. There is a great amount of uncertainty in the projected future change in habitat conditions and the associated SI values. As long as the uncertainty of any particular futures projection is acknowledged and perhaps different scenarios are projected and analyzed, the usability of the models is probably not compromised in any way.

Although the differences in AAHUs of FWOP and FWP are easily understood, the results assume that the field data and projected values that were entered in models are reasonable. Although the variables and SI values were carefully selected by scientists familiar with the habitats being modeled, it is difficult to scientifically defend these models because virtually all of them lack any reference to the primary literature, to research findings, or to best available science. These sources of support should be used for justification when selecting variables, SI value curves, and weights for variables. There is no real evidence given that any of the variables were examined and evaluated in any way prior to application.

Once errors with the model calculations have been corrected, the models will probably perform correctly (e.g., present reasonable results) for the intended purpose. However, the process and results from the WVA may be subject to variations in loss and conversion in the future that diverges from predictions made as part of the process. Storms, SLR, subsidence, wave action from a particular direction (local storms) and sudden changes in sediment deposits due to nearby feature changes can cause sudden conversions and loss of shoreline that will override model predictions. Given the uncertainty in predicting future events such as storms, there will be inherent inaccuracy in the predictions, and it might be useful to simulate several different scenarios to evaluate results with and without storms, or with storms/washovers at different target years in the future.

As previously stated, all models are, by definition, abstractions of reality. There is always a trade-off between complexity and utility. The statement above presents a reasonable caveat, given these realities. Any model must always be presented, and used, with its limitations and faults clearly identified. The use of future projections may cause some misunderstandings. Recent research on decision-making under uncertainty (which clearly has relevance to WVA models) has shown that simulation tools that generate scenarios are much more useful than those that purport to predict the future (go to http://dcdc.asu.edu/dedcmain/index.php and http://dcdc.asu.edu/dedcmain/publications/pubsearchSimple.jsp). Scenario models may be adjusted by managers and policy-makers in real time, showing them future effects of today’s decisions. This kind of fundamental shift in approach may not be appropriate at this point in WVA model development and application, but some thought to the use of words such as
“projection” and “prediction” might be in order.

The decision to develop community- or ecosystem-level models is appropriate given the objectives of the models. Although single-species valuations are important for management decisions that affect threatened and endangered species, the use of a more holistic approach (WVA/HEP) is both desirable and justified.

An assumption that is missing that should be present in any HSI model is some definition of “performance measure” (Stiehl 1995). For any model, an implicit assumption is always that as the HSI value goes up or down, so does some aspect of the biological system that is being modeled. For a single-species model, it often will relate to population size, reproductive success, survival, and other similar population metrics. The exact relationship between performance measures and HSI values is seldom defined, but it comes from the underlying data used to develop the model, which typically consist of some population measure linked to habitat characteristics. The models used for WVA/HEP are community models rather than single-species models, but the same situation applies. As the HSI increases in value, it can perhaps indicate higher species diversity, greater evenness in species distribution, higher densities, or higher quality for other community measures. This needs to be stated somewhere in the model, and a metric must be provided with which the model could be evaluated as it is applied in the field.

Because the SI relationships are so simple and linear, they will likely be relatively easy to quantify. However, this simplicity does not necessarily relate to proper results, accuracy, or objectivity relative to the actual behavior of the ecosystems being modeled. For situations where the models have been applied, it would be very useful to compare model output to some measure of community quality (i.e. performance measure) on the sites. A simple species richness list for all vertebrates on these sites could be a logical starting point. If the models truly reflect habitat quality for a community, we would expect to encounter more species on sites with higher HSI values. Having a performance measure to compare to HSI model outputs will enhance the iterative nature of model building by allowing evaluation and the modification of models to better fit known data.

There are limitations to the results that are projected for some models. For example, as with any forest ecosystem, swamps take a considerable time to grow and mature as ecosystems. It takes considerably longer than a 20 year project lifetime to grow mature trees. As such, it may be difficult to claim success in a swamp restoration project after only 20 years. There may well be structural indications that the restoration is on a success trajectory (e.g., the presence of viable seedlings of swamp trees, etc.), though there is no way to capture such a success trajectory if the only target years are T1 and T20.

### 3.6.3 Review of Model Documentation

During the review process the peer review panel expressed a number of diverse concerns with the models being used that represent a variety of issues. These issues generally relate to how the system being modeled is being represented and the general lack of documentation for model components and implementation. The models appear to be generally sound, but several do have problems that limit their usability, and all can be improved upon. The concerns that are discussed...
below are important in recognizing that some variables may have issues that could affect model outcomes and could possibly be improved by considering the statement concerning a variable. Some issues are common to more than one model and are discussed first. Concerns related to specific models follow.

**General model concerns**

The peer review process is a critical foundation of scientific integrity. There is no objective way to verify the accuracy or integrity of data, analyses, and interpretations that have not been peer-reviewed. Models are nearly always based on peer-reviewed scientific information, and the peer-reviewed scientific literature should be used to document all aspects of models (model justification, construction, quantitative relationships, and interpretation of output). Expert opinion or best available knowledge may be used to support models, but this is generally only where data from peer-reviewed literature are in conflict or are difficult to apply to a specific model situation. By citing the scientific literature and published data, model developers impart integrity on their models and provide model users with readily available sources to verify the models.

Many decades of high quality research have been conducted in northern Gulf coast ecosystems. The peer-reviewed scientific literature is rich with information that may be used to support the ecosystem descriptions in WVA model documentation. However, only one of the WVA models reviewed (the coastal chenier/ridge model) made any reference to the primary literature. Because of this, much appears to have been simply left to trust. The peer reviewers had little way of knowing how contemporary theory or available, peer-reviewed information was used for ecosystem descriptions or in model justification, assumptions, development, construction, and interpretation.

Supporting data from the literature or unpublished studies were not provided to support many SI curves and HSI aggregation equations. With the exception of the Coastal Chenier/Ridge Community Model, very little support for the models is provided from the primary literature or research. The credibility of the models will be enhanced with published sources of information to support the model variables, structure and SI curves.

The most recent aerial and satellite photos have not been suggested to determine land loss rates, land-use changes and hydrologic changes. The model guidelines should be updated to provide recommendations for the most up-to-date sources for remote sensing imagery that can be used to determine these rates. Doing so will ensure the most accurate outputs from the WVA.

No procedures were documented to quantify and predict hydrologic, geomorphic, or hydrodynamic changes over time. The model documents provide some references which lead to very technical approaches, but these approaches will take a highly trained person to complete. More information provided will ensure proper application of the models.

Page 12 of the CWPPRA WVA Procedural Manual (USFWS 2006b) refers to Appendix B of the Emergent Marsh Community Model. It is assumed that the Emergent Marsh Model is in fact the Coastal Marsh Community Model. This model is lacking an Appendix B, and this apparent error
needs to be clarified.

Coastal Marsh Community Models

There are some discrepancies in variable descriptions between the CWPPRA WVA Procedural Manual (USFWS 2006b) and individual models that can lead to confusion. For example, the Procedural Manual discusses marsh creation and marsh nourishment under V1 (percent cover of emergent vegetation) (p. 9 of CWPPRA WVA Procedural Manual), but the marsh model manual does not discuss these at all.

References to support assignment of variable weights and SI values for variable measurements would help justify and lend credibility to model outputs. Specific examples include:

- High SI values with low salinity in the Saline Marsh Community Model are questionable. Some documentation to justify the values would be useful.
- Variable V6 (aquatic organism access) is limited as are V1 and V2 because it can only achieve an SI of 1.0 at an access value of 1.0. The peer reviewers recommend assignment of more ecologically relevant values based on the scientific studies and the available literature.
- In the marsh models, the rationale for grouping and weighting variables V1, V2, and V6 and grouping variables V3, V4, and V5 and isolating them is not clearly explained and justified. There is no justification for how the six variables were weighted in these calculations. Weighting may be appropriate, but detailed justification is required. For example, aquatic access is “considered more important in a saline marsh” (p. 8), but a rationale for the exact weighting is not provided. Also, the split model for marsh and open water SI calculations is reasonable, but the rationale for weighting marsh and open water AAHUs calculations differently for the different marsh ecosystem types is not well documented or defended. The validity of weighted averaging of AAHUs from marsh and open water is discussed in more detail in Section 3.3.7 of this report. Literature citations need to be provided to justify these numbers.

Swamp Community Model

Guidelines in this document call for applying the WVA Swamp Community Model if ≥33% of the total project area is swamp; otherwise the WVA Fresh/Intermediate Marsh Community Model is to be applied. Referring this conversion from one habitat type to another as “habitat loss” is not ecologically correct. In the Swamp Community Model documentation (USFWS 2008), the first sentence of the third paragraph on page 13 might be changed to “conversion of emergent or wooded habitat to open water.” Conversion to marsh versus outright loss of swamp habitat does need to be carefully documented and handled separately on case by case basis. Within the WVA/HEP context, it is easily possible to accommodate conversion of one cover type to another, such as swamp to marsh. That would be appropriate in this situation.

In the Swamp Community Model it is unclear how to link DBH and basal area in calculations for V2. More guidance needs to be provided here. There are in fact three components to this variable: DBH of trees in bald cypress cover, DBH of trees in tupelo and gum cover, and the total basal
area. While the spreadsheet does have input cells for these data, there is no direction provided in the model as to how these three components are combined to provide the value for SI2, which then becomes part of the HSI equation.

**Adequacy of Model Specifications in the Specification Documents**

In general, the specification documents are extremely good at describing how the model should operate. Usually, there are actual formulas for calculations. This level of specification is uncommon in model development.

However, there are a few problems in model specification. These are described in detail in Final Panel Comment 12, Part 2 (see Appendix B). In some cases, the problem is most likely incorrect specifications, leading to incorrect coding. In other cases, there is coding for which there is no specification or for which the specification is incompatible with the coding. In such cases, the problem is either in the specifications or the coding. Testers must be able to compare the specifications with the spreadsheet code. A lack of specification or an incorrect specification is a serious problem in spreadsheet development.

Customer documentation should also be included in the model documentation. This refers to documentation for the customer of the results—decision makers who will use information from the model. There is no clear requirement for such documentation, but its absence will reduce the value of the models. This information might be included in specification documents, but separate documentation for customers is desirable.

**Adequacy of In-Workbook Documentation for Users and Maintainers**

There is very little in-workbook documentation for users and maintainers. Problems with in-workbook documentation are discussed in detail in Final Panel Comment 13 (see Appendix B). These problems fall into several categories.

**Initial Documentation.** There needs to be an introductory documentation sheet that briefly describes what the spreadsheet model does and any notable limits in the model.

**User Documentation.** While the written specification documents contain a great deal of information, they are not geared to the needs of spreadsheet users. There is a need for a user documentation worksheet in the workbook. The user should be able to get context information for everything he or she needs to do.

**User Cueing.** The model seems to have been written with a goal of sparseness and visual cleanliness. However, users are not even visually cued where to enter data, and the spreadsheet labels are of little help to users. The problem is especially of concern because the model is sensitive to how units are entered, and there is no cueing regarding what units to use when entering data. The lack of even simple cueing makes this problematic because there is a high potential for erroneous outputs, particularly since there is no data validation built into the models to prevent the use of erroneous or non-sensible data.
Maintainer Documentation. The written specification documents, while better suited to the needs of maintainers, still fall short of what is needed for maintainers. In particular, there is no explanation for how various model sections are instantiated in the spreadsheet model. The logic of the AAHU calculation implementation in the spreadsheet is particularly complex. The model generally lacks things that maintainers need to know, such as version information.

Copying Specification Documents into a Worksheet. The PDF or Word for Windows document for each spreadsheet model should be copied into a worksheet in the workbook so that it is available for immediate reference. Omission of this information will not harm the user or maintainer if the document is readily available, but having the documentation in the workbook is useful if the document is not immediately available. Finally, having a copy of the specification document in the worksheet would ensure that the correct version of the documentation matches the particular version of the spreadsheet model.

To address these concerns, the model documentation should be revised to:

- Clarify how peer-reviewed data and analyses were used, by citing the scientific literature, in model documentation justifying: 1) ecosystem descriptions; 2) assumptions; 3) selection of HSI variables; 4) quantification of SI relationships; 5) weighting factors in the combined HSI equations, and; 6) the use of model output. Every variable and aggregation equation in every model should be fully documented.
- Clarify when and how expert opinion or best scientific information was used to augment peer-reviewed data and analysis from the primary literature.
- Correct model specifications or coding as appropriate for consistency between specifications and calculations.
- Include user and maintainer documentation in the model spreadsheets.

3.7 Model Assessment Summary

A review of the technical quality, system quality, and usability of the WVA models determined that the models appear to be generally technically sound, but some improvements to the models, augmented documentation to support model development and application, and correction of some model formulas has been suggested. The models are based on well-established and widely accepted procedures; however, whether they are “based on well-established contemporary theory” (USACE Protocols for the Certification of Planning Models, July 2007) could not be determined. The theoretical development of each model was weak and generally not well documented from the literature or other sources. The HSI model output typically ranges from 0.0 (no habitat value) to 1.0 (optimal habitat), while the WVA models contain variables that can inexplicably only have SI values ranging from 0.1 to 1.0, meaning that it is impossible for any habitat to have no value to fish and wildlife. Also, HSI model output is theoretically linked to or represents some characteristic of the population or community being represented (i.e., a performance measure), and no performance measures are defined for the WVA models.

By necessity, models are simplified representations of complex systems. As such, not all variables can be included in models without losing sensitivity. Several external components were identified that could impact the quality of the ecosystems being modeled but were not included in the models (e.g., sea level rise, invasive species, and in some cases human
disturbance). Although the variables in the models will certainly respond to these external stressors, it was suggested that they might be included in the models as important variables. Risk and uncertainty associated with the models capturing, responding to, and predicting the impacts of extreme environmental conditions (e.g., severe weather) were not considered.

The decision to use policy over science to assign SI values to some variables may limit the ability of the models to accurately assess the value of the ecosystems being represented. In some cases, optimal conditions were defined as “no habitat loss” rather than conditions that are most suitable for fish and wildlife to thrive. For example, 100% vegetation coverage in a marsh is not optimal for foraging and breeding by fish and wildlife to occur.

There was concern over the lack of documentation for prescribing data collection methods and the subjectivity of some variable measurements. Both can lead to variability in results between projects and, more importantly, between sampling teams because of differences in professional opinion.

For the most part, model assumptions are not explicitly stated in the model documents. Stating the assumptions for the WVA/HEP method and HSI models would improve confidence in the results and provide model users with guidance on how the models are to be applied.

The model contains several problems in its calculations and formulas. These were classified as formula calculation errors, specification errors, or error message problems. Specification errors are difficult to separate from formula errors because it is not always clear whether the specification or the calculation is incorrect. Correction of these problems is critical to ensuring reliable and accurate model outputs. Incorporating validation into the model spreadsheets is recommended to prevent the use of non-sensible data or data being entered in the incorrect format.
4.0 CONCLUSIONS

Overall, the concept and application of the models are sound for planning efforts. Models are simple representations of complex systems and, as such, must balance complexity and reality with simplicity and usability. For the WVA models, the balance has been struck fairly well. The HEP method, which is equivalent to the WVA method, has a long history of being applied to these situations. The models seem to sufficiently capture the habitats being modeled and do not have any irreparable deficiencies.

However, there were some issues identified with the models’ documentation, application, variables, and spreadsheet calculations and formulas. The most glaring deficiency in the WVA models is the lack of documentation to support model development, including the development of aggregation formulas, SI curves, variable weighting, data collection and variable measurement, and use of the model spreadsheets for calculations. Thorough documentation is critical to the scientific defensibility and usability of the models. Because the development and application of the models is not well-documented, there are substantial concerns regarding how future conditions will be projected and the consistent application of models within and across projects.

The peer reviewers found apparent inclusion of policy goals for marsh vegetation cover in construction of selected variables that are not appropriate for ecological goals. In some cases, optimal conditions were defined as “no habitat loss” rather than conditions that are most suitable for fish and wildlife to thrive. (For example, one-hundred percent emergent vegetation coverage in marshes is not optimal for foraging and breeding by fish and wildlife to occur, nor is it realistic, as this precludes the requisite network of tidal creeks that are an inherent part of tidal wetlands; however, the marsh models stipulated 100% emergent vegetation coverage as optimal.) The decision to use policy over science to assign SI values to variables may limit the ability of the models to accurately assess the value of the ecosystems being represented.

HSI model output should also be linked to or represent some characteristic of the population or community being represented (i.e., a performance measure), and no performance measures are defined for the WVA models. An example of a performance measure would be species richness per unit area, based on the assumption that species richness is directly correlated with habitat quality.

The peer reviewers suggested that other variables should be considered for inclusion in the models, and they were concerned about how the variables that are currently included in the models are measured. There were suggestions to include additional variables to reflect sea level changes (all models) and human disturbance (some models). Many of the variable measurements appear to be subjective, and a lack of detailed protocols will lead to extensive application of best professional judgment and inconsistencies in results between projects and between project teams.

Some serious or potentially serious problems were identified in the model spreadsheet calculations that could limit the usability and accuracy of the models. These included formula calculation errors, specification errors, and problems with error messages. The reviewers also
made recommendations for improving the usability of the spreadsheets, which can also reduce user error.

The reviewers strongly suggest incorporating the recommended resolutions into the model documentation and model spreadsheets before allowing widespread use of the models for planning purposes. The models will be better able to achieve their stated purpose if suggested revisions are made. In their current condition, they are highly subjective and may not be able to accurately predict future conditions.
5.0 REFERENCES

LDNR (Louisiana Department of Natural Resources). 1994. Habitat Assessment Models for Fresh Swamp and Bottomland Hardwoods Within the Coastal Louisiana Zone. Louisiana Department of Natural Resources, Baton Rouge, LA.


Appendix A

Biographic Information for Model Review Panel Experts
Habitat Evaluation Procedures Expert – Dean Stauffer
Dr. Stauffer holds a Ph.D. in forestry, wildlife, and range science from the University of Idaho and is currently a Professor of Wildlife Sciences at Virginia Tech. He teaches Wildlife Habitat Evaluation and Advanced Habitat Analysis and, since 1991, has taught 27 week-long workshops on conducting Habitat Evaluation Procedures (HEPs). Along with HEP, his professional qualifications include building wildlife-habitat relationship models, wildlife management, terrestrial ecology, wildlife monitoring and census taking, and statistical modeling, design, and analysis. The majority of Dr. Stauffer’s research has centered on modeling relationships of wildlife species to their habitat and he has placed particular emphasis on the application of basic ecological knowledge to land use impact assessment. He has served as an HEP consultant for numerous projects across the country, including developing Habitat Suitability Index models for a variety of bird, mammal, reptile, and amphibian species. He has published approximately 75 papers in refereed journals and other publications in addition to being involved with 79 presentations at professional meetings.

Planning Expert – Samuel Brody
Dr. Brody holds a Ph.D. in environmental planning from University of North Carolina—Chapel Hill and is currently an associate professor at Texas A&M University in the Department of Landscape Architecture and Urban Planning. He is also the Acting Director of Texas A&M’s Hazard Reduction and Recovery Center, which researches hazard and disaster mitigation, preparedness, response, and recovery from an interdisciplinary point-of-view. He is also the co-director of A&M’s Center for Texas Beaches and Shores, where he is actively involved in addressing wetland loss, beach erosion, and restoration issues all along the Texas coastline. He is the author or co-author of numerous planning books and articles, including Ecosystem Planning in Florida: Solving Regional Problems Through Local Decision Making (Ashgate Press: 2008); Does Biodiversity Matter? Implementing the Principles of Ecosystem Management in Florida (WIT Press: 2003); and “Examining the Relationship between Wetland Alteration and Watershed Flooding in Texas and Florida” (in Natural Hazards, 2007).

Hydraulic Engineer – Billy Edge
Dr. Edge is Professor and Head of the Ocean and Civil Engineering Division of the Zachry Department of Civil Engineering at Texas A&M University and also serves as Director of the Haynes Coastal Engineering Laboratory. He holds an M.S. in civil engineering from Virginia Polytechnic Institute and a Ph.D. in civil engineering from Georgia Institute of Technology. His areas of expertise include coastal engineering, dredging technology, coastal zone management, hydraulic engineering, and water quality modeling. He has performed extensive research in applied hydrodynamics, coastal structures, coastal ecosystem restoration, dynamic coastal processes, mathematical modeling of natural systems, marine pollution control, physical modeling of hydraulic phenomena, sediment transport, and estuarine analysis. He has authored refereed journal articles and numerous technical reports and serves on several engineering societies and committees. He currently is the President of the Association of Coastal Engineers, the Associate Editor of the Journal of Ocean Engineering, and a member of the Marine Board, National Academy of Engineering and Executive Committee NAS/NAE Marine Board, and Committee for Coastal Engineering Research and Education, NAS/NAE Marine Board. Dr. Edge is recognized internationally as an expert in coastal engineering and dredging technology.
Coastal Wetlands Ecologist – Dan Childers
Dr. Childers is a Professor at the Arizona State University School of Sustainability and an Associate Director for Research Development at the University’s Global Institute of Sustainability. Dr. Childers holds a Ph.D. in marine science from the Louisiana State University Center for Wetland Resources. He has 25 years experience working in coastal ecological systems including Louisiana and the Gulf of Mexico. He has taught a variety of ecology and biology courses focusing on wetland ecology, coastal ecosystems, and ecological modeling at the undergraduate and graduate levels. Dr. Childers' research focuses on wetland ecosystem ecology, in particular questions about controls on primary production, biogeochemical cycling, and soil dynamics. He has worked in both forested and herbaceous wetland ecosystems, and in many different freshwater and estuarine systems around the world. He has been awarded many prestigious research grants and has served as the primary author on numerous refereed publications. Dr. Childers led the Florida Coastal Everglades Long-Term Ecological Research project from its inception in 2000 until 2008.

Coastal Ecosystems Ecologist – James Webb
Dr. Webb recently retired in 2005 after 27 years as a Professor in the Marine Biology Department of Texas A&M University at Galveston. He holds a Ph.D. from Texas A&M in Range Science. His primary field of research centered on coastal habitat and plant ecosystem relationships and their values to the environment and society, as well investigating estuarine food webs. Dr. Webb has taught courses specializing in coastal plant ecology, wetlands ecology, and wetland delineation. He has spent many years researching marsh plant communities, bottomland hardwoods, forested coastal ridges, plant communities of Mississippi River revetments, and the use of plants to prevent shoreline erosion. His work experience as an environmental consultant includes construction and re-vegetation techniques for coastal wetlands, shorelines, and dunes. He has also been involved in the development of nursery techniques for dune plants, marsh plants and sea grasses. Dr. Webb is well-known within the wetland professional community and frequently sought after for his field expertise in coastal habitats and wildlife biology.

Software Programmer/Spreadsheet Auditor – Raymond Panko
One of the best-known spreadsheet researchers in the world, Dr. Panko holds a Ph.D. in communication research and is currently a Professor of Information Technology management at the University of Hawaii’s Shidler College of Business. He began doing research on end user computing in 1980 and refined his focus to spreadsheet development, testing, validation, and verification. Dr. Panko is widely published in the field and is the owner of and primary contributor to one of the world’s most cited and consulted spreadsheet research websites (http://panko.shidler.hawaii.edu/SSR/index.htm). He is also an expert on error rates on human cognitive processes. His publications have included, among many others, “What We Know About Spreadsheet Errors” (Journal of End User Computing, 1998); “Hitting the Wall: Errors in Developing and Code Inspecting a ‘Simple’ Spreadsheet Model” (Decision Support Systems, 1998); and “Two Experiments in Reducing Overconfidence in Spreadsheet Development” (Journal of Organizational and End User Computing, 2007). In addition to his substantial research background, his operational experience has included advising a major telecommunications company on the auditing their multi-billion dollar budgeting worksheet. Since 1995, he has conducted approximately two dozen audits and code inspections of operational or pre-operational spreadsheets for commercial companies.
Final Panel Comments

The following forms include the Final Panel Comments from the review of the Wetland Value Assessment (WVA) Models. These comments reflect the key issues identified during the assessment of the model certification criteria described in the USACE Protocols for the Certification of Planning Models. Each form contains a concise statement of the issue (the comment), the basis of the comment, the significance of the comment, and recommendations for resolution. Significance levels are defined as follows:

**High:** Describes a fundamental problem with the model(s) that could affect the models’ ability to serve their intended purpose

**Medium:** Affects the completeness or understanding of the model(s), model usability, or the level of performance of the model(s)

**Low:** Affects the technical quality of the model documentation but will not affect the performance of the model(s)

Final Panel Comments are arranged from High to Low significance, but in no other particular order.
**Comment 1:**

Starting the SI curves for all variables at 0.1 is problematic because even habitat with no ecological value appears to have some ecological value.

**Basis for Comment:**

Habitat Suitability Index (HSI) models are intended to reflect habitat quality on a scale of 0.0 (absolutely no value to the species/community of interest) to 1.0 (best possible habitat). The Suitability Index (SI) values associated with each variable contributing to the model also typically take values that range from 0.0 (no value for that particular variable) to 1.0 (best possible level of the variable).

The SI values are aggregated in some manner to generate a single number that reflects the HSI value for the site being assessed. When none of the SI values are allowed to take a value of 0.0, and when aggregation equations are additive and use arithmetic means rather than multiplicative (incorporating geometric means), even the worst possible habitat will have a value of 0.1, which could be interpreted to mean that the habitat has 10% of the potential possible value.

When a habitat component is absolutely limiting for a species or community (i.e., when that component is lacking, the species/community cannot exist on the site) it is critical to have SI curves that can take a value of 0.0. If the species/community can exist on the site even if the habitat component is absent or of low quality, then it may be reasonable to have an SI that does not drop to 0.0.

The Coastal Chenier HSI model is a good example of this situation. It is a well-documented, clear model with 3 appropriate variables. The primary purpose of the model is stated to evaluate resting/stop-over habitat for migratory songbirds. However, if there was a coastal ridge with no tree canopy cover ($V_1$, SI=0.1), no shrub cover ($V_2$, SI = 0.1), and no woody species at all ($V_3$, SI=0.1), the overall HSI would be 0.1 for this barren, unvegetated site. In terms of habitat for migratory songbirds, this clearly is not reasonable; the habitat value should logically be 0.0.

**Significance – High:**

Models that can generate an HSI value no lower than 0.1 will consistently overstate the habitat quality/potential of low-quality sites.

**Recommendations for Resolution:**

To resolve these concerns, the documentation would need to be expanded to include:

- Narratives for each model variable should be enhanced to provide the exact reasoning for each associated SI curve.
- Closely evaluate each SI curve for each model and justify keeping the SI above 0.1.
- Evaluate each aggregation equation, especially those that use arithmetic means to ensure that the potential effect of a 0.0 SI can accurately be reflected.
**Comment 2:**

**Justification for assigning variable weights needs to be provided.**

**Basis for Comment:**

Weights in the models involve two aspects; 1) the weight or importance of a variable against other variables; and 2) Suitability index (SI) graph values assigned by class or variable measurements for a particular variable. A suitability index graph is a graphical representation of how fish and wildlife habitat quality or "suitability" of a given habitat type is predicted to change as values of the given variable change, and allows the model user to numerically describe, through a Suitability Index, the habitat quality of an area for any variable value. In these models each Suitability Index ranges from 0.1 to 1.0, with 1.0 representing the optimal condition for the variable in question. Suitability Index (SI) graphs are constructed for each variable in the models.

The weighting assumptions for variable importance and assigned SI values for variable measurements should be justified based on scientific literature. The SI curves are not well supported by referenced literature or detailed discussion. More detail is needed with supporting data for the SI curves in nearly all models. Some weights appear to be subjective. Including relevant citations would lend considerable confidence in and credence to the model, and in some cases make them believable.

In none of the models (except perhaps the Coastal Chenier/Ridge Community Model) are the explanations of the reasoning and supporting data behind the SI curves provided. The SI value for any variable depends on where variable values are placed along the SI curve, thus establishing the weighting within a variable. In particular, seldom if ever was a sound, reasonable, biologically supported (by data and references) argument made for the specific shape of SI curves. Although there is a pretty sound biological basis for most of the SI curves, they should be documented and supported.

In a number of cases weighting was used in aggregation equations, yet very weak support was provided to support the degree of weighting. Example 1) In the Barrier Island and Barrier Headland Community Models, the rationale for the selected weights is not clearly explained and justified. The weights assigned to individual variables appear to be somewhat arbitrary. For example $V_1$ & $V_2$ get a 0.14 and $V_3$ gets 0.17. The difference of 0.03 is not really meaningful. Also, $V_6$ gets a weight of 0.15 and $V_4$ & $V_7$ get a weight of 0.1. More justification and explanation here would be quite useful – as it now stands, there is no strong support for minor differences in the weights. No reasons are given for the weights.

Example 2) The intertidal habitats probably should be handled separately in the marsh models. Based on available literature, a geometric mean rather than arithmetic mean appears more suitable for the aggregation equation. Also, based on our knowledge of models it might have been reasonable to consider two components of the model, and perhaps combine variables $V_1 - V_3$ in one equation, which would represent the overall physical characteristics of the island, and then use $V_7$ and possibly $V_6$ as modifiers of the resulting HSI value.

**Significance – High:**

In most cases the assigned weights on SI curves or weights of variables are not well supported by cited literature or detailed discussion and can lead to erroneous values of habitat value.

**Recommendations for Resolution:**

To resolve these concerns, the documentation would need to be expanded to include:

- Supporting data from the literature or unpublished studies should be provided to further support the weighting of variables and SI curves.
### Comment 3:

The number of target years should be increased to improve the predictive ability of the models given that changes are often non-linear.

#### Basis for Comment:

The overall model currently requires projecting ecological conditions at 0, 1, and 20 years into the future. Predicting future conditions based on only three time periods may make it difficult to accurately estimate target years when ecological changes occur on a more frequent basis. Increasing the number of target years will more fully capture nonlinear change functions, such as s-curves and improve the predictive capability of the overall models.

#### Significance – High:

Using only three target years to assess ecological conditions will significantly increase the likelihood that estimated future conditions are inaccurate or biased, leading to flawed decision making associated with a particularly restoration project.

#### Recommendations for Resolution:

To resolve these concerns, the documentation would need to be expanded to include:

- Protocols with target years spaced at a minimum of five-year intervals.
- Protocols to observe ecological conditions in the future so that models can be recalibrated based on actual conditions.
**Comment 4:**

In the spreadsheet for the marsh models, open water and emergent marsh AAHUs are incorrectly combined and should be added rather than taking the weighted arithmetic mean (model issue).

**Basis for Comment:**

The Coastal Marsh Community Habitat Suitability Index (HSI) models appropriately recognize that the contribution of open water and marsh cover can be different, and separate HSI values are calculated for marsh and open water. These HSI values are then multiplied by their respective areas of open water or marsh, Habitat Units (HU) are determined for each target year being evaluated, and ultimately Average Annual Habitat Units (AAHUs) are determined for the period of analysis.

To determine the total HUs or AAHUs for the area being assessed, the user would next combine the contributions from marsh and open water by adding the HUs or AAHUs together. However the Benefit Assessment section of the Coastal Marsh Community Models document (page 9) provides weighted formulas to calculate the average AAHUs. This is incorrect, because it results in model output of fewer AAHUs than are being evaluated.

To illustrate, assume 200 ha was being evaluated and the site was 100 ha of marsh, and 100 ha of open water. Assume the derived HSI for the marsh was 0.6 resulting in 60 HU for the marsh, and that the HSI for open water was 0.4, resulting in 40 HU for the open water. (We will simplify the example and assume habitat is consistent over time, and the HU = AAHU.) If this was a Fresh Marsh, using the equation on page 9, we would calculate the “net AAHUs” as \([(2.1 \times 60) + 40] / 3.1 = 53.55\) AAHU provided by the 200 ha.

This value is clearly wrong. A total of 200 ha was being evaluated, and the total AAHUs provided by the two cover types (marsh and open water) will be 60 + 40 = 100 AAHU. It is inappropriate to carry out the weighting at this point. If, in fact, the open water habitats are of lower quality than the marsh, then that should be reflected in the HSI calculation.

**Significance – High:**

Applying the current formula will consistently result in fewer AAHUs than actually will occur on the site being evaluated and result in invalid results.

**Recommendations for Resolution:**

To resolve these concerns, the documentation and/or spreadsheets would need to be revised as follows:

- Do not use the weighted AAHU formulas as presented on page 9 of the marsh community model documentation because they are incorrect.
- Apply simple addition to sum the AAHU provided by both open water and marsh.
- Develop an approach to weight marsh more than open water by applying a modifier to the Open Water HSI calculation. For example, the user could apply a “penalty” factor such as 0.6 or 0.8 as a multiplier to the Open Water HSI to reflect the perceived lower quality of this cover type relative to marsh. The result, when calculating total HUs and AAHUs appropriately summing the subtotals from Marsh and Open Water, will be to reduce the overall contribution from the Open Water.
## Comment 5:

Off-site or surrounding human impacts and disturbances should be addressed by the models.

### Basis for Comment:

The project site is not isolated in space, but instead will be impacted from adjacent or surrounding human activities. Land use changes involving increased area of impervious surfaces or high intensity uses should be considered when predicting the conditions of future ecological conditions at the site level. Many projects will be implemented in areas expecting human population growth and development within a twenty-year time horizon that will affect ecological conditions within the project area.

### Significance – High:

Without thoroughly incorporating offsite human disturbances, models that predict ecological conditions for target years may be inaccurate or biased, leading to poor decision making associated with restoration projects.

### Recommendations for Resolution:

To resolve these concerns, the documentation and/or spreadsheets would need to be revised as follows:

- Incorporate variables into the models that represent existing and expected human disturbances, including but not limited to: land use changes, increased areas of impervious surfaces, high intensity uses, rapid population growth, watershed-level inputs, etc. OR
- Develop a protocol for including the effects of human impacts/disturbances for future projections external to the model.
**Comment 6:**

Sea level is an important phenomenon and relative sea level rise and climate change should be included in the models.

**Basis for Comment:**

- Relative sea level rise is accepted as a real ongoing phenomenon that will have a significant impact on any long-term project or prediction.
- In the general area of application in LA and TX relative sea level is likely to increase during the next 100 years at least 0.3 m across the region and as much as 2 m in some parts of the region. These higher rates will be largely in the LA and eastern TX area where subsidence rates are the highest. This projected rate is consistent with historical trends and the IPCC 4th Assessment Report findings. There are also higher published estimates which would even increase these rates of relative sea level rise.
- The vegetation and, consequently, the habitat will change as the relative elevation changes with regard to the adjacent waterbody, fresh or salt, as a result of sea level rise or subsidence. For example, in a saline environment, over time the *Spartina patens* will convert to *Spartina alterniflora*. This process will occur slowly but will definitely affect the relative value of the habitat.

**Significance – High:**

The change in Average Annual Habitat Units (AAHU) is estimated over a 20 year period in many cases, and the results of the investment in a habitat could readily disappear as the habitat changes to adapt to the proximity to sea level.

**Recommendations for Resolution:**

To resolve these concerns, the report would need to be expanded to include:

- Guidance on selecting appropriate rates of relative sea level rise tied to geographic regions.
- Direction on how to incorporate change in variables as position of sea level increases and encroaches on or inundates the study area. The effect of relative sea level rise on conversion of intertidal to subtidal is an example of an obvious change that will affect the AAHU estimates.
Comment 7:

**Validation of the models based on performance measures needs to be described and documented.**

**Basis for Comment:**

An important step in any model building process is to ensure that the model performs in the way intended, and that output of the model is reasonable. Validation and testing can be conducted at several levels:

1. **Expert review** – Knowledgeable individuals can be asked to go over the model, the assumptions, input variables and expected outputs. An expert review can, at the very least, provide some verification of the model structure and expected output.

2. **Testing with hypothetical data** – The model can be validated and evaluated by developing hypothetical data sets that represent different sets of habitat conditions. Running the model on different data sets allows the user to assess whether the model structure and output are logical and reasonable. This approach can also be used to assess the sensitivity of the model to changes in the various variables.

3. **Testing with field data** – This is the best means to evaluate just how well a model achieves its goals. For HSI models, the ideal would be to select several study sites and record the required habitat variables on the sites along with measures of the population/community that reflect the performance measure. A positive relationship between the performance measure and model output will indicate a valid model that can be applied with confidence.

There was no evidence that any of the models reviewed had been tested or validated in any way.

**Significance – High:**

Without testing, the user has no way to be assured of the validity of the models being applied.

**Recommendations for Resolution:**

To resolve these concerns, implement and document the following actions:

- Develop sample data sets representing different habitat conditions and run them through the model to evaluate the output.
- As many of these models have been in use, determine whether ancillary data are available for the performance measure from the sites where they have been applied. The model output could then be compared to the performance measure.
- Consider conducting field studies specifically designed to evaluate model output relative to the performance measure for the models being reviewed.
Comment 8:

The model documentation should clearly state the basis for the model assumptions, the theoretical basis of the models and how the science is applied for these ecosystems, and how the models were developed to eliminate the appearance of subjectivity.

Basis for Comment:

The peer-review process is a critical foundation of scientific integrity. There is no objective way to verify the accuracy or integrity of data, analyses, and interpretations that have not been peer-reviewed. Models are [nearly always] based on peer-reviewed scientific information, and the peer-reviewed scientific literature should be used to document all aspects of models (model justification, construction, quantitative relationships, and interpretation of output). Expert opinion or best available knowledge may be used to support models, but this is generally only where data from peer-reviewed literature are in conflict or are difficult to apply to a specific model situation. By citing the scientific literature and published data, model developers impart integrity on their models and provide model users with readily available sources to verify the models.

Many decades of high-quality research has been conducted in northern Gulf coast ecosystems. The peer-reviewed scientific literature is rich with information that may be used to support the ecosystem descriptions in WVA model documentation and assumptions. However, only one of the WVA models reviewed (the coastal Chenier/ridge model) made any reference to the primary literature or to past research. Because of this, much appears to have been simply left to trust. The peer review panel had little way of knowing how contemporary theory or available, peer reviewed information was used in model justification, assumptions, development, construction, and interpretation.

Significance – High:

The integrity and validity of the WVA models may be questioned if it is not clear that data and analyses from the peer-reviewed scientific literature were used in all aspects of model development. It is not as critical that ecosystem descriptions be supported by the scientific literature, but this would lend considerable trust and model integrity.

Recommendations for Resolution:

To resolve these concerns, the documentation would need to be expanded to include:

- The use of peer-reviewed data and analyses by citing the scientific literature in model documentation justifying: 1) assumptions; 2) selection of HSI variables; 3) quantification of SI relationships; 4) weighting factors in the combined HSI equations, and; 5) the use of model output.
- Explanations of when and how expert opinion or best scientific information was used to augment peer-reviewed data and analysis from the primary literature.
Comment 9:

The methods for data collection are unclear and not well-documented, therefore data quality is uncertain.

Basis for Comment:

How variables are to be measured is not clear in different HSI models and needs to be clarified. Generally the variables are measurable, but the models need better descriptions of exactly how to get the variable estimates. There were inconsistencies in descriptions of measured variables between documents, and of the data sources that were discussed, some were outdated, and many did not have enough associated metadata to determine how data could be retrieved. There needs to be a limitations section for the degree to which data are available and the accuracy to which variables can be measured.

Examples of problems in documentation:

- There is a need to clarify how to measure rates of wetland loss and how to measure dunes.
- Relative to V3 of the Coastal Marsh Models, “interspersion” should be defined. This term can have different meanings and interpretations, and the references in the methods section to an appendix only made it more difficult to fully understand what is meant by “interspersion”.
- The salinity variable is supposedly collected at the surface and bottom of water column, but it is not clear how to use the information, whether the difference, an average, or other treatment.
- In some cases (e.g., salinity) there is considerable reliance on existing data, while in other cases (e.g., SAV coverage) there is a surprising reliance on subjective sources, such as land managers and local stakeholders. The latter are not necessarily less reliable, simply less consistent across projects.
- Suggestions for measurement appear to be reasonable but somewhat ambiguous. For example, for V1 (Swamp Community Model) the recommendation is for using “plots or transects.” A more exact description of what sort of transect or plot to apply (e.g., point intercept, line intercept) would help to ensure that all projects are consistent in their data collection approach.
- In some cases, there were discrepancies between the introductory material, procedural manual, and individual model documentation. For example, the procedures manual is different from the habitat models (e.g., p. 9 of the procedures manual discusses marsh creation, marsh nourishment, etc. under V1, but the marsh model manual does not discuss these at all [p.3 & 4]).
- The documentation for classifying communities and determining boundaries between communities is lacking for the most part. Inconsistencies in classification can result in an inappropriate model application or interpretation of variable.
- The justification for a 50% credit for shoreline erosion with a created nourished marsh should be explained.
- There is no mention of the use of LIDAR data, although this is an available and accurate data source for elevations.

In south Louisiana estuaries, typical tidal ranges are on the order of 30 cm while across the coast sea level varies by roughly 30 cm over the year (with peak coastal sea levels in late summer/early fall and the lowest levels in the winter). Given that water levels vary daily and seasonally by about a foot, using a single value for percent open water for a given year seems reasonable unless it is possible to dramatically increase the temporal resolution of this variable.

- The hydrologic data and the WVA Swamp Community Model must be able to differentiate seasonality in water levels.
- Details of how V1 (stand structure) and V2 (stand maturity) will be measured were not adequate in the Swamp Community Model. Swamp ecosystem stability and longevity depends on the forest having a balance of mature and young trees and viable seedlings and saplings of critical species. It is not clear whether the model developers intend for a full-range age structure to be measured from descriptions of V1 and V2 or how this full-range age structure of the trees would be measured (it cannot be done by overflights, for example).
- It is unclear in V2 (Swamp Community Model) how to link DBH and basal area in calculations.
- For the Swamp Community Model percent cypress variable, it is unclear whether this is overstory...
percent. What number are you supposed to enter for basal area from the suitability index line in methods?

- There were no procedures to quantify hydrologic, geomorphic or hydrodynamic changes over time. There are some references which lead to very technical approaches which will take a highly trained person to complete.
- Hydrological data sources should be better described, with recognition of their spatial errors and inconsistencies. Better quality data contribute to better model applications.
- In the marsh models, no mention was made of how V4 will be quantified in the field for any given project.
- For V3, the marsh edge and interspersion classes are open for interpretation and may result in some inconsistencies of measurement and results.
- For the Barrier Island and Barrier Headland Community Models, the variables are relatively easily measured. However, there may be overlap between V4 and V5 that should be clarified. V6, interspersion and edge, is somewhat subjective and has the potential to be misinterpreted by model users.
- A rationale needs to be provided for having the optimal SI values for V1, V2, and V3 (which should be additive for total island land cover) always total 100%.
- Some of the variables in the models are very subjective (e.g., V6, edge and dispersion, is very subjective).
- There is no allowance for the percent of beach affected by beach/surf features (i.e., length of beach protected by breakwaters).

**Significance – High:**

Without consistent protocols that are clearly laid out, it may be difficult to replicate data collection across multiple sites and provide consistent application of the models with variation in personnel.

**Recommendations for Resolution:**

To resolve these concerns, the documentation would need to be expanded to include:

- Greater documentation related to variable measurement in the field. For example, more exact descriptions of how to collect the data for some variables are needed (e.g., canopy cover, midstory cover).
- Protocols for evaluating each site at which a model will be applied to determine whether proper data are available and can be collected properly.
- Protocols for field verifying classification of communities for some projects and documentation in the application, to assure appropriate data are collected.
- Standardized protocols for boundary determination should be developed with particular attention to spatial scale, again to assure appropriate data are collected for any particular community.
- Guidance for taking additional on-site measurements via GPS or surveyors and using new photography for more recent time periods should be provided. Alignment of photos or placement of GPS points, survey points, in GIS overlay maps are important to obtain reliable data.
- Some additional clarification or guidance related to the “small” or “insignificant” areas of habitat patches within larger areas. For some species/communities, particular cover types may have importance disproportionate to their size. Following the path suggested here, they could be lumped in with other cover types, and their potentially significant contribution lost in the analysis. We suggest that a couple of modifications be considered: First, perhaps establish a percentage of area threshold to be met; for example, if a cover type is less than 5% of the total area, then it could be considered for combining with other types. The second suggestion is that these decisions should be made and agreed to by the whole evaluation team and not be made by just one individual, and then reported and justified. Lacking this, the decision to include or to lump a cover type could be quite arbitrary.
Comment 10:

For some model variables, policy decisions appear to supersede what is known about the ecology and hydrology of the relationships.

Basis for Comment:

Habitat Suitability Index (HSI) models are intended to capture, within the constraints of the approach, the ecological and hydrologic relationships of habitat suitability to the species/community being modeled. Accordingly, the Suitability Index (SI) relationships that are developed for each variable should reflect the best data available, and include citations from the primary literature for justification.

For two variables in the Coastal Marsh Community Models it appears that the needs of CWPPRA have overridden logical SI relationships. This specifically occurs for:

$V_1$ – Percent of wetland area covered by emergent vegetation. On page 4 of the model we read:

"Optimal vegetative coverage is assumed to occur at 100 percent (SI=1.0). That assumption is dictated primarily by the constraint of not having graph relationships conflict with the CWPPRA's purpose of long term creation, restoration, protection, or enhancement of vegetated wetlands. The EnvWG had originally developed a strictly biologically-based graph defining optimal habitat conditions at marsh cover values between 60 and 80 percent, and sub-optimal habitat conditions outside that range. However, application of that graph, in combination with the time analysis used in the evaluation process (i.e., 20-year project life), often reduced project benefits or generated a net loss of habitat quality through time with the project."

The authors clearly acknowledge that that optimal percent cover of emergent vegetation in a marsh is between 60-80%; this is biologically sound, and can be well supported from the literature. However, apparently because of the CWPPRA goal of establishing marshes with 100% cover, the SI curve for $V_1$ only achieves a value of 1.0 at 100% cover which makes $V_1$ more likely to generate successful outcomes for restoration projects but not ecologically defensible. Tidal marshes by definition cannot be 100% marsh because tidal creeks are necessary to convey tidal water and energy. The actual marsh:open water optimum will depend on tidal range (which equates to energy), land slope, etc. These values should come from the primary literature.

$V_3$ – Marsh edge and interspersion – the effects of the SI curve developed for $V_1$ directly impact the edge/interspersion variable. This is a good, logical variable and marshes with good interspersion of open water and emergent cover are biologically optimal for the greatest number of species. For example, a considerable amount of research has been done and published on how marsh edge:area ratios relate to shrimp use of intertidal marsh (though this literature was not cited). Given this, it was surprising to see that interspersion Class 1, which has little or no marsh edge and very few tidal creeks, was given an SI of 1.0. The justification for this seems to be that Class 2 is probably a marsh that has deteriorated from a Class 1 status. This makes neither biological nor physical sense. Intertidal marshes have an inherent drainage dendrology that is related to tidal range and tidal energy. This creek network is essential to the movement of tidal water and its contents (animals, nutrients, organic matter, etc.) and thus to the functioning of the marsh ecosystem. Interspersion Class 1 should probably have a lower SI than Class 2. Notably, on page 5 of the model the following rationale is presented:

"A relatively high degree of interspersion in the form of stream courses and tidal channels (Interspersion Class 1) is assumed to be optimal (SI=1.0); streams and channels offer interspersion, yet are not indicative of active marsh deterioration. Areas exhibiting a high degree of marsh cover are also ranked as optimal, even though interspersion may be low, to avoid conflicts with the premises underlying the SI graph for variable $V_1$."

While this reduces potential conflict with $V_1$, it also is not logical, that two substantially different marsh conditions, solid emergent vegetation, and marsh with a high degree of interspersion of open water and emergent vegetation, should have the same value of 1.0.
There is a conflict here that confounds the model. If the goal is to develop marshes with 100% emergent cover, then that is the only variable that need be considered, and a model is not necessary. If, however, the goal is to develop marshes with the highest ecological value possible to the associated animal community/assemblages, then $V_1$ and $V_3$ must be changed to reflect ecological and hydrologic/physical reality rather than policy.

**Significance – High:**

The marsh models as they now exist do not reflect ecological reality and their application is suspect.

**Recommendations for Resolution:**

To resolve these concerns, the models and documentation would need to be revised as follows:

- Change $V_1$ to reflect an SI value of 1.0 when cover is between 60 and 80% emergent vegetation, as discussed in the model discussion or as the scientific literature supports for any given marsh ecosystem type.
- Change $V_3$ so that a marsh with 100% emergent cover and no interspersion cannot receive an SI value of 1.0.
- Change $V_2$ – this variable only takes an SI value of 1.0 at 100% cover of SAV in areas of open water. This is unreasonable, and it is unlikely that open water will ever have the optimal conditions. Further research is necessary and the SI optimum should be justified using the scientific literature, noting that a goal-oriented SI of 1.0 for 100% cover is still possible.
Comment 11:

The spreadsheets for the models as created are likely to lead to errors in maintenance and use.

Basis for Comment:

There are two related issues. The first is that the spreadsheet user interface is designed to be clean and minimal. However, the person inputting the data is given so little cueing that errors are almost inevitable. This issue is discussed in Comments 13 and 14.

The second issue, which is the focus of this comment, is that there are several places where the user is expected to do calculations that the spreadsheet should be doing. Having the user do calculations is likely to lead to error. In addition, how the user did a particular calculation will not be captured on the sheet, leading to the impossibility of auditing.

Swamp WVA: V1 Stand Structure [Minor Problem]
The user has to refer to the documentation to enter a Class value based on overstory closure, scrub-shrub midstory cover, and herbaceous cover. To do this, the user must refer to printed documentation. This is very poor practice. The user has already entered the values needed for the calculation of the class. The spreadsheet should compute the class value. At the very least, if the value is not calculated, the table should be placed on the spreadsheet for the user.

SWAMP

Variable V1 Stand structure.

Each component of stand structure should be viewed independently to determine the percent coverage.

<table>
<thead>
<tr>
<th>Class</th>
<th>Overstory Closure</th>
<th>Scrub-shrub Midstory Cover</th>
<th>Herbaceous Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>&lt;33%</td>
<td>&lt;33%</td>
<td>&lt;33%</td>
</tr>
<tr>
<td>Class 2</td>
<td>33%≤50% and</td>
<td>&lt;33% and</td>
<td>&lt;33%</td>
</tr>
<tr>
<td>Class 3</td>
<td>50%≤75% and</td>
<td>&gt;33% or</td>
<td>&gt;33%</td>
</tr>
<tr>
<td>Class 4</td>
<td>50%≤75% and</td>
<td>&gt;33% or</td>
<td>&gt;33%</td>
</tr>
<tr>
<td>Class 5</td>
<td>≥50%</td>
<td>≥33%</td>
<td>≥33%</td>
</tr>
<tr>
<td>Class 6</td>
<td>≥75%</td>
<td>≥33%</td>
<td>≥33%</td>
</tr>
</tbody>
</table>

OR
Swamp WVA Variable V2, Stand Maturity [Serious Problem]
The SI is the basal area times a factor based on density. The user should be able to select a density, perhaps from a drop-down menu, followed by the basal area in square feet (again, cueing the user for units). The spreadsheet should then do the SI calculation for V2. This is a doubly serious problem because the documentation for V2 does not tell the user what to put in the input cell for Basal Area.

AAHU Calculations [Serious Problem]
The AAHU calculations are not intuitive. The user must type the year numbers and the acreage for each year. In addition, the last year should be 20, because the AAHU calculation normally divides the Total CHUs by 20. This section is not at all obvious to someone looking at the spreadsheet. Even if they read the documentation, understanding how the spreadsheet implements the required calculations is not easy to understand.

In addition, the year of the project could be made a data entry cell for the year in SI calculations for the individual years. It could then be copied down to the AAHU calculation area.

Note:
Problems are defined as follows:
- Very serious - the error is likely to lead to a substantially incorrect final number or that the model will not compute an answer
- Serious - there is a reasonable possibility that the error will lead to a somewhat incorrect final number or there is a lower possibility that the model will lead to a substantially incorrect number
- Minor - the likelihood of leading to substantially incorrect number is low, but the error should be corrected
- Substantially - the margin of error is likely to be larger than 10%

**Significance – High:**

Requiring the user to do calculations is a serious problem. First, it tends to increase errors because every time a human does a calculation there is a small but significant error rate. Second, the model’s use cannot be audited or defended because there is no way to know how a user who did a calculation arrived at that number.

**Recommendations for Resolution:**

The way to resolve issues regarding unnecessary user calculations is to have the worksheet do these calculations.
### Comment 12:

Several inaccuracies were identified in the model spreadsheets that should be corrected (spreadsheet issue).

#### Basis for Comment:

Inaccuracies come in four types.

1. There are calculation errors—formulas that are incorrect in terms of the specifications.
2. There are some specifications that are wrong or missing.
3. There are some problems with error messages.
4. There is a spelling error. Hydrology is spelled “Hyrology” in the Swamp LDNR model.

#### 1. Calculation Errors

**Brackish Marsh**

AAHU Calculation [Potentially Serious Problem]

The cumulative HU total is divided by 50 instead of by 20. This appears to be an error. If so, it will create a major bottom-line error in the AAHU calculation.

There is a “2” in H8. Nothing in the specification indicates that it should be there. This may be left over from a previous use of the spreadsheet. [minor but confusing and unprofessional in appearance]

AAHUs: #REF errors appear. Nothing in the specification indicates that they should be there. These also may be left over from previous use, and they also should be changed. [minor but unprofessional in appearance]

**Barrier Island**

V6 Interspersion [Very Serious Problem]

In the review copy of the model, an error message appeared even if the values were entered correctly.
### Swamp WVA

V2 SI Calculation [Potentially Very Serious Problem]
The HSI calculation does not include D127, the contribution from the trees.
This appears to be an error, but the specification document is unclear.
At the minimum, the document must be clarified.
If the formula for HSI is wrong, it must be changed.

---

#### WETLAND VALUE ASSESSMENT COMMUNITY MODEL

**Barrier Island**

**Project:**

**Condition:** Future Without Project

<table>
<thead>
<tr>
<th>Variable</th>
<th>TY 0</th>
<th></th>
<th>TY 1</th>
<th></th>
<th>TY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value</td>
<td>SI</td>
<td>Value</td>
<td>SI</td>
<td>Value</td>
</tr>
<tr>
<td>V1 % Dune</td>
<td>20</td>
<td>0.82</td>
<td>20</td>
<td>0.82</td>
<td>20</td>
</tr>
<tr>
<td>V2 % Supratidal</td>
<td>20</td>
<td>1.00</td>
<td>20</td>
<td>1.00</td>
<td>20</td>
</tr>
<tr>
<td>V3 % Intertidal</td>
<td>20</td>
<td>0.10</td>
<td>20</td>
<td>0.10</td>
<td>20</td>
</tr>
<tr>
<td>V4 % Vegetative Cover</td>
<td>20</td>
<td>0.38</td>
<td>20</td>
<td>0.38</td>
<td>20</td>
</tr>
<tr>
<td>V5 % Woody Cover</td>
<td>20</td>
<td>1.00</td>
<td>20</td>
<td>1.00</td>
<td>20</td>
</tr>
<tr>
<td>V6 Interspersion Class 1</td>
<td>20</td>
<td></td>
<td>20</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Class 2</td>
<td>20</td>
<td></td>
<td>20</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Class 3</td>
<td>20</td>
<td></td>
<td>20</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Class 4</td>
<td>20</td>
<td></td>
<td>20</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Class 5</td>
<td>20</td>
<td></td>
<td>20</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>V7 Beach/Surf Zone</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\text{HSI} = 0.447
\]

There is an ERROR message even when the interspersion class percentages equal 100
canopy, weaker trees are out-competed and eventually die, forming additional snags and downed treetops that would not be present in younger stands. The suitability graph for this variable assumes that snags, cavities, downed treetops, and invertebrate production are present in suitable amounts when the average diameter-at-breast height (DBH) of canopy-dominant and canopy-co-dominant trees is above 16 inches for baldcypress and above 12 inches for tupelologum and other species. Therefore, stands with those characteristics are considered optimal for this variable (SI = 1.0).

Another important consideration for this variable is stand density, measured in terms of basal area. A scenario sometimes encountered in mature swamp ecosystems is an overstory consisting of a very few, widely-scattered, mature baldcypress. If stand density was not considered, and average DBH only, then those stands would receive a high SI for this variable without providing many of the important habitat components of a mature swamp ecosystem, specifically a suitable number of trees for nesting, foraging, and other habitat functions. Therefore, the SI for this variable is dependent on average DBH and basal area which is used as a measure of stand density.

Swamp LDNR Model [Potentially Serious Problem]

V2. Maturity: Age or Species Composition and DBH

In case of age, the SI for V2 can be less than 0.1 while the documentation indicates that SIs range from 0.1 to 1.0.
Swamp LDNR Model
V₆ Disturbance [Potentially Serious Problem]
If there are several disturbance types, V₆ must be computed for each type, and a weighted SI must be computed. The spreadsheet does not do this.

Although this is a potentially serious problem, incorporating multiple areas in the spreadsheet would be quite a bit of work.

Swamp LDNR Model
AAHU Calculations [Potentially Serious Problem]
The model divides the Cumulative HUs by 50 instead of the usual 20. No justification for this is provided in the specifications.
2. Specification Errors
Testers must be able to compare the specifications with the spreadsheet code. A lack of specification or an incorrect specification is a serious problem in spreadsheet development.

Swamp WVA
Variable V2 Stand Maturity [Very Serious Problem]
The Basal Area calculation for SI is not defined in the specification. In the spreadsheet, the logic is Basal Area times the Factor selected from the table below, although the variable is labeled as Basal Area.

<table>
<thead>
<tr>
<th>Density</th>
<th>Basal Area</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>&lt;40ft²</td>
<td>0.2</td>
</tr>
<tr>
<td>Moderately</td>
<td>40ft² ≤ BA ≤ 80ft²</td>
<td>0.4</td>
</tr>
<tr>
<td>Open</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>81ft² ≤ BA ≤ 120ft²</td>
<td>0.6</td>
</tr>
<tr>
<td>Moderately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dense</td>
<td>121ft² ≤ BA ≤ 160ft²</td>
<td>0.8</td>
</tr>
<tr>
<td>Dense</td>
<td>&gt;161ft²</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Perhaps to conserve space, SI for Basal Area is not defined in the instructions.

\[ SI = \text{Basal Area} \times \text{Factor} \]

Swamp LDNR Model
V2. Maturity: Age or Species Composition and DBH [Potentially Serious Problem]
An ERROR message appears unless the sum of the Cyprus and Tupelo percentages is 100%. There is nothing in the documentation to justify this. Either this is a spreadsheet error or the specification is incorrect or incomplete.

Fresh-Intermediate Spreadsheet
Incorrect Graph in Specification Document [Minor Problem]
For the fresh and intermediate marshes, the specification document shows SIs falling to zero for V5. The documentation indicates that all SIs should range from 0.1 to 1.0. This is an error in the specification only. The spreadsheet correctly forbids salinity values greater than 5 and 7. The documentation should be changed to avoid later confusion.
Variable $V_5$  Mean salinity during the growing season (March to November).

Suitability Graph

Swamp WVA
Variable $V_2$ Stand Maturity [Minor Problem]
The specifications for $V_2$ are confusing. There are three steps. They should be placed one after another and should be consistent.
3. Error Message Problems

**Swamp WVA**

Variable $V_3$: Water Regime [Serious Problem]

There is no error message if the user fails to enter a value for $V_3$. Failing to enter a value will automatically make the HSI for the year equal to zero.
Although this is a problem with error messages, potential consequences are so large that it has a strong potential for serious errors in final numbers.

**Barrier Island**

V6 Interspersion [Minor Problem]

As soon as you enter the first percentage, an error message appears. This may incorrectly lead the user to believe that he or she is doing something wrong.

---

<table>
<thead>
<tr>
<th>Variable</th>
<th>TY 0</th>
<th>TY 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value</td>
<td>SI</td>
</tr>
<tr>
<td>V1</td>
<td>% Dune</td>
<td>20</td>
</tr>
<tr>
<td>V2</td>
<td>% Supralidal</td>
<td>20</td>
</tr>
<tr>
<td>V3</td>
<td>% Intertidal</td>
<td>20</td>
</tr>
<tr>
<td>V4</td>
<td>% Vegetative Cover</td>
<td>20</td>
</tr>
<tr>
<td>V5</td>
<td>% Woody Cover</td>
<td>20</td>
</tr>
<tr>
<td>V6</td>
<td>Interspersion</td>
<td>%</td>
</tr>
<tr>
<td>Class 1</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Class 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V7</td>
<td>Beach/surf Zone</td>
<td>HSI</td>
</tr>
</tbody>
</table>

If user does not enter a table lookup SI value for the water regime, HSI will be zero because the SI value for the water regime will be taken as zero if the SI is not entered, and HSI multiplies the SI of the water regime by other variables, automatically giving an HSI of zero. There is no error message if V3’s SI is left blank.
### Note:
Problems are defined as follows:
- **Very serious** - the error is likely to lead to a substantially incorrect final number or that the model will not compute an answer
- **Serious** - there is a reasonable possibility that the error will lead to a somewhat incorrect final number or there is a lower possibility that the model will lead to a substantially incorrect number
- **Minor** - the likelihood of leading to substantially incorrect number is low, but the error should be corrected
- **Substantially** - the margin of error is likely to be larger than 10%

### Significance – High:
Errors identified in the spreadsheets affect the usability of the models and confidence in the model output, and could result in erroneous model results leading to improper decision-making for planners.

### Recommendations for Resolution:
In all cases, the solution to the problem is to fix the error identified, using recommendations included with the description of the Basis for Comment.
Comment 13:

The usability of the spreadsheets is limited because of the spreadsheets’ user interface and user and maintainer documentation.

Basis for Comment:

User Interface Issues
Visually, the calculation worksheets are extremely clean. The developers even used the Excel CALL function to hide formulas until the user enters data in appropriate cells. While this may be visually pleasing, users need help entering data into forms. This is especially true if a professional delegates data input to a clerical person or any other person inexperienced with the concepts; but it is even likely to be true for people with strong domain knowledge.

Shading Data Input Cells
It is not obvious where the user should enter the data. Input cells are the same color as other cells—white. Formulas are hidden until data are entered in particular cells; this too makes finding input cells difficult. The solution is to lightly shade all input cells so that users are cued appropriately.

Cueing for Units
Once the user finds an input cell, the next step is to enter data. This requires the user to know what units are appropriate. Units should always be indicated in labels or through data validation messages, which are discussed under Final Panel Comment 14.

The cueing problem is severe for percentages. The user is not provided any guidance regarding whether to enter 85% as 85, 85%, or 0.85. The answer is that the user should enter the number as a whole number (85). If the person types 85% or .85, this will be taken as 0.85 rather than 85. This will not create error messages, but it will generate sizeable errors in the suitability indices and subsequent calculations. Also, once someone types 85% in a cell, the cell format will be changed to percentage. If someone then correctly types 85, this will be taken as .85.

The problem of percentages does not admit of any clean solution. The user should be prompted to enter whole numbers for percentages. Stating this in the separate written specification documentation is not sufficient. It must be stressed with label cells in the sheet for every input cell.
If data validation is used, as discussed in Comment 14, then if a user enters a value less than one—such as 85% or .85, the user should receive an information message clearly explaining that percentages should be entered as numbers between 0 and 100.

**Generally Descriptive Labels for Users**
In general, sparse labels should be rewritten to give specific information on what the user should do. This goes beyond cueing for data entry format, such as explaining what a user should do in the AAHU section.

**In-Sheet User Documentation.**
In well-developed spreadsheets, there should be documentation for users regarding how to use the spreadsheet correctly. This usually is done in a workbook sheet with a label something like *User Documentation*. This sheet should be general information that users must need plus specific information about each variable and the entry of data for the variable. Ideally, each input cell should have a link to its particular documentation.

The specification documents cannot replace in-spreadsheet user documentation. First, the specification document was created primarily for spreadsheet developers. While some user assistance is present in the specification document, it is insufficient. For instance, the way that the user must enter data into the average units calculation area is very complex. The specification documents provide no help to the user regarding what they must do to enter data. Despite this, in-sheet user documentation should refer to specific pages in the specification document to help users work through problems.

In addition, the PDF or Word for Windows specification document should be copied into a worksheet in the workbook. Written or online specification documents are not always available when a user needs help. Copying the specification document into a separate worksheet and then naming the sheet appropriately addresses this problem. Although this increases spreadsheet file size, the file sizes are very small, so copying the documentation should create no problems. In particular, it would not increase recalculation time as a large amount of logic would.

**Written Maintainer Documentation.**
The spreadsheet will need to be maintained. There should be a documentation worksheet for maintainers separate from the documentation worksheet for users. This will again have an overview and links to individual input cells summarizing calculations.

This worksheet will document how the spreadsheet is organized for each calculation. For example, some SI-related calculations are done to the right of the input section for the variables. The maintainer must understand that calculations do not read from left to right, as they normally should. To give another example, the AAHU calculation section and its direct antecedents is rather difficult to understand. Specific information on these sections is critical for maintainers. In general, the logic of spreadsheets is not self-documenting. The step from specifications to spreadsheet logic is sometimes complex. It must always be documented, even if the developer feels that calculations are obvious.

Maintainers also need such standard information as version number, file name, storage location, and similar information. They also need information on version history, so that they can understand what changes were made in each revision and why they were made.

As noted earlier in this comment, the PDF specification document for each model should be copied and pasted into a tab on the spreadsheet. This will prevent the PDF specifications from being lost. However, such voluminous information is no substitute for user documentation or maintenance documentation.

**Introductory Documentation**
When a user, maintainer, or manager comes across a spreadsheet for the first time or after long non-use, he or she needs to see quickly what the spreadsheet model does and what limitations it has. An introductory documentation worksheet should give this information in concise format. It should not describe in detail how the spreadsheet works.
**Significance – High:**

With little visual guidance on the calculation worksheets and no in-workbook documentation, users and maintainers are likely to make more errors and spend more time doing simple tasks.

**Recommendations for Resolution:**

Specific resolution recommendations were included in the Basis for Comment. These fell into three general categories.

- To improve the user interface, there should be shaded data input cells, cueing for units, and generally more descriptive labels.
- There should be documentation worksheets separate from the calculation worksheets. One should give an introduction to the spreadsheet, another should have user documentation, and another should have maintainer documentation.
- The specification documents in PDF or Word for Windows format should be copied into its own worksheet.
### Comment 14:

**Data validation needs to be built into the spreadsheets.**

### Basis for Comment:

Users may enter incorrect data in input cells. In some cases, they may enter numerical data out of range. As noted in Comment 11, the user may enter a percentage as a percentage instead of a whole number. Or, the user may enter a minus sign before a number that should be positive. In other cases, users may enter text or other information where they should enter a number. For instance, if text is placed in an input cell, it often will be treated as a zero in calculations.

### Significance – High:

If text is placed in an input cell, it often will be treated as a zero in calculations. This can create serious errors. This is especially true in these models because variables are often multiplied together, and multiplication by zero always gives zero. If the user enters a percentage as a percentage instead of a whole number, a serious error will occur in the calculation of SIs.

### Recommendations for Resolution:

Excel data validation should be applied to every user input cell. Excel data validation can cue the user what to enter in a cell and warn them or prevent them if they attempt to enter out-of-bounds input text or numbers.

To apply Excel Data Validation to a cell, the developer clicks on the input cell, then selects Data Validation under the data menu. This brings up the Data Validation dialog box.

The dialog box shown below is open to the Settings tab. If the spreadsheet should require a whole number, the developer can select Whole Number. Selecting any choice other than any value will lead to a second dialog box that will allow the developer to select a range of possible whole numbers.

![Data Validation Dialog Box](image)

Depending on which type of data the user will allow, appropriate selection criteria will appear.
Under the Input Message tab, The developer can specify an input message. This is a good way of addressing the need to tell the user how to enter percent values or in general what values are acceptable. To avoid clutter, input messages are optional.

Under the Error Alert tab, the developer can also specify an action to take if the user ends an out-of-bounds value. This can reject the input value (Stop), accept it but warn the person (Warning), or accept it but provide information on the issue (Information). The latter two Styles accept the data value but differ in the sternness of their feedback.
As noted in Comment 11, percentages are special problems. If the entered value is less than 1.0, then it is highly likely that the user entered the percentage as a percentage or a decimal number such as .35. The error alert message might ask the person to be certain that they are entering percentages as numbers between 0 and 100 rather than as percentages.
**Comment 15:**

The WVA method should be expanded to handle risk and uncertainty in areas exposed to episodic events.

**Basis for Comment:**

- The effects of storm surge, waves and wind are exceptionally strong at the coastline. Further inland, the effects of surge and wind can be very significant. The effect of these storms can cause vegetative and animal impacts that take many years to recover to pre-storm conditions if ever.
- Risk is not only about the probability of a storm affecting the region or project, but it is about the value of the damages suffered from the effects of the storm.
- Most of the coastline in LA and TX is highly vulnerable to erosion and habitat loss in association with tropical storms and frontal passages. For example, it is estimated that 56,000 ha of land were lost in Louisiana alone during Hurricane Katrina.
- Although there are reasonable statistics on the return period of tropical storms, including hurricanes, the prediction of a storm with specific characteristics is not possible. For example, the Sea Rim State Park in Texas has survived several severe hurricanes and tropical storms, Rita, Katrina, Alicia and Allison, that passed nearby and did little to affect the area. Hurricane Ike, while similar in intensity to Rita and Alicia, caused damages that will take decades to recover. The difference was primarily due to the track of the storm relative to the Park when compared with the above named storms.
- The potential for storms to affect an area should be considered in the context of a probabilistic event. While risk and uncertainty is not covered in the referenced documents, there should be a discussion of the process of determining the risk for a specific project.
- Very clearly, the location of any coastal habitat project within 10 miles of the Gulf coast will face a real risk which should be quantified. For example, the loss of dunes can be determined for ‘design conditions’ and then their protective and habitat values can be recalculated for those conditions.

**Significance – High:**

Habitat assessment is being considered for sites that are in areas exposed to tropical storms and are therefore at risk of assessment scores changing as the habitat is affected by these episodic events. This impacts projected habit quality values based on models that do not account for these episodic events.

**Recommendations for Resolution:**

To resolve these concerns, the documentation would need to be expanded to include:

- Discussion of the importance of considering risk in the development and evaluation of coastal habitat projects.
- Procedures to evaluate the risk associated with damages to habitats in areas that are vulnerable to tropical storms.
### Comment 16:
The WVA method should be updated, taking into account new sources of GIS data, LIDAR, and other new data sources, as well computer simulation and visualization tools.

### Basis for Comment:
The WVA process references older geospatial data for boundary determination and variable measurement. Taking into account more recent available data sources, which may include NOAA Coastal Change Analysis Program (C-CAP) data, Landsat imagery, LIDAR, etc. at finer spatial resolutions may significantly improve the accuracy of measurement and reliability of model applications.

### Significance – High:
Using outdated sources of information at course spatial scales could lead to inaccurate boundary determinations and a biased WVA measures.

### Recommendations for Resolution:
To resolve these concerns, the documentation would need to be expanded to include:
- More recent spatial data sources.
- Simulation models and visualization technology tools to better predict and represent project areas and future ecological conditions.
- Protocols for regular updates as new tools and data sources become available.
| Comment 17: | Development and documentation of a more precise approach to measurement of some variables could be improved. |
| Basis for Comment: | A more precise and clear description of how to measure all input variables to the HSI models is needed. Some descriptions for data collection are vague, which could lead to considerable variation in the way in which field data are collected. As a result there could be inconsistency in the results generated by the WVA process. Each HSI model should include detailed, documented descriptions of how to record field data, as should the WVA procedures manual. |

There was uneven treatment of methods for data collection in the documentation. The issues of greatest concern are:

- The level of accuracy in photos used in GIS to calculate differences between years is unclear. Errors can occur due to improper alignment of photography, scale at which photography is digitized, quality of photos, time of year of photos, habitat recognition (classification) differences between personnel and time periods. These differences should be specified, if possible, so that users can decide on the reliability of the data used in models.
- Suggestions for measurement often appear to be reasonable but somewhat ambiguous, for example for V1 (Swamp Community Model) the recommendation is for using “plots or transects”. A more exact description of what sort of transect or plot to apply (point intercept, line intercept?) would help to ensure that all projects are consistent in their data collection approach.
- Details of how V1 (stand structure) and V2 (stand maturity) will be measured were not adequate in Swamp Community Model. Swamp ecosystem stability and longevity depends on the forest having a balance of mature and young trees and viable seedlings and saplings of critical species. It is not possible to determine from descriptions of V1 and V2 how this full-range age structure of the trees would be measured.
- In the Swamp Community Model, data sources for flooding depth, flooding duration, and water exchange factors used in variables V1 and V2 are not specified. It is not clear from this document how these hydrologic parameters will be quantified. The description on p.14 merely identified them—correctly—as being important.
- It is not clear from the Swamp Community Model documentation how V3 hydrologic parameters will be quantified. The description on p.15 merely notes that it is important to include conditions outside the project area in quantifying baseline conditions.
- In Barrier Headland Community Model, V6 needs to be clarified. It seems overly subjective, and it might be suitable to use habitat patch metrics. It is very difficult to quantify, and the available photos need to have scales to aid in comparisons.
- For the Chenier/Ridge Community Model, there are easy, repeatable forestry techniques for quantifying tree canopy cover from the ground that could be used for V1 and V2 and should be described.
- V4 (Percent of Open Water ≤ 1.5 Feet Deep in Relation to Marsh Surface) in the marsh models needs documentation to describe how it will be measured.
- V5, the salinity variable, of the marsh models is supposedly collected at surface and bottom of water column, but how the difference is utilized in model is not stated. Clarification needs to be given on this variable’s measurement.

Significance – High:

Proper and consistent measurement of variables is needed for models to produce reliable, consistent, and comparable AAHU estimates.

Recommendations for Resolution:
To resolve these concerns, the documentation would need to be expanded to include:

- A recommendation to acquire the most recent aerial or satellite images available or establish projections based on recent historic rates of marsh loss.
- A suggestion to consider using the NOAA CCAP dataset, which is rectified over multiple years at a 30 meter resolution.
- Clear, concise and unambiguous descriptions of variable measurement for every variable in each model.
Comment 18:

The use of the geometric mean may be more appropriate than the arithmetic mean to derive some HSIs. Provide scientific basis for the decision to use one over the other.

<table>
<thead>
<tr>
<th>Basis for Comment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The aggregation equation used to combine Suitability Index (SI) values to derive the Habitat Suitability Index (HSI) for a study site can take a diversity of forms. Whatever form they take should reflect, as best as possible, the ecological relationships underlying the model variables and how they combine to influence habitat quality for the species/communities being evaluated. Adding SI values together is commonly done when no individual variable could be limiting and often when habitat components are supplemental to one another (Stiehl, R.B. 1995. Habitat Evaluation Procedures Workbook. USGS Biological Resources Division, Fort Collins, CO.) Geometric means are commonly used to combine SI values when a factor might be limiting, and they will provide a value typically more conservative than an arithmetic mean for the same values. Alternatively, when all the model variables are potentially limiting, the minimum of the several SI values contributing to the HSI can be taken as the overall HSI (following Liebig’s law of the minimum). The Barrier Island and Barrier Headland Community Models use a simple weighted additive function to combine SI values. This may not be biologically realistic, and when combined with the fact that no SI curves have values less than 0.1, ensures that no matter how poor the habitat, the minimum HSI value possible is 0.1, which may not be realistic for very poor habitat. If some or all the SI curves had the option of taking a value of 0.0 for very poor habitat, then using a geometric mean will provide the opportunity of an HSI value of 0.0 when a critical habitat component is missing, which may better reflect reality than using an additive function.</td>
</tr>
</tbody>
</table>

Significance – Medium:

Using arithmetic means and additive functions for aggregation equations may result in HSI values that are not biologically realistic.

Recommendations for Resolution:

To resolve these concerns, the models would need to be evaluated and possible revised as follows:

- Closely evaluate the aggregation equations applied for each model to assess whether they make biological sense.
- Consider whether to use geometric means or other biologically defensible mathematical functions for the models where additive arithmetic mean functions are used.
- Develop sample data sets and apply the model to them with geometric means, arithmetic means, and the additive functions, comparing output to assess which is the most biologically reasonable.
- Provide the rationale for the aggregation equation for each model.
Comment 19:

A performance measure should be stipulated to identify the measurable community characteristics to which the HSIs are related.

Basis for Comment:

Habitat Suitability Index models by definition are intended to provide an index to habitat quality for a specified species or community. Part of the process in constructing an HSI model is to identify clearly what attribute of the species or community is being indexed by the model. This attribute is called the “performance measure” (Stiehl, R.B. 1995. Habitat Evaluation Procedures Workbook. USGS Biological Resources Division, Fort Collins, CO.) and must be stated in terms of some output per unit area.

For single species models, the performance measure often would be population characteristics such as density, number of young produced per unit area, number of juveniles surviving to adulthood per unit area, and so on. For a community model, logical performance measures may be some community measure such as total number of different species per unit area. The model user must know what component of the community is linked to changes in habitat suitability.

Significance – Medium:

Without a stipulated performance measure, we do not know what is being indexed by the models.

Recommendations for Resolution:

To resolve these concerns, the methods and documentation would need to be expanded to include:

- For each of the HSI models being considered, the authors should state explicitly what the community performance measure is that is assumed to be linked to the HSI values generated by the model.
<table>
<thead>
<tr>
<th>Comment 20:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The geographic boundaries/domain of the models is unclear.</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Basis for Comment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Models are, by definition, abstractions of reality. As such, when modeling ecosystems it must be clear what natural systems are being abstracted. Rarely are ecosystem-scale models general enough to be applied to a broad geographic variety of systems. The geographic boundaries of the WVA models reviewed seem somewhat subjective and may be largely based on administrative or political considerations, since only Louisiana and east Texas are included in geographic range. No maps were used to clearly demarcate the geographic domains of the models. The general model documentation suggests that many of these WVA models may be applicable in Texas but documentation for many of the specific models generally referred only to Louisiana.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Significance – Medium:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A lack of clarity about the geographic domains of the WVA models generates risk in model use if the models are applied to systems for which they are not appropriate; for this reason, it is important to clearly define and justify the geographic boundaries and domains of all models.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recommendations for Resolution:</th>
</tr>
</thead>
<tbody>
<tr>
<td>To resolve these concerns, the documentation would need to be expanded to include:</td>
</tr>
<tr>
<td>- Clear definition and justification of the geographic boundaries and domains of all models, and include maps to support these definitions.</td>
</tr>
</tbody>
</table>
Comment 21:

An explicit statement should be provided regarding the minimum area to which the models can be applied.

Basis for Comment:

In none of the model documents was the minimum size of area to which the models could be applied specified. It is not uncommon to have a minimum area to which a model should be applied. For single species models, this area typically will be at least as large as the animal’s home range or territory size. For community models such as these, it might be reasonable to identify the minimum area to which the models should be applied. However, specifying the minimum size area for application can be challenging.

Because of the species-area relationships common in natural systems, it would be unreasonable to apply the models to areas of habitat that are too small. Models applied to a small site, say 10 acres, might indicate high quality habitat based on the model variables. Thus, the user might infer the area has the potential to support a community of high diversity. However, because of the limited space, such a site may be able to support the relatively few species whose home range or territory size can be accommodated by the 10 acres available. A site of 100 acres with the same habitat conditions and HSI value may well support two or three times more species, simply because of the greater area. A review of the scientific literature will provide useful information to help guide the minimum area to be evaluated.

The peer review panel suggests that perhaps 50 acres or more will be a reasonable size to consider. This is based on the fact that the communities presumably being modeled are dominated by small to medium sized birds, mammals, reptiles, fish and amphibians. A number of allometric equations have been developed relating home range size to body size. Home range requirements vary with taxon (mammals, birds, fish, reptiles) and the trophic level (herbivore, omnivore, predator). Since a community is composed of all species of all sizes, a first approximation to the area to be evaluated might be made by making a simplifying assumption that a “typical” larger animal in the community would be a raccoon-sized animal, an approximately 6.4 kg omnivore (Lindstedt et al. 1986) Using an allometric equation developed by Harestad and Bunnell (1979):

\[ A_{hr} = 3.4 \times M^{0.92} \]

where \( A_{hr} \) = home range in ha and \( M \) is mass in kg,

The expected home range can be calculated to be approximately 18.75 ha or 46 acres. Allowing some extra space, we can assume that an area of 50 acres is capable of supporting animals of the size of a raccoon or smaller. While such an area will still not be capable of fully supporting larger animals with larger home ranges, this may serve as a reasonable starting point. A thorough review of the scientific literature related to species common in the communities being modeled will provide useful information to help guide the minimum area to be evaluated.

This may not be as critical for the Coastal Chenier/Ridge Community Model because its stated focus is on habitat for migratory songbirds. At the time that these habitats are most critical for migrants during the fall and spring, they are not territorial and will form large, multi-species flocks. Since they are not limited by area, perhaps sites as small as 5 acres would be suitable for assessment with the Coastal Chenier/Ridge Community Model. Again, a thorough literature review should be undertaken to determine the minimum size necessary to be of value.


Significance – Medium:
Without a minimum area specified, a user might apply the model(s) to an area that is too small to be reasonable or appropriate to the performance measure.

**Recommendations for Resolution:**

To resolve these concerns, the documentation would need to be expanded to include:

- Specify for each model the minimum area to which the model should be applied.
### Comment 22:

**Additional error checks should be incorporated into the model spreadsheets.**

**Basis for Comment:**

The model provides many error checks. However, some merely say “ERROR”. This is not as useful as more specific error messages. Even if error messages appear in long IF statements, more detail should be given.

One specific error checking issue is whether the percentage of emergent and open swamp area should equal 100%. The specifications do not make it clear whether this is or is not the case. If it is the case, then an error check should be added.

**Significance – Low:**

The model is already strong in error checking, but richer error messages could improve their utility.

**Recommendations for Resolution:**

To resolve these concerns, the spreadsheets would need to be revised as follows:

- Improve the quality of existing error messages.
- Incorporate an error check for emergent and open portions of swamps being 100% if this is the case.
ATTACHMENT A

Work Plan

as Submitted on May 5, 2009
This page intentionally left blank
US ARMY CORPS
OF ENGINEERS

FINAL WORK PLAN
MODEL CERTIFICATION REVIEW
For the
Wetland Value Assessment Models

Battelle Memorial Institute
505 King Avenue
Columbus, OH  43201

Prepared for
U.S. Army Corps of Engineers
Ecosystem Planning Center of Expertise
Mississippi Valley District

Contract No. W911NF-07-D-0001
Task Control Number: 09-032
Delivery Order Number: 0594

May 06, 2009
FINAL WORK PLAN
Model Certification Review
for the
Wetland Value Assessment Models

Submitted to:

Department of the Army
U.S. Army Corps of Engineers
Ecosystem Planning Center of Expertise
Mississippi Valley Division

Contract Number: W911NF-07-D-0001
Task Control Number: 09-057
Delivery Order Number: 0605

Prepared by:

Battelle
505 King Avenue
Columbus, OH 43201

May 06, 2009
Table of Contents

BACKGROUND ........................................................................................................................................ 1

TECHNICAL APPROACH .......................................................................................................................... 4

  Task 1. Participate in Kick-off Meeting .............................................................................................. 4
  Task 2. Prepare Work Plan .................................................................................................................. 5
  Task 3. Prepare and Finalize Charge to Model Reviewers .................................................................. 5
  Task 4. Identify Candidate Model Certification Peer Reviewers and Select and Finalize Contracts with Candidate Model Certification Peer Reviewers .............................................. 6
  Task 5. Conduct Model Certification Assessment ............................................................................. 8
  Task 6. Meeting to Discuss Findings ................................................................................................ 9
  Task 7. Prepare Draft Report for Model Certification Review ........................................................... 9
  Task 8. Meeting to Discuss Draft Report for Model Certification Review ........................................ 10

MILESTONES AND DELIVERABLES ................................................................................................. 11

SCHEDULE ........................................................................................................................................... 7

Appendix A. Final Charge Guidance and Questions for the Wetland Value Assessment Models ......... A-1
Appendix B. Wetland Value Assessment Model Certification Review Panel Considerations and Proposed Selection/Exclusion Criteria ................................................................. B-1
Appendix C. Peer Review Conflict of Interest Inquiry ........................................................................ C-1

List of Tables

Table 1. WVA Model Certification Review Milestones and Deliverables by Activity .................. 12
This page intentionally left blank
BACKGROUND

The Wetland Value Assessment (WVA) methodology was developed for wetland restoration and planning projects in coastal Louisiana and East Texas, and is a tool that is used to evaluate potential changes in ecosystem benefits. It is a modification of the U.S. Fish and Wildlife Service’s (USFWS) Habitat Evaluation Procedures (HEP) which is widely used by the USFWS and other agencies to evaluate the impacts of development projects on fish and wildlife resources. While the HEP utilizes species-specific models, the WVA utilizes a community-level approach.

The WVA models are community-based ecosystem output models developed for several types of wetland habitats found in Louisiana, including fresh-intermediate marshes, brackish marshes, saline marshes, barrier islands, barrier headlands, swamp, bottomland hardwood wetlands, and forested coastal ridges (e.g., coastal cheniers). They are planning models that were originally developed for use in determining wetland benefits for project proposals submitted for funding under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA). The WVA models are currently being used for the Barataria Basin Shoreline Restoration Integrated Feasibility Study and are intended for use on current and future United States Army Corps of Engineers (USACE) projects (such as Louisiana Coastal Area projects).

Although the WVA models were developed for use in Louisiana coastal wetlands, these wetlands extend into eastern Texas, as shown on EPA maps for the ecoregions of Texas. In particular, the models may be used on the wetland habitats in the coastal areas of Orange, Jefferson, Chambers, Liberty, and Galveston Counties from Sabine Pass to the eastern edge of Galveston Bay for barrier headlands; coastal chenier ridges; saline, brackish, and fresh-intermediate marshes; bottomland hardwood wetlands; and cypress-tupelo swamp. Extensive marsh, swamp, and bottomland hardwood habitat can be found along the Trinity River in Chambers and Liberty County and the lower Neches and Sabine Rivers in Jefferson and Orange County.

Each WVA model contains habitat variables which are weighted based on their importance to habitat quality. Project evaluations involve data collection to determine baseline habitat conditions, and prediction of habitat conditions for FWP and FWOP scenarios. The WVA models operate 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 optimal conditions 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. Each model consists of 1) a list of variables that are considered important in characterizing fish and wildlife habitat; 2) a Suitability Index 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.

The WVA models have been developed for determining the suitability of Louisiana coastal wetlands for 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 common fish and wildlife species utilizing a given habitat type in that geographic area and similar areas. The models should also apply to similar wetland areas in Texas, as described above.

As a quantitative habitat-based assessment methodology, the WVA models quantify changes in fish and wildlife habitat quality and quantity that are expected to result from a proposed wetland restoration project, although they could be applied equally as well to created wetlands used to mitigate impacts associated with civil works projects. The results of the WVA models, 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, WVA methodology provides an estimate of the number of acres benefited or enhanced by the project and the net acres of habitat protected or restored.

Project evaluations involve data collection to determine baseline habitat conditions and predict habitat conditions for FWP and FWOP scenarios. The WVA models were designed to be applied, to the greatest extent possible, using only existing or readily obtainable data. They have proven to be an efficient and cost-effective methodology for evaluating proposed restoration projects.

USACE requires that planning models be reviewed and certified. The purpose of the review is to evaluate the technical quality, system quality, and usability of the planning models. The results of the model review will be used by USACE to determine whether to certify the model for inclusion in the toolbox of USACE planning models. The Ecosystem Planning Center of Expertise (ECO-PCX) is proposing to conduct an Intermediate Level review on these regional models, based on the anticipated wide use for projects under Louisiana Coastal Area authority and in applicable areas of Texas.

As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering peer review panels for USACE, Battelle was engaged to conduct the model certification review for the WVA models. Independent, objective peer review is regarded as a critical element in ensuring technical quality, system quality, and usability of the models. The model certification review will be conducted in accordance with the Department of the Army, U.S. Army Corps of Engineers, Planning Models Improvement Program: Model Certification (EC 1105-2-407) and Protocols for Certification of Planning Models (July 2007). To accomplish the models certification review, subject matter experts will be recruited to participate in the peer review panel. Potential candidates for the peer review panel will be screened for availability, interest, and technical experience in defined areas of expertise and any actual or perceived conflicts of interest will be determined. Ultimately, no more than six experts will be selected for the final model certification review panel using predetermined criteria related to
technical expertise and credentials in the subject matters related to the documents and materials to be reviewed. The following is a list of documents and reference materials that will be provided for the review and the cross-referenced USACE files (in parentheses). The documents and files presented in bold font are those which are to be reviewed. All other documents are provided for reference.

1. Draft Engineering Reports for Barataria Basin Barrier Shoreline Restoration:
   b. Caminada Headland Reach (caminada_description_of_alternatives.pdf)
   c. Sabine-Neches (snww_deis_appendices_c-i.pdf)

2. Ecological Modeling Reports for Barataria Basin Barrier Shoreline Restoration:
   a. Shell Island (ecological_modeling_report_for_shell_island_wva_pis.pdf)
   b. Caminada Headland (ecological_modeling_report_for_caminada_wva_pis.pdf)

3. WVA Excel worksheets and land loss spreadsheets for Barataria Basin Shoreline Restoration:
   a. Shell Island Reach (shell_island_wva_analysis_march_2008_032808.xls and shell_island_wva_acreage_summary_2-13-08_032808.xls)
   b. Caminada Headland Reach (caminada_wva_analysis_alt_5_6_7_9_040808.xls and 03b1_land_loss_caminada_alt_5_6_7_9_040808.xls)

4. Coastal Wetlands Planning, Protection and Restoration Act, Wetland Value Assessment Methodology information, including:
   a. Introduction (wva_methodology_intro_3-7-06.doc_032708_wpk.pdf)
   b. WVA Methodology Procedural Manual (WVA Procedural Manual 3-7-06032708.pdf)
   d. Emergent Marsh (Saline Marsh) Community Model marsh_models__fresh-intermediate__brackish__saline__1-22-07.pdf and saline_marsh_wva_model_spreadsheet_revised_1-22-07.xls)
   e. Fresh-Intermediate Marsh Community Model (marsh_models__fresh-intermediate__brackish__saline__1-22-07.pdf and fresh-int_wva_model__spreadsheet_revised_1-22-07.xls)
   f. Brackish Community Model (marsh_models__fresh-intermediate__brackish__saline__1-22-07.pdf and brackish_marsh_wva_model_spreadsheet_revised_1-22-07.xls)
   g. Barrier Island Community Model (barrier_island_model.pdf and barrier_island_wva_model_spreadsheet.xls)
   h. Barrier Headland Community Model (barrier_headland_model.pdf and barrier_headland_wva_model_spreadsheet.xls)
   i. Swamp Community Model (Two models are being reviewed – the original model developed by LDNR and the model developed for restoration under CWPPRA. Information for the original LDNR swamp models are in bottomland_hardwoods_model.pdf and LDNR Swamp WVA Model 8-5-
08.xls. Information for the CWPPRA restoration models are in Swamp Model 6-1-08.pdf and Swamp WVA model 7-31-08.XLS.)

j. Bottomland Hardwoods Community Model (bottomland_hardwoods_model.pdf and bottomland_hardwoods_wva_model_spreadsheet.xls)

k. Forested Coastal Ridge (Coastal Chenier) Community Model (Coastal Chenier Model 8-1-02.pdf and coastal_chenier_wva_model_spreadsheet.xls)


This model certification review is to be conducted in accordance with Department of the Army, USACE’s guidance Planning Models Improvement Program: Model Certification (EC 1105-2-407) and Protocols for Certification of Planning Models (July 2007) (items 6 and 7). During the planning phase for the model certification, up to twelve available potential experts for the review panel will be identified, and six will be selected to review the models and the model documentation.

One of the initial steps in the process is to prepare a detailed work plan (this document) under Task 2. Additional tasks are detailed in the Technical Approach described in the following sections. These tasks are based on the USACE Statement of Work (SOW).

TECHNICAL APPROACH

The key tasks for the model certification review are defined in detail in the WVA Statement of Work (SOW). The general tasks to be performed for this model certification review are summarized in the following sections. The review of the models shall be performed independent of government supervision, direction, or control.

Task 1. Participate in Kick-off Meeting

Battelle will participate in a teleconference with USACE Headquarters Civil Works (CECW) representatives, representatives from the USACE Ecosystem Planning Center of Expertise (ECO-PCX), and the Model Proponents. The purpose of the teleconference is to brief Battelle on USACE’s specific goals and objectives for the model certification review tasks and provide additional information pertaining to the model certification review. After the peer reviewers are under subcontract, a second teleconference will be convened with Battelle, the peer reviewers, the PCX, and the PDT. The purpose of the teleconference is to provide the peer reviewers with an opportunity to be briefed on the project and the model specifically, as well as ask questions
directly of USACE. Battelle and the peer reviewers will review the USACE’s *Planning Model Improvement Program: Model Certification* and the *Protocols for Certification of Planning Models* documents prior to the call. Battelle will confirm the list of documents to be reviewed by the model certification review panel and learn any details necessary to conduct the review from the model developers prior to the kick-off teleconference. Additionally, Battelle will ask USACE to identify specific points of contact should questions arise during the model review.

**Task 2. Prepare Work Plan**

The draft work plan serves to describe the process for conducting the tasks of the model certification review, and provides the process for conducting the model assessment, including screening criteria for model review team members, schedule, selection of model reviewers, charge to model review team, communication and meetings with USACE project team, quality control, and compilation and dissemination of review panel comments. A teleconference, if necessary, will be conducted to discuss comments from USACE on the draft work plan. Battelle will consolidate and address all comments on the final work plan, which will be submitted within three working days of the teleconference or receipt of USACE comments.

**Task 3. Prepare and Finalize Charge to Model Reviewers**

Battelle will prepare a charge to model reviewers, which will contain the instructions to the external reviewers regarding the objective of the model certification review and the specific input sought. It should focus the reviewers by presenting questions and concerns regarding the technical merit of the model and model documentation, as well as invite reviewers to offer a broad evaluation of the overall product. Guidance provided in the Department of the Army, USACE’s guidance *Planning Models Improvement Program: Model Certification* (EC1105-2-407) and *Protocols for Certification of Planning Models* (July 2007) is followed in the development of the charge.

The process and evaluation criteria for the review, as outlined in the *Protocols for Certification of Planning Models* (July 2007), may include the any or all of the following steps:

1. Peer reviewers determine whether project needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.
2. Peer reviewers evaluate the technical quality of the models (review of model documentation) to determine whether the:
   a. Model is based on well-established contemporary theory;
   b. Model is a realistic representation of the actual system;
   c. Analytical requirements of the model are properly identified and the model addresses and properly incorporates the analytical requirements;
   d. Assumptions are clearly identified, valid, and support the analytical requirements;
   e. USACE policies and procedures related to the model are clearly identified, and the model properly incorporates USACE policies and accepted procedures; and,
   f. Formulas used in the model are correct and model computations are appropriate and done correctly.
3. Peer reviewers evaluate system quality (review by running test data sets or reviewing the results of beta tests) to determine whether the:
a. Rationale for selection of supporting software tool/programming language and hardware platform is adequately described, and supporting software tool/programming language is appropriate for the model;

b. Supporting software and hardware is readily available;

c. Programming was done correctly;

d. Model has been tested and validated, and all critical errors have been corrected; and,

e. Data can be readily imported from/into other software analysis tools, if applicable.

4. Peer reviewers evaluate the usability of the model to:

   a. Examine the data required by the model and the availability of the required data;
   b. Examine how easily model results are understood;
   c. Evaluate how useful the information in the results is for supporting project objectives;
   d. Evaluate the ability to export results into project reports;
   e. Determine if training is readily available;
   f. Determine whether user documentation is available, user friendly, and complete;
   g. Determine if adequate technical support is available for the model;
   h. Determine if the software/hardware platform is available to all or most users;
   i. Determine if the model is easily accessible; and,
   j. Determine if the model is transparent and allows for easy verification of calculations and outputs.

Each peer reviewer will be provided with a model certification review charge that will guide their review of the model documentation and worksheets. The charge will include an assessment of most of the criteria listed above and ask them to respond to specific charge questions or directives regarding individual sections of the model documents and spreadsheets. Peer reviewers will also be provided with a model documentation table that provides information on the models being evaluated and a crosswalk to the model documentation. There will be no software provided for this review because the models are spreadsheet-based. The reviewers will be provided with the spreadsheets and have an opportunity to test the models. The charge for evaluating system quality has been modified accordingly. The reviewers also will not be evaluating model availability, training and technical support, as the models are not available for widespread use.

Battelle has prepared a final charge (included in Appendix A of this document) to the model certification review panel. The draft charge will be finalized based on technical direction received from USACE. The final charge will be submitted to USACE for final approval and distribution to the external peer reviewers.

**Task 4. Identify Candidate Model Certification Peer Reviewers and Select and Finalize Contracts with Candidate Model Certification Peer Reviewers**

Battelle will identify up to twelve available potential experts and determine their hourly rates for the model certification review panel. This includes developing criteria for selecting the candidate external peer reviewers and contacting the reviewers to evaluate technical skills,
potential conflicts of interest, and availability. The selection criteria used to identify candidate peer reviewers are provided in Appendix B, and a draft peer review conflict of interest inquiry form is provided in Appendix C. To identify potential reviewers, Battelle will review candidates in Battelle’s database of peer reviewers, seek recommendations from colleagues, contact former peer reviewers, and conduct targeted internet searches. Preliminary information about the potential reviewers will be provided to USACE as early as possible. The list of up to twelve potential external peer reviewers, along with their brief biographical information, will be provided to USACE on April 23, 2009, and Battelle will select six peer reviewers according to the selection criteria (included in Appendix B).

Specifically, the final panel will include peer reviewers with the following expertise:

- One expert in Habitat Evaluation Procedures;
- One expert in planning;
- One expert in hydraulic engineering;
- One expert in coastal wetlands ecology;
- One expert in coastal ecosystems ecology; and,
- One expert software programmer/spreadsheet auditor.

Greater detail for each of the six positions is presented in Appendix B of this document, along with the selection criteria.

Battelle will prepare a scope of work for each reviewer. A request for quotation will be sent to each reviewer along with the peer reviewer scope of work description and conflict of interest inquiry form (see Appendix C). Upon receipt of the reviewers’ written quotations indicating willingness to participate and the absence of a conflict of interest, Battelle will establish contracts with the peer reviewers at agreed-upon rates and hours to ensure/secure participation.

The scope of work for each external peer reviewer will consist of:

- Participation in a Battelle kick-off meeting (via teleconference);
- Participation in a USACE kick-off teleconference meeting with Model Proponents and Battelle;
- Review of the Wetland Value Assessment documents and worksheets and preparation of individual written comments;
- Participation in a panel review teleconference to agree on list of key topics/issues that will form the basis for the final model certification review panel comments;
- Participation in a discussion (via teleconference) with the CECW, representatives from the ECO-PCX, and Model Proponents to ask clarifying questions regarding the key issues identified in the model certification review panel comments, if necessary;
- Preparation of the Draft Report for Model Certification Review based on key issues;
- Review of the Draft Report for Model Certification Review before it is submitted to USACE;
• Participation in a final panel teleconference with USACE to discuss USACE comments on the draft report;
• Review of the Final Report for Model Certification Review before it is submitted to USACE; and,
• Provide additional technical support as directed.

It is estimated that the time commitment required for the model certification review will be approximately 50 hours, including about 2 hours for kick-off teleconferences; 30 hours for review and the preparation of individual experts written comments; and, up to 16 hours for participating in the panel review teleconference discussion, preparing the final panel comments, and conducting other activities as listed above.

Task 5. Conduct Model Certification Assessment

Model certification is a new requirement for USACE, as stated in EC-1105-2-407, *Planning Models Improvement Program: Model Certification*. Detailed protocols for model certification are provided in the USACE July 2007 *Protocols for Certification of Planning Models*. Model certification involves a review of the technical quality, system quality, and usability of models, as well as the determination of whether the models meet the project objectives. Peer reviewers are tasked with evaluating specific criteria used to assess the models.

Models to evaluate habitat value and function have been developed for the dominant ecological communities present in coastal Louisiana and eastern Texas. The selected peer reviewers will be responsible for reviewing the WVA models based on the charge provided (see Task 3).

Battelle will provide the peer reviewers with electronic copies of the model report, support documents, and the final charge prepared under Task 3 by May 13, 2009. Battelle will prepare and deliver a summary letter to instruct the peer reviewers to undertake and complete the entire review process by July 15, 2009. The letter also will outline the steps and interim deadlines. This will include approximately three weeks for review and assessment of the models and preparation of individual written comments in response to the charge; and six weeks for participation in a panel review teleconference, review of the teleconference meeting notes, preparation of final peer review comments, and review of the Draft and Final Reports for Model Certification Review. Working with USACE, Battelle will respond to any reviewer questions or information requests during the review process.

After receipt of all individual model certification review panel comments, Battelle will merge all comments into one document and share the document with the entire model certification review panel. In addition, Battelle will carefully review the comments and identify key issues/topics specifically associated with the technical quality, system quality, and usability of the models, as well as the model descriptions and model testing. These key issues/topics will be distributed to the model certification review panel along with the merged panel comments.

A panel review teleconference will be convened to ensure the exchange of technical information among the panel experts, many of whom will be from diverse scientific backgrounds, and to
identify key issues/topics specifically associated with the technical quality and usability of the model, as well as the model description and model testing. The result of the teleconference will be a list of key issues/topics (i.e., findings) that the model certification review panel agrees should be presented to USACE (Task 6) and highlighted in the report (Task 7). The panel will prepare the key issues/topics by grouping them as they relate to the specific criteria of technical quality, system quality, and usability of the model as described in Task 3.

Task 6. Meeting to Discuss Findings

Battelle will provide USACE with a list of overall findings from the model review. Battelle and the peer reviewers will participate in a teleconference on June 10, 2009 with the USACE Technical Point of Contact, the CECW, representatives from the ECO-PCX, and Model Proponents to discuss the initial findings of the model review and layout the plan for the Draft Report for Model Certification Review. The peer reviewers will also participate.

Task 7. Prepare Draft Report for Model Certification Review

Battelle will prepare the Draft Report for Model Certification Review that presents the results of the model review and includes the following sections:

1.0 Introduction
   1.1. Model Purpose
   1.2. Model Assessment
   1.3. Contribution to Planning Effort
   1.4. Report Organization

2.0 Model Description
   2.1. Model Applicability
   2.2. Model Summary
   2.3. Model Components

3.0 Model Evaluation
   3.1. Assessment Criteria
      3.1.1. Technical Quality
      3.1.2. System Quality
      3.1.3. Usability
   3.2. Approach to Model Testing
   3.3. Technical Quality Assessment
      3.3.1. Review of Theory and External Model Components
      3.3.2. Review of Representation of the System
      3.3.3. Review of Analytical Requirement
      3.3.4. Review of Model Assumptions
      3.3.5. Review Ability to Evaluate Risk and Uncertainty
3.3.6. Review Ability to Calculate Benefits for Total Project Life
3.3.7. Review of Model Calculations/Formulas

3.4. System Quality
  3.4.1. Review of supporting software
  3.4.2. Review of programming accuracy
  3.4.3. Review of model testing and validation

3.5. Usability
  3.5.1. Review of Data Availability
  3.5.2. Review of Results
  3.5.3. Review of Model Documentation

3.6. Model Assessment Summary

4.0 Conclusions

5.0 References

Although Sections 3.1.2 and 3.4 will be included in the report, the assessment of system quality will be based on the model spreadsheets rather than software. Therefore, reporting for this portion of the assessment will be modified to reflect review of less complex system components. For example, review of programming language will be replaced with a review of model formulas. The Draft Report for Model Certification Review will be submitted electronically to USACE on June 24, 2009.

Task 8. Meeting to Discuss Draft Report for Model Certification Review

Battelle and the panel members will meet via teleconference with the CECW, representatives from the ECO-PCX, and Model Proponents to discuss the Draft Report for Model Certification Review on July 8, 2009. Suggested revisions will be incorporated into the report within five days of the teleconference.
Task 9. Prepare Final Report for Model Certification Review

Battelle will prepare the Final Report for Model Certification Review including a description of the process used to assess the models, assessment of the model based on the criteria outlined in Section 3.a of EC-1105-2-407, Planning Models Improvement Program: Model Certification, and issues related to model recommendation. The final report will include the sections outlined under Task 7 and incorporate revisions discussed with the CECW, representatives from the ECO-PCX, and Model Proponents under Task 8. The Final Report for Model Certification Review will be submitted to USACE by July 15, 2009.

MILESTONES AND DELIVERABLES

The due dates for milestones and deliverables in the table below are based on the notice to proceed (NTP) date of April 8, 2009. All deliverables will be sent electronically in pdf format, unless otherwise requested.
## Table 1. WVA Model Certification Review Milestones and Deliverables by Activity

<table>
<thead>
<tr>
<th>Activity</th>
<th>Deliverable (D) or Milestone (M)</th>
<th>Projected Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notice to Proceed</td>
<td>M</td>
<td>April 8 2009</td>
</tr>
<tr>
<td>Receipt of review documents</td>
<td>M</td>
<td>April 16, 2009</td>
</tr>
<tr>
<td><strong>Task 1</strong> Conduct initial meeting on model certification review requirements with USACE</td>
<td>M</td>
<td>April 14, 2009</td>
</tr>
<tr>
<td><strong>Tasks 2 and 3</strong> Submit draft work plan to USACE, including draft charge</td>
<td>D</td>
<td>April 30, 2009</td>
</tr>
<tr>
<td>Receive comments from USACE on draft work plan</td>
<td>M</td>
<td>May 5, 2009</td>
</tr>
<tr>
<td>Submit final work plan to USACE, including final charge</td>
<td>D</td>
<td>May 12, 2009</td>
</tr>
<tr>
<td>Receive approval from USACE on final work plan, including final charge</td>
<td>M</td>
<td>May 13, 2009</td>
</tr>
<tr>
<td><strong>Task 4</strong> Submit list of up to 12 potential model review experts and their credentials to USACE.</td>
<td>D</td>
<td>April 23, 2009</td>
</tr>
<tr>
<td>Receive comments from USACE on expert list</td>
<td>M</td>
<td>April 28, 2009</td>
</tr>
<tr>
<td>Identify 6 experts and complete contracts with experts</td>
<td>M</td>
<td>May 11, 2009</td>
</tr>
<tr>
<td><strong>Task 5</strong> Review documents and charge sent to model review panel</td>
<td>M</td>
<td>May 13, 2009</td>
</tr>
<tr>
<td>Conduct kick-off teleconference with model review panel and USACE CECW, ECO-PCX and Model Proponents</td>
<td>M</td>
<td>May 14, 2009</td>
</tr>
<tr>
<td>Receive comments from model review panel</td>
<td>M</td>
<td>June 3, 2009</td>
</tr>
<tr>
<td>Conduct meeting with review panel to discuss comments</td>
<td>M</td>
<td>June 5, 2009</td>
</tr>
<tr>
<td><strong>Task 6</strong> Conduct teleconference with USACE and model review panel to discuss panel clarifying questions</td>
<td>M</td>
<td>Not applicable</td>
</tr>
<tr>
<td><strong>Task 7</strong> Submit Draft Report for Model Certification Review to USACE for review</td>
<td>D</td>
<td>July 7, 2009</td>
</tr>
<tr>
<td><strong>Task 8</strong> Receive comments from USACE on Draft Report for Model Certification Review</td>
<td>M</td>
<td>July 15, 2009</td>
</tr>
<tr>
<td>Conduct teleconference meeting with USACE to discuss comments on the Draft Report for Model Certification Review</td>
<td>M</td>
<td>July 21, 2009</td>
</tr>
<tr>
<td><strong>Task 9</strong> Submit Final Report for Model Certification Review to USACE</td>
<td>D</td>
<td>July 28, 2009</td>
</tr>
<tr>
<td>Project Closeout</td>
<td></td>
<td>September 30, 2009</td>
</tr>
</tbody>
</table>

Note: This schedule was updated after submission of the Work Plan.
APPENDIX A
Final Charge Guidance and Questions to the Peer Reviewers for the Wetland Value Assessment Models

BACKGROUND

The Wetland Value Assessment (WVA) methodology was developed for wetland restoration and planning projects in coastal Louisiana and East Texas, and is a tool that is used to evaluate potential changes in ecosystem benefits. It is a modification of the U.S. Fish and Wildlife Service’s (USFWS) Habitat Evaluation Procedures (HEP) which is widely used by the USFWS and other agencies to evaluate the impacts of development projects on fish and wildlife resources. While the HEP utilizes species-specific models, the WVA utilizes a community-level approach.

The Wetland Value Assessment (WVA) Models are community-based ecosystem output models developed for several types of wetland habitats found in Louisiana, including fresh-intermediate marshes, brackish marshes, saline marshes, barrier islands, barrier headlands, swamp, bottomland hardwood wetlands, and forested coastal ridges (e.g. coastal cheniers). They are planning models that were originally developed for use in determining wetland benefits for project proposals submitted for funding under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA). The WVA models are currently being used for the Barataria Basin Shoreline Restoration Integrated Feasibility Study and are intended for use on current and future United States Army Corps of Engineers (USACE) projects (such as Louisiana Coastal Area projects).

Although the WVA Models were developed for use in Louisiana coastal wetlands, these wetlands extend into eastern Texas, as shown on EPA maps for the Ecoregions of Texas. In particular, the models may be used on the wetland habitats in the coastal areas of Orange, Jefferson, Chambers, Liberty, and Galveston Counties from Sabine Pass to the eastern edge of Galveston Bay for barrier headlands; coastal chenier ridges; saline, brackish, and fresh-intermediate marshes; bottomland hardwood wetlands; and cypress-tupelo swamp. Extensive marsh, swamp, and bottomland hardwood habitat can be found along the Trinity River in Chambers and Liberty County and the lower Neches and Sabine Rivers in Jefferson and Orange County.

Each WVA model contains habitat variables which are weighted based on their importance to habitat quality. Project evaluations involve data collection to determine baseline habitat conditions, and prediction of habitat conditions for FWP and FWOP scenarios. 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 optimal conditions 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. Each model consists of 1) a list of variables that are considered important in
characterizing fish and wildlife habitat, 2) a Suitability Index 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.

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 common fish and
wildlife species utilizing a given habitat type in that geographic area and similar areas. The
models should also apply to similar wetland areas in Texas, as described above.

The WVA models are a quantitative habitat-based assessment methodology. The WVA
quantities changes in fish and wildlife habitat quality and quantity that are expected to result
from a proposed wetland restoration project and could apply equally as well to created wetlands
used to mitigate impacts associated with Civil Works projects. The WVA is also used to assess
the environmental impacts of projects, including Civil Works projects. 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, WVA methodology provides an estimate of the number of acres beneﬁted or
enhanced by the project and the net acres of habitat protected/restored.

Project evaluations involve data collection to determine baseline habitat conditions and predict
habitat conditions for FWP and FWOP scenarios. The WVA was designed to be applied, to the
greatest extent possible, using only existing or readily obtainable data. The WVA has proven to
be an efﬁcient and cost-effective methodology for evaluating proposed restoration projects.

USACE requires that planning models be reviewed and certiﬁed. The purpose of the review is to
evaluate the technical quality, system quality and usability of the planning models. The results
of the model review will be used by USACE to determine whether to certiﬁcate the model for
inclusion in the toolbox of USACE planning models. The Ecosystem Planning Center of
Expertise (ECO-PCX) is proposing to conduct an Intermediate Level review on these regional
models, based on the anticipated wide use for projects under Louisiana Coastal Area authority
and in applicable areas of Texas.

The Corps of Engineers Planning Models Improvement Program (PMIP) was established in 2003
to assess the state of planning models in the U.S. Army Corps of Engineers (USACE) and to
make recommendations to assure that high quality methods and tools are available to enable
informed decisions on investments in the Nation’s water resources infrastructure and natural
environment. The main objective of the PMIP is to carry out “a process to review, improve and
validate analytical tools and models for USACE Civil Works business programs.” The review
for the model certiﬁcation will follow the guidance described in the Department of the Army,
U.S. Army Corps of Engineers document entitled Planning Models Improvement Program:

**MODEL CERTIFICATION REVIEW**

The following outlines the basic steps for the USACE model certification process. These steps are designed to guide the model review. Model development is a multi-step, iterative process, with the number of steps and iterations being dependent upon the complexity of the model. In general, these steps occur in four fundamental stages.

- **Stage 1 (Requirements Stage)** involves identifying the need for a specific analytical capability and the options for tools to meet the need.
- **Stage 2 (Development Stage)** involves the development of software programming code or a spreadsheet and testing by the model developer.
- **Stage 3 (Model Testing Stage)** involves a beta test of the model by selected users whose objective is to validate the model and ensure that it is usable in real world applications.
- **Stage 4 (Implementation Stage)** involves providing training, user support, maintenance and continuous evaluation of the model.

The certification procedure depends on the stage of model development. The process may include the following steps.

1. Peer reviewers determine whether project needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.
2. Peer reviewers evaluate the technical quality of the models (review of model documentation).
   a. Model is based on well-established contemporary theory.
   b. Model is a realistic representation of the actual system.
   c. Analytical requirement of the model are properly identified and the model addresses and properly incorporates the analytical requirements.
   d. Assumptions are clearly identified, valid, and support the analytical requirements.
   e. USACE policies and procedures related to the model are clearly identified, and the model properly incorporates USACE policies and accepted procedures.
   f. Formulas used in the model are correct and model computations are appropriate and done correctly.
3. Peer reviewers evaluate system quality (review by running test data sets or reviewing the results of beta tests).
   g. Rationale for selection of supporting software tool/programming language and hardware platform is adequately described, and supporting software tool/programming language is appropriate for the model.
   h. Supporting software and hardware is readily available.
   i. Programming was done correctly.
   j. Model has been tested and validated, and all critical errors have been corrected.
   k. Data can be readily imported from/into other software analysis tools, if applicable.
4. Peer reviewers evaluate the usability of the model.
   l. Examine the data required by the model and the availability of the required data.
m. Examine how easily model results are understood.
n. Evaluate how useful the information in the results is for supporting project objectives.
o. Evaluate the ability to export results into project reports.
p. Training is readily available.
q. User documentation is available, user friendly and complete.
r. Adequate technical support is available for the model.
s. Software/hardware platform is available to all or most users.
t. Model is easily accessible.
u. Model is transparent and allows for easy verification of calculations and outputs.

The WVA Models are at Stage 3 in the development process. This review will focus primarily on the technical quality of the models as well as their usability. A review of the system quality will also be conducted, but since the models are spreadsheet-based, there is no software to evaluate and review of the models is somewhat less complex.

The final deliverable for this effort will be a Final Report for Model Certification Review that Battelle will deliver to USACE. The model review panel members will contribute to the preparation of the Draft and Final Reports for Model Certification Review, as well as participate in a teleconference with USACE and the Model Proponents to discuss USACE comments on the Draft Report for Model Certification Review. The general outline for the Report for Model Certification Review will include:

1.0 Introduction
   1.1. Model Purpose
   1.2. Model Assessment
   1.3. Contribution to Planning Effort
   1.4. Report Organization

2.0 Model Description
   2.1. Model Applicability
   2.2. Model Summary
   2.3. Model Components

3.0 Model Evaluation
   3.1. Assessment Criteria
       3.1.1. Technical Quality
       3.1.2. System Quality
       3.1.3. Usability
   3.2. Approach to Model Testing
   3.3. Technical Quality Assessment
       3.3.1. Review of Theory and External Model Components
       3.3.2. Review of Representation of the System
       3.3.3. Review of Analytical Requirement
3.3.4. Review of Model Assumptions
3.3.5. Review Ability to Evaluate Risk and Uncertainty
3.3.6. Review Ability to Calculate Benefits for Total Project Life
3.3.7. Review of Model Calculations/Formulas

3.4. System Quality
3.4.1. Review of supporting software
3.4.2. Review of programming accuracy
3.4.3. Review of model testing and validation

3.5. Usability
3.5.1. Review of Data Availability
3.5.2. Review of Results
3.5.3. Review of Model Documentation

3.6. Model Assessment Summary

4.0 Conclusions
5.0 References

DOCUMENTS PROVIDED

The following documents (and their corresponding file names) are being provided to the peer reviewers:

1. Draft Engineering Reports for Barataria Basin Barrier Shoreline Restoration:
   b. Caminada Headland Reach (caminada_description_of_alternatives.pdf)
   c. Sabine-Neches (snww_deis_appendices_c-i.pdf)
2. Ecological Modeling Reports for Barataria Basin Barrier Shoreline Restoration:
   d. Shell Island (ecological_modeling_report_for_shell_island_wva_pis.pdf)
   e. Caminada Headland (ecological_modeling_report_for_caminada_wva_pis.pdf)
3. WVA Excel worksheets and land loss spreadsheets for Barataria Basin Shoreline Restoration:
   f. Shell Island Reach (shell_island_wva_analysis_march_2008_032808.xls and shell_island_wva_acreage_summary_2-13-08_032808.xls)
   g. Caminada Headland Reach (caminada_wva_analysis_alt_5_6_7_9_040808.xls and 03b1_land_loss_caminada_alt_5_6_7_9_040808.xls)
4. Coastal Wetlands Planning, Protection and Restoration Act, Wetland Value Assessment Methodology information, including:
   1. Introduction (wva_methodology_intro_3-7-06.doc_032708_wpk.pdf)
   2. WVA Methodology Procedural Manual (WVA Procedural Manual 3-7-06032708.pdf)
4. Emergent Marsh (Saline Marsh) Community Model marsh_models__fresh-intermediate__brackish__saline__1-22-07.pdf and saline_marsh_wva_model_spreadsheet_revised_1-22-07.xls
5. Fresh-Intermediate Marsh Community Model (marsh_models__fresh-intermediate__brackish__saline__1-22-07.pdf and fresh-int_wva_model__spreadsheet_revised_1-22-07.xls)
7. Barrier Island Community Model (barrier_island_model.pdf and barrier_island_wva_model_spreadsheet.xls)
8. Barrier Headland Community Model (barrier_headland_model.pdf and barrier_headland_wva_model_spreadsheet.xls)
9. Swamp Community Model (Two models are being reviewed – the original model developed by LDNR and the model developed for restoration under CWPPRA. Information for the original LDNR swamp models are in bottomland_hardwoods_model.pdf and LDNR Swamp WVA Model 8-5-08.xls. Information for the CWPPRA restoration models are in Swamp Model 6-1-08.pdf and Swamp WVA model 7-31-08.XLS.)
10. Bottomland Hardwoods Community Model (bottomland_hardwoods_model.pdf and bottomland_hardwoods_wva_model_spreadsheet.xls)
11. Forested Coastal Ridge (Coastal Chenier) Community Model (Coastal Chenier Model 8-1-02.pdf and coastal_chenier_wva_model_spreadsheet.xls)


NOTE: The documents and files which are presented in bold font are those which are to be reviewed. All other documents are provided for reference.
## SCHEDULE

<table>
<thead>
<tr>
<th>Activity</th>
<th>Deliverable (D) or Milestone (M)</th>
<th>Projected Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notice to Proceed</td>
<td>M</td>
<td>April 8, 2009</td>
</tr>
<tr>
<td>Receipt of review documents</td>
<td>M</td>
<td>April 16, 2009</td>
</tr>
<tr>
<td><strong>Task 1</strong> Conduct initial meeting on model certification review</td>
<td>M</td>
<td>April 14, 2009</td>
</tr>
<tr>
<td>requirements with USACE</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tasks 2 and 3</strong></td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Submit draft work plan to USACE, including draft charge</td>
<td>D</td>
<td>April 30, 2009</td>
</tr>
<tr>
<td>Receive comments from USACE on draft work plan</td>
<td>M</td>
<td>May 5, 2009</td>
</tr>
<tr>
<td>Submit final work plan to USACE, including final charge</td>
<td>D</td>
<td>May 12, 2009</td>
</tr>
<tr>
<td>Receive approval from USACE on final work plan, including final charge</td>
<td>M</td>
<td>May 13, 2009</td>
</tr>
<tr>
<td><strong>Task 4</strong> Submit list of up to 12 potential model review experts and</td>
<td>D</td>
<td>April 23, 2009</td>
</tr>
<tr>
<td>their credentials to USACE.</td>
<td>M</td>
<td>April 28, 2009</td>
</tr>
<tr>
<td>Identify 6 experts and complete contracts with experts</td>
<td>M</td>
<td>May 11, 2009</td>
</tr>
<tr>
<td><strong>Task 5</strong> Review documents and charge sent to model review panel</td>
<td>M</td>
<td>May 13, 2009</td>
</tr>
<tr>
<td>Conduct kick-off teleconference with model review panel and USACE</td>
<td>M</td>
<td>May 14, 2009</td>
</tr>
<tr>
<td>CECW, ECO-PCX and Model Proponents</td>
<td>M</td>
<td>June 3, 2009</td>
</tr>
<tr>
<td>Receive comments from model review panel</td>
<td>M</td>
<td>June 5, 2009</td>
</tr>
<tr>
<td>Conduct meeting with review panel to discuss comments</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td><strong>Task 6</strong> Conduct teleconference with USACE and model review panel</td>
<td>M</td>
<td>Not applicable</td>
</tr>
<tr>
<td>to discuss panel clarifying questions</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Task 7</strong> Submit Draft Report for Model Certification Review to USACE</td>
<td>D</td>
<td>July 7, 2009</td>
</tr>
<tr>
<td>for review</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Task 8</strong> Receive comments from USACE on Draft Report for Model</td>
<td>M</td>
<td>July 15, 2009</td>
</tr>
<tr>
<td>Certification Review</td>
<td>M</td>
<td>July 21, 2009</td>
</tr>
<tr>
<td>Conduct teleconference meeting with USACE to discuss comments on the</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Draft Report for Model Certification Review</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Task 9</strong> Submit Final Report for Model Certification Review to USACE</td>
<td>D</td>
<td>July 28, 2009</td>
</tr>
<tr>
<td>Project Closeout</td>
<td></td>
<td>September 30, 2009</td>
</tr>
</tbody>
</table>

Note: This schedule was updated after submission of the charge to the peer review panel.
CHARGE FOR PEER REVIEW

The charge questions and guidelines are based on the model certification criteria discussed in the Protocols for Certification of Planning Models from the USACE Planning Models Improvement Program. The intent of these questions is to focus your thinking, not to suggest or dictate your answers. We want you to consider several aspects of models during your review, from the inputs to the outputs to the underlying structure.

General Charge Guidance

1. Please answer the scientific and technical questions listed below and conduct a broad overview of the WVA models. Please focus on your areas of expertise and technical knowledge.

2. Evaluate the soundness of models as applicable and relevant to your area of expertise. Comment on whether models explain past events and how models will be validated.

3. Please focus the review on scientific information, including factual inputs, data, the use and soundness of model calculations, assumptions, and results that inform decision makers.

4. Offer opinions as to whether the model parameters and formulas are sufficient to quantify ecosystem function.

5. Model certification review panel members may contact each other. However, panel members should not contact anyone who is or was involved in the project, prepared the subject documents, developed the models, or was part of the USACE Independent Technical Review.

6. Please contact the Battelle deputy project manager, Amanda Maxemchuk (MaxemchukA@Battelle.org) and cc: Karen Johnson-Young (johnson-youngk@battelle.org) if you have questions for Battelle or USACE or need additional information.

7. In case of media contact, notify the Battelle deputy project manager immediately.

8. Your name will appear as one of the panelists in the peer review. Your comments will be included in the Final Report for Model Certification Review, but will remain unattributed. The Final Report for Model Certification Review is expected to be released to the public by USACE at some time in the future.

Please submit your comments in electronic form to Amanda Maxemchuk, MaxemchukA@Battelle.org, no later than June 3, 2009, 10 pm EDT.
Wetland Value Assessment Models
Model Certification Review

Final Charge Questions

MODEL ASSESSMENT CRITERIA

General Questions

1. Is the purpose of the models clearly defined?

2. Can the models described achieve the stated purpose?

Technical Quality

3. Comment on the overall technical quality of the models.

4. Are the models based on well-established contemporary theory?
   a. Is the available science applied correctly?
   b. Are the models empirically supported?

5. Are the models realistic representations of the actual systems?

6. Are the analytical requirements of the models properly identified?

7. Do the models address and properly incorporate the analytical requirements?

8. Are the assumptions clearly identified, valid, and do they support the analytical requirements?

9. Are the formulas used in the models mathematically correct and are the model computations appropriate and done correctly?

10. Comment on the ability of the models to address risk and uncertainty.

11. Comment on the ability of the models to calculate benefits for total project life.

12. Do the models adequately assess the full range of ecosystem benefits associated with wetlands in this geographic range?

13. Will the models be useful in capturing and quantifying the full extent of benefits expected to be obtained from anticipated coastal restoration projects?
System Quality

14. Have the models been sufficiently tested and validated, or do critical errors still exist?

Usability

15. Comment on the models’ usability.

16. Comment on the availability of the data required by the models.

17. How easily are model results understood?

18. Comment on how useful the information in the results is for supporting project objectives.

19. Is user documentation available, user friendly, and complete?

20. Are the models transparent and do they allow for easy verification of calculations and outputs?

OTHER GENERAL QUESTIONS

21. Can the models be adapted to other geographic regions?
   a. If so, how much can the models be modified before they need to be reviewed again?

22. Is it clear where the models’ geographic boundaries fall?

23. Is the approach to the development and use of the models described clearly enough to allow the approach to be repeated and obtain the same or similar results?
   a. If not, why?
   b. If not, what needs to be done to make the approach repeatable?

24. Comment on the ability of the models to calculate benefits for total project life.

25. Can the models be used for both mitigation and restoration projects?
   a. For which application are they most suitable?

26. Comment on whether the models are more suitable for prioritizing projects or if they are also appropriate for assessments.

27. Are the applications of the models defensible?

28. Comment on whether there are any resolution issues with the models (i.e., size of the area that can effectively be evaluated).
a. At what scale (e.g. acres, hundreds of acres) can the models be effectively applied?

29. Comment on whether all of the most important variables are included in the models.
   a. Are variables that are both stressors and drivers included in the models?
   b. Should additional variables be included?
   c. Are some of the variables more sensitive than others?

30. To what extent is best professional judgment used in the models?

31. To what extent are the models developed specifically for the Louisiana Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA)?

32. Are error checks built into the models?

33. Are USACE policies and procedures related to the model clearly identified?

34. Do the models properly incorporate USACE policies and accepted procedures?

35. Is sea level change addressed by the models?
   a. If yes, is it internal to the models or does it need to be addressed externally?

36. Do the models work using both sensible and non-sensible data (e.g., negative land area)?

**Document 1: Coastal Wetlands Planning, Protection and Restoration Act, Wetland Value Assessment Methodology: Introduction** (file: 04a_wva_methodology_intro_3-7-06.doc_032708_wpk.pdf)

1. Comment on the differences between the WVA and HEP methods.
   a. Is the use of a community approach rather than a species-oriented approach justified and appropriate in this setting and for the purpose of the models?

2. Have all of the important Louisiana/East Texas coastal wetland ecosystems been captured by the models?
   a. What additional models would you include in the WVA suite, if any?
   b. Would you distinguish among the ecosystems that were modeled in any different way?

3. Would you recommend any additional criteria for the selection of model variables?

4. Is the WVA method clearly described?
   a. If not, what needs to be described more clearly?

Introduction

No questions

Evaluation of Nominated Projects

No questions.

Field Investigation of Candidate Projects

5. Do you believe that the review would benefit from a site visit?
   a. If so, how would your review benefit?
   b. What are you unable to review, if anything, because of unfamiliarity with the project site?

Project Boundary Determination

6. Comment on the project boundary determination process.
   a. What would you do differently, if anything?

7. How are land use changes and hydrologic changes accounted for after 2000?

8. Is enough detail provided for field investigations?
   a. If not, explain what is lacking.

9. Is enough detail provided to evaluate hydrologic changes over the 50-year period of analysis?

Use of the Community Habitat Models

10. Comment on the statement that, “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.”
    a. Where are the points of subjectivity in these models?
    b. How does this affect the usability of the WVA models?

Marsh Community Models

11. Comment on the implications of a potential shift in marsh habitats and the need to use more than one marsh model on model outcomes.

12. Comment on the approach to calculating land loss rate.

13. Are the limitations of the approach to habitat classification and land/water data clearly defined?
a. Are there other limitations?
b. Other than what is described, are there ways to overcome the limitations of the approach?

14. Comment on the conventions for selecting project target years.
   a. What would you do differently, if anything?

15. Is each variable clearly described?
   a. Are the variables selected appropriate for the models?
   b. Are the variables expressed at the appropriate level of detail?
   c. What additional variables would you include in the models, if any?

16. Comment on the approach for measuring each of the variables.
   a. How can measurements be improved, if at all?

17. Is the approach for predicting each of the variables clearly described?
   a. How can predictions be improved, if at all?

18. Is the use of a single value for percent of open water depth ($\leq 1.5$ feet) sufficient, or should seasonal values be used?

Swamp Community Model

19. Comment on the application of the swamp community model.
   a. Is the application clearly described?
   b. What would you do differently, if anything?

20. Comment on the definition of wetland loss.
   a. Is the definition appropriate?
   b. How would you change the approach to measuring wetland loss, if at all?

21. Comment on the selection of project target years.
   a. What would you do differently, if anything?

22. Is each variable clearly described?
   a. Are the variables selected appropriate for the model?
   b. Are the variables expressed at the appropriate level of detail?
   c. What additional variables would you include in the model, if any?

23. Comment on the approach for measuring each of the variables.
   a. How can measurements be improved, if at all?

24. Is the approach for predicting each of the variables clearly described?
   a. How can predictions be improved, if at all?
25. Comment on the data sources for flooding depth, flooding duration, and water exchange factors used in variables V₁ and V₂.

26. Comment on the data sources and methods used to determine variable V₃ under baseline and future conditions.

27. Comment on the hydrology changes to be considered for variable V₄.

**Barrier Island/Headland Community Models**

28. Comment on the approach to classifying habitats.
   a. How would you do things differently, if at all?

29. Comment on the selection of project target years.
   a. What would you do differently, if anything?

30. Is each variable clearly described?
    a. Are the variables selected appropriate for the model?
    b. Are the variables expressed at the appropriate level of detail?
    c. What additional variables would you include in the model, if any?

31. Comment on the quantification of variable V₆ (Edge and Interspersion).

32. Comment on how the dynamics of habitat loss and conversion may affect the performance of the models.

33. Comment on the engineering methods used for determining the effects of coastal processes.

34. Comment on the approach for measuring each of the variables.
   a. How can measurements be improved, if at all?

35. Is the approach for predicting each of the variables clearly described?
   a. How can predictions be improved, if at all?

36. Is the overall approach that has been adopted to determining the wetland benefits of proposed projects complete when applied to barrier islands, particularly with regard to the issue of barrier island morphology changes over time due to coastal erosion, sea level rise, and extreme storm inundation?

37. Comment on the adequacy of the discussion of barrier island change in distribution of habitat types due to barrier island erosion/accretion/migration.
   a. Is the discussion of coastal engineering models presented complete?
   b. Should an additional coastal erosion model be considered?

38. Is adequate guidance provided regarding when coastal erosion models should be applied?
a. Should a formulaic procedure be prescribed to determine when application of such models is necessary?

39. Comment on the applicability, accuracy, and completeness of the highlighted sediment transport/coastal erosion models (SBEACH, GENESIS, and Delft3D) with regard to predictions of any significant changes in barrier island morphology and habitat.
   a. Was the applicability, accuracy, and completeness clearly described?

40. Is a discussion of the effect of climate change, sea level rise, and the frequency of extreme storm events on barrier island morphology warranted?

Coastal Chenier/Ridge Community Model

41. Comment on the application of the coastal chenier/ridge community model as it compares with the other HSI models.

42. Comment on the selection of project target years.
   a. What would you do differently, if anything?

43. Is each variable clearly described?
   a. Are the variables selected appropriate for the model?
   b. Are the variables expressed at the appropriate level of detail?
   c. What additional variables would you include in the model, if any?

44. Comment on the approach for measuring each of the variables.
   a. How can measurements be improved, if at all?

45. Is the approach for predicting each of the variables clearly described?
   a. How can predictions be improved, if at all?

Additional Notes

46. Comment on the Project Information Sheet.
   a. Should additional information be required?


I. Introduction

No questions.
II. Variable Selection

47. Is the variable selection process clearly described?

48. Please, comment on the process used for the selection of variables based on what is described?

49. Are variable selection criteria clearly defined?

50. Comment on the HSI models (Table 1) consulted for variables for potential use in the marsh models.

51. Comment on the variables selected for determining habitat suitability for fish and wildlife.
   a. Would you have selected the same variables?
   b. Are the variables expressed at the appropriate level of detail?
   c. What other variables would you have included in the models, if any?

52. Comment on the detail provided for variable V3 (Marsh Edge and Interspersion).

53. Comment on the data and methods used to determine variable V4 (Percent of Open Water ≤ 1.5 Feet Deep in Relation to Marsh Surface).

III. Suitability Index Graph Development

54. Are the purpose and method for developing the Suitability Index Graphs clearly and thoroughly described?

55. Are the assumptions for each variable in creating the Suitability Index Graphs clearly identified?
   a. Comment on the scientific basis of the assumptions for each variable.
   b. What other assumptions would you have included, if any?

IV. Habitat Suitability Index Formulas

56. Is the rationale for grouping and weighting variables V1, V2 and V6 and grouping variables V3, V4 and V5 and isolating them clearly explained and justified?
   a. Comment on whether you agree with how the variables were weighted and explain why.

57. Comment on the approach to address the “scaling” problems associated with using a single model to determine suitability of marsh habitat.
   a. Describe the approach you would recommend if you would do it differently.

V. Benefit Assessment
58. Is the approach for calculating net AAHUs clearly described and justified?

**Fresh/Intermediate Marsh, Brackish Marsh, and Saline Marsh HSI Calculations**

59. Are the HSI calculations correct?
   a. What would you have done differently, if anything?

60. Do you agree with the Suitability Index Graphs developed?
   a. Why or why not?
   b. What would you have done differently, if anything?

61. Comment on the measurability and subjectivity of the variables.

62. Comment on the sensitivity of the models to ecosystem changes.

63. Comment on the robustness of the models for not responding to changes they were not intended to detect.

64. Are the ranks for the interspersion classes clearly explained?

**Procedure for Calculating Access Value**

65. Is aquatic organism access and how it is measured clearly explained and justified?
   a. Explain how you would have measured it differently, if at all.

**Spreadsheet calculations for Fresh/Intermediate Marsh, Brackish Marsh, and Saline Marsh**

66. Are the model spreadsheet formulas correct and accurate?

67. Are the results transparent and can the calculations be verified?

68. How easily are the spreadsheet models inadvertently manipulated?

69. How can the spreadsheets be improved, if at all?

**Document 4: Coastal Wetlands Planning, Protection and Restoration Act, Wetland Value Assessment Methodology: Barrier Island Community Model (and associated model spreadsheet)** (files: 04g_barrier_island_model.pdf and 04g_barrier_island_wva_model_spreadsheet.xls)

I. **Introduction**

No questions

II. **Variable Selection**
70. Is the variable selection process clearly described and justified?
   a. Explain whether you agree with the variable selection process and why you agree
      or disagree.

71. Comment on the variables selected for determining habitat suitability for fish and
    wildlife.
   a. Would you have selected the same variables?
   b. Are the variables expressed at the appropriate level of detail?
   c. What other variables would you have included in the models, if any?

72. Comment on the quantification and level of detail of variable $V_6$ (Edge and
    Interspersion).

III. Suitability Index Graph Development

73. Are the purpose and methods for developing the Suitability Index Graphs clearly and
    thoroughly described?

74. Are the assumptions for each variable in creating the Suitability Index Graphs clearly
    identified?
   a. Comment on the scientific basis of the assumptions for each variable.
   b. What other assumptions would you have included, if any?

IV. Habitat Suitability Index Formulas

75. Comment on the weighting of variables in the formula.
   a. Is the rationale for the selected weights clearly explained and justified?
   b. Would you have assigned different weights to the variables?
      i. If yes, how would you have weighted the variables?
      ii. If yes, why would you have weighted the variables differently?

V. Benefit Assessment

76. The document refers the user to the Wetland Value Assessment Methodology
    Introduction for the benefit assessment calculations. Are the calculations of HUs,
    AAHUs, and net AAHUs clearly described in the Wetland Value Assessment
    Methodology Introduction?

Barrier Island Habitat HSI Calculations

77. Are the HSI calculations correct?
   a. What would you have done differently, if anything?

78. Do you agree with the Suitability Index Graphs developed?
   a. Why or why not?
b. What would you have done differently, if anything?

79. Comment on the measurability and subjectivity of the variables.

80. Comment on the sensitivity of the models to ecosystem changes.

81. Comment on the robustness of the models for not responding to changes they were not intended to detect.

Appendix A

82. Are the ranks for the interspersion classes clearly explained?

Spreadsheet calculations for Barrier Island

83. Are the model spreadsheet formulas correct and accurate?

84. Are the results transparent and can the calculations be verified?

85. How easily are the spreadsheet models inadvertently manipulated?

86. How can the spreadsheets be improved, if at all?

Document 5: Coastal Wetlands Planning, Protection and Restoration Act, Wetland Value Assessment Methodology: Barrier Headland Community Model (and associated model spreadsheet) (files: 04h_barrier_headland_model.pdf and 04h Barrier Headland WVA Model Spreadsheet.xls)

I. Introduction

87. Comment on and explain whether you agree with the rationale for developing a model for barrier headlands that is different from the model developed for barrier islands.

II. Variable Selection

88. Is the variable selection process clearly described and justified?
   a. Explain whether you agree with the variable selection process and why you agree or disagree.

89. Comment on the variables selected for determining habitat suitability for fish and wildlife.
   a. Would you have selected the same variables?
   b. Are the variables expressed at the appropriate level of detail?
   c. What other variables would you have included in the models, if any?
III. Suitability Index Graph Development

90. Are the purpose and methods for developing the Suitability Index Graphs clearly and thoroughly described?

91. Are the assumptions for each variable in creating the Suitability Index Graphs clearly identified?
   a. Comment on the scientific basis of the assumptions for each variable.
   b. What other assumptions would you have included, if any?

IV. Habitat Suitability Index Formulas

92. Comment on the weighting of variables in the formula.
   a. Is the rationale for the selected weights clearly explained and justified?
   b. Would you have assigned different weights to the variables?
      i. If yes, how would you have weighted the variables?
      ii. If yes, why would you have weighted the variables differently?

V. Benefit Assessment

93. The document refers the user to the Wetland Value Assessment Methodology Introduction for the benefit assessment calculations. Are the calculations of HUs, AAHUs, and net AAHUs clearly described in the Wetland Value Assessment Methodology Introduction?

Barrier Headland Habitats HSI Calculations and Suitability Index Graphs

94. Are the HSI calculations correct?
   a. What would you have done differently, if anything?

95. Do you agree with the Suitability Index Graphs developed?
   a. Why or why not?
   b. What would you have done differently, if anything?

96. Comment on the measurability and subjectivity of the variables.

97. Comment on the sensitivity of the models to ecosystem changes.

98. Comment on the robustness of the models for not responding to changes they were not intended to detect.

Spreadsheet calculations for Barrier Headland

99. Are the model spreadsheet formulas correct and accurate?

100. Are the results transparent and can the calculations be verified?
101. How easily are the spreadsheet models inadvertently manipulated?

102. How can the spreadsheets be improved, if at all?

Two fresh swamp models are being reviewed for this model certification: the WVA model developed for restoration efforts under CWPPRA and the original Louisiana Department of Natural Resources (LDNR) WVA model. The restoration model is described in Document 6 and the associated spreadsheet, and the original model is described in Document 7 along with the bottomland hardwood model and the associated spreadsheet. Please consider differences in the models during your review.

Document 6: Habitat Assessment Models for Fresh Swamp and Bottomland Hardwoods Within the Louisiana Coastal Zone (and associated model spreadsheet) (files: 04i_Swamp Model 6-1-08.pdf and 04i_Swamp WVA model 7-31-08 .XLS)

I. Introduction

No questions

VI. Variable Selection

103. Is the variable selection process clearly described and justified?
   a. Explain whether you agree with the variable selection process and why you agree or disagree.

104. Comment on the variables selected for determining habitat suitability for fish and wildlife.
   a. Would you have selected the same variables?
   b. Are the variables expressed at the appropriate level of detail?
   c. What other variables would you have included in the models, if any?

105. Comment on the water regime classification (including data sources, methodology, and variability) for variable V3 (Hydrology).

106. Comment on the justification for eliminating some of the variables used in the original LDNR WVA model.

VII. Suitability Index Graph Development

107. Are the purpose and methods for developing the Suitability Index Graphs clearly and thoroughly described?

108. Are the assumptions for each variable in creating the Suitability Index Graphs clearly identified?
a. Comment on the scientific basis of the assumptions for each variable.
b. What other assumptions would you have included, if any?

VIII. Habitat Suitability Index Formulas

109. Comment on the weighting of variables in the formula.
   a. Is the rationale for the selected weights clearly explained and justified?
   b. Would you have assigned different weights to the variables?
      i. If yes, how would you have weighted the variables?
      ii. If yes, why would you have weighted the variables differently?

IX. Benefit Assessment

110. The document refers the user to the Wetland Value Assessment Methodology Introduction for the benefit assessment calculations. Are the calculations of HUs, AAHUs, and net AAHUs clearly described in the Wetland Value Assessment Methodology Introduction?

Suitability Index Graphs

111. Do you agree with the Suitability Index Graphs developed?
   a. Why or why not?
   b. What would you have done differently, if anything?

112. Comment on the measurability and subjectivity of the variables.

113. Comment on the sensitivity of the models based on the Suitability Indices for each of the variables.

114. Comment on the robustness of the models based on the Suitability Indices for each of the variables.

Spreadsheet calculations for Fresh Swamp restoration models

115. Are the model spreadsheet formulas correct and accurate?

116. Are the results transparent and can the calculations be verified?

117. How easily are the spreadsheet models inadvertently manipulated?

118. How can the spreadsheets be improved, if at all?

Document 7: Habitat Assessment Models for Fresh Swamp and Bottomland Hardwoods Within the Louisiana Coastal Zone (and associated model spreadsheets) (files: 04j_bottomland_hardwoods_model.pdf, 04i_LDNR Swamp WVA Model 8-5-08.xls, and 04j_bottomland_hardwoods_wva_model_spreadsheet.xls)
I. Introduction

No questions

II. Concept/Methodology

119. Comment on whether the concept and methodology of these models is consistent with that for the CWPPRA models.
   a. If it is different, please explain how.

III. Variable Selection

120. Is the variable selection process clearly described and justified?
   a. Explain whether you agree with the variable selection process and why you agree or disagree.

121. Comment on the use of four hydrology classes.

122. Comment on the water regime classification in Bottomland Hardwoods variable V4 (Hydrology).

123. Comment on the water regime classification in Swamp variable V3 (Hydrology).

IV. Suitability Index Graphs

124. Are the purpose and methods for developing the Suitability Index Graphs clearly and thoroughly described?

V. Suitability Index Graph Assumptions

a. Fresh Swamp Model

125. Is the definition of a fresh swamp comprehensive and accurate?
   a. If not, comment on how it could be defined better.

126. Comment on the assumptions for each variable in creating the Suitability Index Graphs clearly identified?
   a. Comment on the scientific basis of the assumptions for each variable.
   b. What other assumptions would you have included, if any?

b. Bottomland Hardwoods Model

127. Is the definition of bottomland hardwoods comprehensive and accurate?
   a. If not, comment on how it could be defined better.
128. Comment on the assumptions for each variable in creating the Suitability Index Graphs clearly identified?
   a. Comment on the scientific basis of the assumptions for each variable.
   b. What other assumptions would you have included, if any?

129. Comment on the variables selected for determining habitat suitability for fish and wildlife for meeting the purpose of the models.
   a. Would you have selected the same variables?
   b. Are the variables expressed at the appropriate level of detail?
   c. What other variables would you have included in the models, if any?

VI. Habitat Suitability Index Formulas

130. Comment on the weighting of variables in the formula.
   a. Is the rationale for the selected weights clearly explained and justified?
   b. Would you have assigned different weights to the variables for each of the models?
      i. If yes, how would you have weighted the variables?
      ii. If yes, why would you have weighted the variables differently?

131. Are the HSI calculations correct?
   a. What would you have done differently, if anything?

132. How are these calculations different from those developed for CWPPRA?
   a. How do these differences impact the results of the models?

VII. Appendix A: Fresh Swamp

133. Do you agree with the Suitability Index Graphs developed?
   a. Why or why not?
   b. What would you have done differently, if anything?

134. Comment on the measurability and subjectivity of the variables.

135. Comment on the sensitivity of the models based on the Suitability Index Graphs.

136. Comment on the robustness of the models based on the Suitability Index Graphs.

VIII. Appendix B: Bottomland Hardwoods

137. Do you agree with the Suitability Index Graphs developed?
   a. Why or why not?
   b. What would you have done differently, if anything?

138. Comment on the measurability and subjectivity of the variables.
139. Comment on the sensitivity of the models based on the Suitability Index Graphs.

140. Comment on the robustness of the models based on the Suitability Index Graphs.

IX. Appendix C: Species List

141. Comment on the species list provided.
   a. Have the dominant species been identified?
   b. Is the list accurate?
   c. What species, if any, would you include or exclude?

Spreadsheet calculations for Fresh Swamp index model

142. Are the model spreadsheet formulas correct and accurate?

143. Are the results transparent and can the calculations be verified?

144. How easily are the spreadsheet models inadvertently manipulated?

145. How can the spreadsheets be improved, if at all?

Spreadsheet calculations for Bottomland Hardwoods model

146. Are the model spreadsheet formulas correct and accurate?

147. Are the results transparent and can the calculations be verified?

148. How easily are the spreadsheet models inadvertently manipulated?

149. How can the spreadsheets be improved, if at all?

Comparison of Document 6 and Document 7

150. Is there a clear difference between the CWPPRA and LADNR models?
   a. Describe the primary differences, if any.

151. For what applications is each model most appropriate?

152. Do the documents provide a clear description of how to determine whether to use the CWPPRA model or LADNR model?

I. Introduction

153. Comment on the potential applicability of the coastal chenier/ridge community model on a regional scale considering the specific area of the state for which it was developed.
   a. Will it be possible to adapt the model for the same type of community over a broader geographic range?
   b. If so, how much would the model need to be modified?

II. Variable Selection

154. Is the variable selection process clearly described and justified?
   a. Explain whether you agree with the variable selection process and why you agree or disagree.

155. Comment on the variables selected for determining habitat suitability for fish and wildlife.
   a. Would you have selected the same variables?
   b. Are the variables expressed at the appropriate level of detail?
   c. What other variables would you have included in the models, if any?

III. Suitability Index Graph Development

156. Are the purpose and methods for developing the Suitability Index Graphs clearly and thoroughly described?

157. Are the assumptions for each variable in creating the Suitability Index Graphs clearly identified?
   a. Comment on the scientific basis of the assumptions for each variable.
   b. What other assumptions would you have included, if any?

IV. Habitat Suitability Index Formulas

158. Comment on the weighting of variables in the formula.
   a. Is the rationale for the selected weights clearly explained and justified?
   b. Would you have assigned different weights to the variables?
      i. If yes, how would you have weighted the variables?
      ii. If yes, why would you have weighted the variables differently?

159. Comment on the use of the geometric mean rather than the arithmetic mean for combining variables into an HSI formula.
   a. Explain why you agree or disagree with this approach.
   b. Has this been done with the other WVA models, as well?

160. Is the HSI calculation correct?
   a. What would you have done differently, if anything?
V. Benefit Assessment

161. Is the approach for calculating HSIs, HUs, and AAHUs clearly described and justified?
   a. If so, comment on whether you agree with the approach.

Suitability Index Graphs

162. Do you agree with the Suitability Index Graphs developed?
   a. Why or why not?
   b. What would you have done differently, if anything?

163. Comment on the measurability and subjectivity of the variables.

164. Comment on the sensitivity of the models based on the Suitability Indices for each of the variables.

165. Comment on the robustness of the models based on the Suitability Indices for each of the variables.

Spreadsheet calculations for Coastal Chenier

166. Are the model spreadsheet formulas correct and accurate?

167. Are the results transparent and can the calculations be verified?

168. How easily are the spreadsheet models inadvertently manipulated?

169. How can the spreadsheets be improved, if at all?
APPENDIX B
Wetland Value Assessment Model Certification Review Panel
Considerations and Proposed Selection/Exclusion Criteria

According to the documents for the Wetland Value Assessment Models, the overall Model Certification Review scope includes:
- Habitat Evaluation Procedures
- Planning
- Hydraulic engineering
- Coastal wetlands ecology
- Coastal ecosystems ecology
- Software programming/spreadsheet auditing

Technical Criteria /Areas of Expertise for Potential External Peer Reviewers

Technical areas related to Habitat Evaluation Procedures (1 expert):
- Ecosystem output evaluations
- Development of ecosystem output methods based on the U.S. Fish and Wildlife Service Habitat Evaluation Procedures

Technical areas related to planning (1 expert):
- Evaluating and comparing alternative plans for ecosystem restoration

Technical areas related to hydraulic engineering (1 expert):
- Hydraulic engineering associated with ecosystem restoration in coastal areas

Technical areas related to coastal wetlands ecology (1 expert):
- Knowledge and understanding of the coastal wetlands of the Gulf of Mexico
- Knowledge of vegetation and biota of fresh, intermediate, brackish and saline marshes

Technical areas related to coastal ecosystems ecology (1 expert):
- Knowledge and understanding of the coastal ecosystems of the Gulf of Mexico
- Knowledge of vegetation and biota of barrier headlands, swamp, bottomland hardwoods, and forested coastal ridges

Technical areas related to software programming/spreadsheet auditing (1 expert):
- Auditing spreadsheets to check for accuracy of formulas and cell references
- Testing and debugging spreadsheets

Other considerations:
- Must have at least an M.S. degree (except software programmer/spreadsheet auditor)
- Must have at least 10 years of experience
- Participation in previous USACE technical review committees
- Other technical review panel experience
- Louisiana and Texas ecosystem experience
Reviewer Categories [candidate may fit into more than one category]

- Academic
- Consultant (company-affiliated, e.g., architect-engineer or consulting firm)
- Consultant (independent)
- Non-governmental organization (e.g., road and bridge-related public agency)
- Governmental organization (e.g., Department of Transportation)

Potential Exclusion Criteria/Conflicts of Interest

- Involvement in any part of the development of the Wetlands Value Assessment (WVA) Models (community-based ecosystem output models) originally developed for use in determining wetland benefits of project proposals submitted for funding under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA);
- Current personal or firm involvement with other USACE projects, notably the Barataria Basin Shoreline Restoration Integrated Feasibility (Caminada Headland and Shell Island), and future Louisiana Coastal Area projects;
- Current USACE employee;
- Current or future interests in the subject project or future benefits from the project, including current or future involvement in coastal restoration projects in Louisiana or Texas (including, but not limited to, Louisiana Coastal Area [LCA] or Coastal Wetlands Planning, Protection, or Restoration Act [CWPPRA] projects);
- Current personal or firm involvement with other USACE projects, notably if those projects/contracts are with the New Orleans District;
- Previous employment by USACE as a direct employee or contractor (either as an individual or through your firm) within the last 10 years, notably if those projects/contracts are with the New Orleans District;
- Previous experience conducting technical peer reviews;
- A significant portion (i.e., greater than 50%) of personal or firm revenues within the last 3 years came from USACE contracts;
- Any publicly documented statement made by the reviewer or reviewer’s firm advocating for or against the subject project;
- Other possible perceived conflict of interest for consideration, e.g.,
  - Former USACE employee
  - Repeatedly served many times as USACE technical reviewer
  - Paid or unpaid participation in litigation related to the work of USACE
  - Any other perceived COI not listed
Dear (Peer Reviewer -- insert name):

You have been requested by the U.S. Army Corps of Engineers (USACE) to serve as an external peer reviewer for the Model Certification Review of the Wetland Value Assessment Models. Your participation in this review will be greatly appreciated. However, it is possible that your personal affiliations and involvement in particular activities could pose a conflict of interest or create the appearance that you lack impartiality in your involvement for this peer review. Although your involvement in these activities is not necessarily grounds for exclusion from the peer review, you should consult the contact named below or other appropriate official to discuss these matters. Affiliations or activities that could potentially lead to conflicts of interest might include:

- current work or arrangements concerning future work in support of industries or other parties that could potentially be affected by developments or other actions based on material presented in the document (or review materials) that you have been asked to review;
- your personal benefit (or benefit of your employer, spouse or dependent child) from the developments or other actions based on the document (or review materials) you have been asked to review;
- any previous involvement you have had with the development of the document (or review materials) you have been asked to review;
- any financial interest held by you (or your employer, spouse or dependent child) that could be affected by your participation in this matter; and
- any financial relationship you have or have had with USACE such as employment, research grants, or cooperative agreements;
- a significant portion of your personal or firm’s revenues within the last 3 years came from USACE contracts; and,
- a publicly documented statement by you or your firm advocating for or against the subject project.

If you have any concerns over a potential conflict of interest, please contact Mr. Mike Genovese, Battelle (GenoveseM@Battelle.org, (614) 424-4007) to discuss any potential conflict of interest issues at your earliest convenience, but no later than two (2) days after receiving this request.

If you agree to be on this peer review panel, please check one of the following boxes, sign this form, and fax to Ms. Corey Wisneski, Battelle, at (614) 458-3579 no later than two (2) days after receiving this request. She may be reached with questions at (781) 952-5296 or WisneskiC@Battelle.org.
This form does not constitute an authorization to participate in this review; authorization for performance will come from Battelle’s Government Subcontracts office.

[ ] I have no known existing or potential conflicts of interest associated with this task.

[ ] I have identified and disclosed in writing all known existing or potential conflicts of interest associated with this task.

____________________________________  ____________________________________
Signature    Date  Printed Name