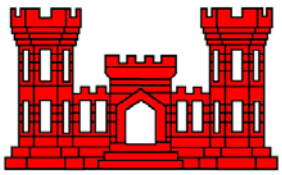
Volume 3
Part 6.4

Model Certification Review Report for SJNM Shorebird Model



U.S. Army Corps of Engineers
Memphis District

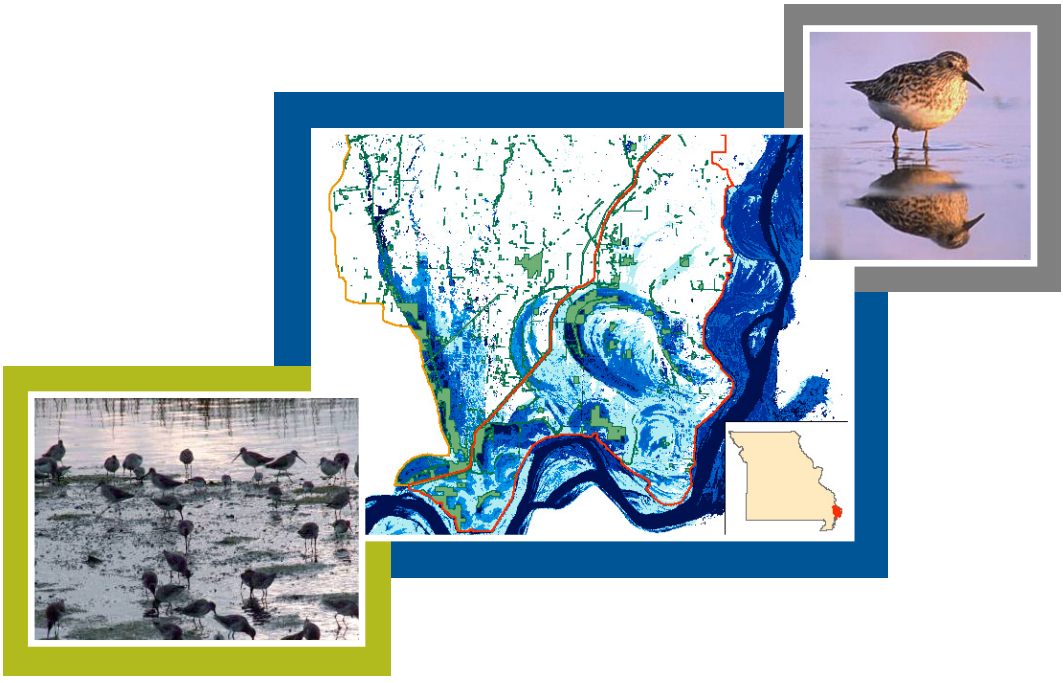
Draft Planning Model Quality Assurance Review Report for the Model Review of the Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri (SJNM Shorebird Model)

Prepared by
Battelle Memorial Institute

Prepared for
Department of the Army
U.S. Army Corps of Engineers
Ecosystem Restoration Planning Center of Expertise
Memphis District

Contract No. W912HQ-10-D-002
Task Order: 0008

April 25, 2011



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DRAFT
PLANNING MODEL QUALITY ASSURANCE REVIEW REPORT
for the

Model Review of the Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri (SJNM Shorebird Model)

EXECUTIVE SUMMARY

A review of the model for the Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri (hereinafter SJNM Shorebird Model) was conducted for the U.S. Army Corps of Engineers (USACE) under Contract Number W912HQ-10-D-002, Task Order 0008 to support the requirements of the Planning Models Improvement Program (PMIP). Established in 2003, 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 2005). Reviews are conducted in accordance with EC 1105-2-407, to ensure that planning models used by USACE are technically and theoretically sound, computationally accurate, and in compliance with USACE planning policy.

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 review of the SJNM Shorebird Model, which is proposed for use for the St. Johns Bayou and New Madrid Floodway Project. Independent, objective peer review is regarded as a critical element in ensuring the technical quality, system quality, and usability of models and tools used for project planning.

The SJNM Shorebird Model Study Plan was developed to assess the spatial and temporal availability of shallow floodwater habitat in the St. Johns-New Madrid Basins in southeastern Missouri that may be used by migrating shorebirds for foraging. USACE is authorized to implement a flood risk management project in these basins, and the proposed project would complete the levee surrounding the New Madrid Basin and install pumping stations in both the St. Johns and New Madrid Basins. The SJNM Shorebird Model will be used to assess potential impacts to shorebird foraging habitat that may result from implementation of the flood risk management project. The model may also be used for mitigation planning. The model is being developed by Dan Twedt of the U.S. Geological Survey (USGS) Patuxent Wildlife Research Center, in cooperation with the USACE Memphis District.

A panel of four experts (a Habitat Evaluation Procedures [HEP] expert, two avian biologists, and a geospatial analyst) was selected by Battelle and charged with performing a review of the SJNM Shorebird Model. Approximately 118 individual comments were received from the model reviewers in response to 31 charge questions designed to focus the review of the SJNM Shorebird Model. The charge questions were based on the model assessment criteria in the *Protocols for Certification of Planning Models* (USACE 2007). The key findings of the model review regarding the model's technical quality, system quality, and usability are summarized in this report and documented as ten Final Panel Comments presented in Appendix B. The Final

Panel Comments in Appendix B are presented in a five-part format that provides: 1) a clear statement of the issues identified, 2) the relevant model assessment criteria, 3) the basis for the issue, 4) the significance of the issue relative to the performance of the model, and 5) recommendations for resolution.

This draft Planning Model Quality Assurance Review Report for the SJNM Shorebird Model describes the model review process, the selection of model reviewers for the Model Review Panel, and the results of the review. USACE and the model reviewers will discuss the review findings and finalization of this report during a teleconference scheduled for 1:00 – 5:00 pm EDT on May 11, 2011. Once this report has been finalized, the results of the model review as presented in the final report will be taken into consideration for using and possibly revising the SJNM Shorebird Model and model documentation.

During the review of the technical quality, system quality, and usability of the SJNM Shorebird Model, the Model Review Panel determined that the conceptual approach is appropriate for the intended purpose of assessing changes in the availability of suitable shorebird foraging habitat that will result from the St. Johns Bayou and New Madrid Floodway Project. However, some issues were identified regarding the technical quality of the SJNM Shorebird Model and the usability of model outputs. Since models are only approximations of actual systems, all models have limitations. The Model Review Panel has made suggestions regarding how to address the limitations of the SJNM Shorebird Model. Testing and validation of the SJNM Shorebird Model must also be performed to clearly demonstrate its sensitivity, accuracy, and ability to support planning decisions.

In addressing and answering charge questions designed to focus the review of the SJNM Shorebird Model based on the model assessment criteria in the *Protocols for Certification of Planning Models* (USACE 2007), the model reviewers identified the following underlying issues or potential issues with the model.

- Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited. This is related to the assumption that land use both upstream and within the project area, and consequently river stage conditions, will not change over time.
- The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy.
- Regarding the model parameters:
    - The model does not include variables for the amount of vegetative cover or vegetation height. Vegetative cover and height strongly influence the suitability of habitat for shorebird foraging, and not including this in the model could lead to an overestimate of available shorebird foraging habitat.
    - The model should weight suitable shorebird habitat for patch size.
    - Qualitative variables need to have quantitative boundaries. This will improve how well model outputs are understood and consistency in application among users.

- The ability of the model to evaluate uncertainty is limited. This is because the response of the model outputs to variation in input parameters and the accuracy of the input parameters has not been quantified.
- The ability to verify and validate the performance of the model is limited. This is because the verification and validation of the model will be based on comparison of the area predicted for shorebird habitat with shallowly inundated area identified in Landsat™ imagery, which has low resolution.
- The model could be strengthened if shorebird use of the habitat was considered during field validation.
- Regarding the model documentation:
  - There is no user documentation for the model.
- If the model is released for more widespread use outside of the project development team (PDT), the model documentation should be improved by providing additional information.

The SJNM Shorebird Model provides a good basis for what could be an effective tool for determining changes in the availability of suitable shorebird foraging habitat at a coarse spatial scale (finer topographic variability is not taken into account). However, the accuracy of the model outputs should be improved for better-informed planning, and the performance of the model needs to be tested and verified before it is applied for decision-making. The Model Review Panel recommends the following actions to improve the technical quality and usability of the SJNM Shorebird Model.

- Estimate the effects of future changes in land use by projecting future changes based on a recent history of land-use changes in the study area, include current and anticipated land use and structural changes upstream when applying historical river-stage data to future conditions, and review and modify the model every 10 years such that the most current changes in river stage and habitat conditions are incorporated.
- Either use the highest-resolution light detection and ranging (LiDAR) data for obtaining the highest model accuracies (preferred), or as an alternative, expand the use of the LiDAR-derived 2-foot contour map from the New Madrid Basin to the St. Johns Basin for obtaining improved model accuracies.
- Conduct an examination of possible methods to distinguish vegetation coverage and heights at a finer scale. If this is not available, provide an explanation of the limitations related to the broad scale definition of vegetation in the model documentation.
- Include a minimum patch size in the definition of suitable shorebird habitat and provide justification for the choice of a minimum patch size.
- Provide quantitative limits for all of the qualitative vegetation variables, including the development of a Suitability Index (SI) value for Conservation Reserve Program (CRP) and set-aside lands.
- Use the model to evaluate ranges of some or all input variables so that the output is a range rather than a single point estimate.

- Consider using higher spatial resolution imagery, such as Sattellite Pour l'Observation de la Terre (SPOT) imagery (10 m pixel size), Quickbird imagery (sub-meter), or SAR imagery (such as TerraSAR-X [1-5 m pixel resolution]) to verify and validate the model.
- Collect data on shorebird use of sites during field validation of the model to confirm shorebird use.
- Expand the SJNM Shorebird Model documentation to:
    - Explain that historic river stages may not represent future river stages and that large scale land-use changes (e.g., changes in agriculture practices) and climate change may result in unforeseen changes to river stage, and include guidelines for how the model will address these changes (e.g., how will changes to inputs be incorporated into the model, what are the minimum levels of change that will require model adjustments, etc.).
    - Emphasize the importance of multiple model runs to assess uncertainty in model outputs.
    - Include an additional section that explicitly details the steps that the users should take for effective application of the model.
    - Provide a clear explanation of the potential impacts from project alternatives on shorebird foraging habitat.
    - Provide a list of terms and their definitions.
    - Include an explanation of the basis for HEP and how the Habitat Suitability Index (HSI) development process was integrated into the development of the SJNM Shorebird Model.
    - Include a description of a validation/modification process that will be applied during the early phases of model application.
    - Provide more information in the existing figures, such as scale and labels.
    - Provide additional figures to help explain the model better.
    - Include the rationale for why 2000 data were chosen for development of the model.
    - Include a complete and comprehensive list of assumptions and limitations in a single location.

This list of actions summarizes the recommendations for resolution in the Final Panel Comments, and more specific detailed recommendations are provided in the Final Panel Comments presented in Appendix B in this report. The level of significance of most of the Final Panel Comments was assigned based on the assumption that the SJNM Shorebird Model is only intended for use by the Project Development Team (PDT) for the St. Johns Bayou and New Madrid Floodway Project, defined to include those who developed the model or know how it was developed; determined and/or understand the methods required to preprocess the data being input to the model and the precision and accuracy required of those data to generate useful model results; served in an advisory role during the development of the SJNM Shorebird Model; and others who served on the teams and without whom the teams would not be complete. If the model is released for general use to a diverse audience, the level of significance of some

comments would be elevated, and all low-significance comments would be assigned medium significance because different users (e.g., public, technical committee and developers) have different levels of understanding, needs and requirements for documentation.

Three issues were identified that need to be addressed for immediate use of the SJNM Shorebird Model by the St. Johns Bayou and New Madrid Floodway Project PDT:

1. The SJNM Shorebird Model needs to consider changes in land use and flood stage.
2. The SJNM Shorebird Model needs to be based on higher resolution geospatial data.
3. The SJNM Shorebird Model needs to be tested and validated to establish its accuracy and determine its sensitivity to variability in model inputs.

Although other issues do not need to be addressed in order for the SJNM Shorebird Model to perform at a very coarse geospatial scale, adopting the recommendations provided would significantly improve the accuracy of the model outputs and the ability to effectively project changes in the availability of suitable shorebird foraging habitat.

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TABLES

ACRONYMS

COI	Conflict of Interest
CRP	Conservation Reserve Program
DEM	Digital Elevation Map
EC	Engineering Circular
ECO-PCX	Ecosystem Restoration Planning Center of Expertise
ha	Hectare
HEP	Habitat Evaluation Procedures
HSI	Habitat Suitability Index
IEPR	Independent External Peer Review
LiDAR	Light Detection and Ranging
m	Meter
PDT	Project Development Team
PMIP	Planning Models Improvement Program
RMSE	Root Mean Square Error
SAR	Synthetic Aperture Radar
SI	Suitability Index
SJNM	St. Johns and New Madrid
SOW	Statement of Work
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

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1.0 INTRODUCTION

A review of the Shorebird Habitat Assessment model within the St. Johns-New Madrid Basins, Missouri (hereinafter SJNM Shorebird Model) was conducted for the U.S. Army Corps of Engineers (USACE) under Contract Number W911NF-07-D-0001, Task Order 0008, Model Certification Support to the Ecosystem Restoration Planning Center of Expertise (ECO-PCX). The objective of the review was to evaluate the technical quality, system quality (limited evaluation), and usability of the SJNM Shorebird Model in accordance with USACE's *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, dated May 31, 2005) and the *Protocols for Certification of Planning Models* (USACE 2007). The USACE Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of USACE planning models and to ensure 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. 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 review for the SJNM Shorebird Model.

1.1 Model Purpose

USACE planning regulations require that ecosystem impacts and benefits be estimated for proposed project alternatives and that results are included in a Cost Effectiveness and Incremental Cost Analysis to determine the best project for implementation. The SJNM Shorebird Model was designed to evaluate potential impacts to shorebird habitat in the St. Johns and New Madrid basins from implementation of flood risk management projects. The original SJNM Shorebird Model developed in 1998 was abandoned based on comments received during a previous model review regarding the model's ability to effectively project changes in available shorebird habitat, and a new model has been developed with the assistance of members from an independent external peer review (IEPR) panel for the St. Johns Bayou and New Madrid Floodway Project. The new model is being reviewed as a separate and independent model.

The primary goal of this review is to assure the quality of the SJNM Shorebird Model for use by the Project Development Team (PDT) for planning purposes on the St. Johns Bayou and New Madrid Floodway Project. Information provided during the model review will be used by USACE to make any necessary revisions to the SJNM Shorebird Model and/or model documentation for application on the St. Johns Bayou and New Madrid Floodway Project. It is anticipated that the SJNM Shorebird Model may be used for future studies or regulatory actions within the Mississippi Alluvial Valley. Information provided during the model review will be used to assess whether to certify the SJNM Shorebird Model for inclusion in the USACE planning toolbox for broader application under similar circumstances.

The review will focus on the Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri, Study Plan (SJNM Shorebird Model Study Plan). The review will not include a technical evaluation of the application of the model on the St. Johns Bayou and New Madrid Floodway Project, as that is the purview of a separate IEPR panel.

1.2 Model Summary

The SJNM Shorebird Model Study Plan was developed to assess the spatial and temporal availability of shallow floodwater habitat in the St. Johns-New Madrid Basins in southeastern Missouri that may be used by migrating shorebirds for foraging. USACE is authorized to implement a flood risk management project in these basins. The proposed project would complete the levee surrounding the New Madrid Basin and install pumping stations in both the St. Johns and New Madrid Basins. The SJNM Shorebird Model will be used to assess potential impacts to shorebird foraging habitat that may result from implementation of the flood risk management project. The model may also be used for mitigation planning. The model is being developed by Dan Twedt, U.S. Geological Survey (USGS) Patuxent Wildlife Research Center, in cooperation with the USACE Memphis District.

1.3 Report Organization

This report presents the approach and the results of the review of the SJNM Shorebird Model and is organized into the following sections:

Section 2.0 Model Evaluation Assessment Criteria and Approach — Describes the model review approach, including the review process and the criteria used to assess technical quality, system quality, and usability.

Section 3.0 Technical Quality Assessment — Describes the key issues identified from the model technical quality assessment.

Section 4.0 System Quality Assessment — Describes the key issues identified from the model system quality assessment.

Section 5.0 Usability Assessment — Describes the key issues identified from the usability assessment.

Section 6.0 Model Assessment Summary — Summarizes the key issues identified during the model review.

Section 7.0 Conclusions — Summarizes the recommendations to resolve the key issues identified during the model review.

Section 8.0 List of Preparers — Contains biographic information on the expert Model Review Panel members selected to perform the review of the model.

Section 9.0 References — Lists the references used for this model assessment and referenced from the model documentation.

Appendix A Contains the final charge guidance and questions to the Model Review Panel to guide the review of the SJNM Shorebird Model.

Appendix B Contains the Final Panel Comment forms that provide the details of the key issues identified by the Model Review Panel during the assessment of the SJNM Shorebird Model.

2.0 MODEL EVALUATION ASSESSMENT CRITERIA AND APPROACH

USACE requires that all planning models be reviewed to ensure that they are technically sound. Models may be certified by USACE either for limited use on a single project or set of projects or for widespread, repeated use across multiple projects within a specified geographic region. The decision whether to certify the model is largely based on results of an independent external peer review (IEPR). Independent, objective peer review is regarded as a critical element in ensuring technical quality, system quality, and usability of the models.

The objective of the review of the SJNM Shorebird Model was to evaluate the technical quality, system quality, and usability of the model, which is proposed for use for the SJNM Assessment, as well as other future studies in the SJNM area. USACE will consider the review findings in determining whether to approve the model for future and/or current regional use.

The main objective of the USACE PMIP is to carry out "a process to review, improve and validate analytical tools and models for USACE Civil Works business programs" (USACE, 2005). Reviews are conducted in accordance with USACE's *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, May 2005) to ensure that models used by USACE are technically and theoretically sound, computationally accurate, and in compliance with USACE planning policy. Model evaluations are conducted following guidance described in the *Protocols for Certification of Planning Models* (USACE 2007).

2.1 USACE Model Development and Review Process

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

Stage 1 ***Requirements Stage:*** Identify the need for a specific analytical capability and the options for tools to meet the need.

Stage 2 ***Development Stage:*** Develop software programming code or a spreadsheet model and test it for accuracy.

Stage 3 ***Model Testing Stage:*** A beta of the model is tested by selected users whose objective is to validate the model and ensure that it is usable in real-world applications.

Stage 4 ***Implementation Stage:*** Provide training, user support, maintenance, and continuous evaluation of the model.

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

1. Model reviewers determine whether model needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.

2. Model 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. Model reviewers evaluate system quality (including 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. Model 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 SJNM Shorebird Model is currently in the development stage. Consequently, only some of the assessment criteria were evaluated by the model reviewers; other assessment criteria can only be evaluated internally by USACE or were not relevant, including whether USACE policy has been incorporated into the model, and whether the model is easily accessible, training is readily available, and adequate technical support is available. The model review results, which are the subject of this report, are based on a review of the SJNM Shorebird Model Study Plan.

2.2 Model Review Approach

The review process was detailed in the *Final Work Plan for the Model Quality Assurance Review Support to the Ecosystem Planning Center of Expertise for the SJNM Shorebird Model*. The model review process is summarized below and consists of seven tasks:

- Task 1 Participate in Kick-off Teleconference Meeting with USACE
- Task 2 Prepare Work Plan
- Task 3 Identify Candidate Model Reviewers and Select and Finalize Subcontracts with Model Reviewers
- Task 4 Conduct Assessment of Model
- Task 5 Prepare Draft Planning Model Quality Assurance Review Report
- Task 6 Conduct Teleconference Meeting to Discuss Model Review Findings
- Task 7 Prepare Final Planning Model Quality Assurance Review Report.

Battelle participated in a kick-off teleconference meeting with representatives from the USACE ECO-PCX and the model development team (Task 1). The purpose of the meeting was to allow an exchange of information between Battelle and USACE regarding the approach used to conduct the model review, USACE's specific goals and objectives for the model review, the review materials, the expertise required for the review, and the review schedule. Battelle prepared a Work Plan, which included the final review schedule and charge questions and guidance to the Model Review Panel, based on the kick-off teleconference discussions and the USACE Statement of Work (SOW) (Task 2).

Battelle initially contacted the experts who served on the original SJNM Shorebird Model to determine their availability. It was most desirable to have the original model reviewers serve on the Model Review Panel because they were already familiar with the intended application of the model. Of the three original reviewers, only two were available to participate in this review, so another avian biologist needed to be identified. In addition, a geospatial analyst was added to the model review panel because one of the predominant issues identified with the original model had to do with the model's spatial resolution. Battelle identified an additional 28 candidates for the SJNM Shorebird Model Review Panel to fill the two open positions, evaluated their technical expertise, and inquired about potential conflicts of interest (COI). Including the two returning model reviewers, Battelle selected five of the most qualified candidates based on background, years of experience, lack of actual or perceived COI, and confirmed interest and availability (Task 3). Of those five candidates, four were selected as the primary model reviewers for the final Model Review Panel, and one was selected as a backup model reviewer. The remaining candidates were not selected for a variety of reasons, including lack of availability, disclosed COI, or because they did not possess the precise technical expertise required. Information about the candidate model reviewers, including brief biographical information, highest level of education attained, and years of experience, was provided to USACE for feedback. Battelle made the final selection of model reviewers according to the selection criteria described in the Work Plan.

Based on the requirements outlined in the USACE SOW, the final Model Review Panel consisted of the following professionals with the desired relevant experience.

- One expert in ***Habitat Evaluation Procedures (HEP)*** with demonstrated experience in the use and development of HEP. In addition, expertise with HEP application during the planning and evaluation of civil works projects, including impact analysis and mitigation planning. The panel member has a doctorate in environmental science/biology.
- Two experts in ***Avian Biology*** with demonstrated experience in evaluating the habitat suitability for migrating shorebirds and knowledge in migration habitat of shorebirds in large floodplain rivers. Panel members have additional familiarity or experience with HEP and spatial habitat modeling. The panel members have doctorates in wildlife biology.
- One expert in ***Geospatial Analysis*** with demonstrated experience in geospatial topographical analysis, preferably with experience in light detection and ranging (LiDAR) analysis and use of UNET modeled stage data. The panel member has a doctorate in geophysics.

Information on the experts selected for the Model Review Panel is presented in Section 8.0 of this report.

After the model reviewers were under subcontract, Battelle conducted a kick-off teleconference to brief the Model Review Panel on the purpose and approach for the review process. Another kick-off teleconference was convened with Battelle, the Model Review Panel, representatives from the USACE ECO-PCX, and the model development team. This provided the model reviewers an opportunity to be briefed specifically on the model and its intended purpose and to ask questions directly of USACE. The model reviewers were provided with electronic versions of the review documents, along with guidance and a charge (Appendix A) that solicited their comments on specific aspects of the materials that were to be reviewed.

The following document was provided to the model reviewers for the review.

1. Twedt, DJ. 2010, Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri. Study Plan 2302-9S270. USGS Patuxent Wildlife Research Center, Vicksburg, MS. 26 pp.

The following additional documents were provided for reference only and were not to be reviewed.

2. Model Documentation for Pre 2010 SJNM Shorebird Model. 18pp.
3. Battelle Memorial Institute. 2010. Final Model Certification Review Report for the Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley (see Appendix B for Final Panel Comments)
4. Battelle Memorial Institute. 2009. Final Independent External Peer Review Report, St. Johns Bayou and New Madrid Floodway, Missouri, Consolidated NEPA Document and Work Plan, Environmental, Economic, and Hydrologic and Hydraulic Review, Phase 1.
5. Battelle Memorial Institute. 2009. Final Panel Comments and Final USACE Evaluator Comments, Final Independent External Peer Review Report, St. Johns Bayou and New Madrid Floodway, Missouri, Consolidated NEPA Document and Work Plan, Environmental, Economic, and Hydrologic and Hydraulic Review, Phase 1.

6. Battelle Memorial Institute. 2010. Addendum to Final Independent External Peer Review Report, St. Johns Bayou and New Madrid Floodway, Missouri Consolidated NEPA Document and Work Plan, Phase 2 Environmental, Economic, and Hydrologic and Hydraulic Review. (See Comments 1, 2 and 15)
7. EC 1105-2-407, Planning - Planning Models Improvement Program: Model Certification, 31 May 2005 http://140.194.76.129/publications/eng-circulars/ec1105-2-407/entire.pdf
8. EC 1105-2-412, Assuring Quality of Planning Models, 30 December 2009. http://inlandwaterways.lrh.usace.army.mil/_kd/Items/actions.cfm?action=Show&item_id=681&destination=ShowItem
9. Almodovar, L., D. Nolton, B. Carlson, J. Walaszek and B. Frechione. 2007. Protocols for the Certification of Planning Models. Planning Models Improvement Program. July 2007 (http://www.usace.army.mil/CECW/PlanningCOP/Documents/models/protocols_cert_7-02-07.pdf)
10. Office of Management and Budget Final Information Quality Bulletin for Peer Review dated 16 December 2004. http://www.whitehouse.gov/sites/default/files/omb/assets/omb/memoranda/fy2005/m05-03.pdf

In addition to these documents, the model reviewers requested specific information on the geospatial data and flood stage data used for the development of the model.

The model reviewers were asked to review the SJNM Shorebird Model using guidance and charge questions provided to them (Appendix A). The charge guidance and questions are based on the model assessment criteria discussed in the *Protocols for Certification of Planning Models* (USACE 2007). The intent of the charge questions was to focus the review on the assessment criteria that are critical for ensuring the technical quality, system quality and usability of planning models. While not strictly prohibited, there was no direct communication between the Model Review Panel and the model development team during the model review process. All communication was through the Battelle Project Manager.

Thirty-one charge questions developed by USACE and reviewed by Battelle were provided to the Model Review Panel in Individual Charge Response Forms to be used during their review. Following completion of the individual reviews of the SJNM Shorebird Model, Individual Charge Response Forms were compiled into a Merged Charge Response Form that contained all of the model review comments. Approximately 118 individual comments were received.

Battelle identified the key issues/concerns with the SJNM Shorebird Model based on the individual review comments received and then conducted a model review teleconference with the Panel to discuss comments regarding the model review assessment criteria, discuss potentially conflicting comments, and reach agreement on the key issues/concerns with the SJNM Shorebird Model identified during the review. The key findings of the model review regarding the models' technical quality, system quality, and usability are documented as Final Panel Comments.

At the conclusion of the model review teleconference, ten Final Panel Comments had been developed to present the key issues/concerns identified during the review of the SJNM Shorebird

Model. Each of the model reviewers was assigned lead responsibility for developing specific Final Panel Comments. The Final Panel Comments are presented in a five-part format that provides: (1) a clear statement of the issues identified, (2) the relevant model assessment criteria, (3) the basis for the comment, (4) the significance of the issue relative to the performance of the model, and (5) recommendations for resolution. Significance levels are defined as follows:

> **High:** Describes a fundamental problem with the model that could affect the model's ability to produce accurate results and serve its intended purpose
>
> **Medium:** Affects the understanding of the model, model usability, or the level of performance of the model
>
> **Low:** Affects the technical quality of the model documentation but will not affect the performance, understanding, usability, or level of performance of the model

Battelle guided the model reviewers on the development of the Final Panel Comments to ensure that the Model Review Panel's viewpoints are clearly represented, appropriate for the review, and not duplicated among Final Panel Comments. The Final Panel Comment statements are presented in the sections of this report that discuss the evaluation of model assessment criteria (Sections 3 through 5). The full five-part Final Panel Comments are presented in Appendix B. The conclusions of the model review, including recommendations for resolution for the key issues identified, are presented in Section 7.0. Of the ten key issues identified in the Final Panel Comments, three were determined to be of high significance, four were determined to be of medium significance, and three were determined to be of low significance. The level of significance was assigned based on the assumption that the SJNM Shorebird Model will currently only be used by the PDT. The number and significance of the review comments may be higher if the model were to be released for broader use outside of the PDT.

Battelle and the Model Review Panel will meet via teleconference with representatives from the ECO-PCX and Model Proponents to discuss the findings of the model review from 1:00 – 5:00 pm EDT on May 11, 2011. During the teleconference, suggested revisions to the draft Planning Model Quality Assurance Review Report will also be discussed. Suggested revisions to the draft report will be considered for preparation of the final Planning Model Quality Assurance Review Report, which will be delivered on May 16, 2011.

2.3 Approach to Model Testing

This review only involved an assessment of the model approach, and no testing of the model was performed for the review.

2.4 Assessment Criteria

In accordance with USACE EC 1105-2-407 (May 2005), the SJNM Shorebird Model was subjected to an IEPR. The review was conducted based on guidance in the *Protocols for Certification of Planning Models* (USACE 2007). As required by USACE (2007), the model was reviewed and assessed for technical quality, system quality, and usability. The review of these three criteria is described in the following sections, which include the Final Panel Comment statements that capture the key issues/concerns identified.

3.0 TECHNICAL QUALITY ASSESSMENT

Analytical tools, including models, used for planning purposes need to be technically sound and based on widely accepted contemporary scientific theory. The potential availability of foraging habitat characterized by the SJNM Shorebird Model must be reasonably represented by the model variables selected, and the correlation of responses of migrating shorebirds with the variables selected must be supported by sound scientific studies. The model calculations must reflect how shorebird habitat quality is expected to change with changes in stage levels due to project actions based on the application of scientific theory. Formulas and calculations that form the mechanics of the model must be accurate and correctly applied, with sound relationships among variables. The model should be able to reflect natural changes as well as the influence of anthropogenic laws, policies, and practices. All model assumptions must be reasonable and should be well-documented. The analytical requirements of the model must be identified, and the model must address these requirements. The model should also produce robust, reproducible results that stand up to rigorous scrutiny in later stages of the plan formulation process.

The technical quality assessment was based on an evaluation of the criteria described in Section 2.1 of this report. The results of the Model Review Panel's assessment of these criteria are summarized in the following sections. The five-part Final Panel Comments are provided in Appendix B.

3.1 Review of Theory

The model reviewers agree that the theoretical basis of the model is well-developed. No issues were identified during the review of the theory behind the model.

3.2 Review of Representation of the System

The model reviewers agree that the SJNM Shorebird Model does a reasonable job of characterizing and projecting available shorebird foraging habitat. However, the model has some limitations that could reduce the accuracy with which it is able to predict available habitat over the life of the project. The following specific issues related to the assessment of the ability of the SJNM Shorebird Model to represent the habitats being modeled were identified (relevant Final Panel Comment numbers are provided in parentheses). The first two issues are of high significance because they have the potential to affect the ability of the SJNM Shorebird Model to produce accurate results and serve its intended purpose. The last two issues are of medium significance, affecting the usability or level of performance of the model.

1. Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited (Final Panel Comment 1). This is related to the assumption that land use both upstream and within the project area, and consequently river stage conditions, will not change over time.
2. The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy (Final Panel Comment 2).

3. The model does not include variables for the amount of vegetative cover and vegetation height (Final Panel Comment 3). Vegetation cover and height are equally as important for characterizing available shorebird habitat as river stage.
4. The model should weight suitable shorebird habitat for patch size (Final Panel Comment 4).

3.3 Review of Analytical Requirements

The data input needs for the model are clear, but the availability of shorebird foraging habitat is very sensitive to topographic gradients. The following specific issue related to the assessment of the model's analytical requirements were identified (relevant Final Panel Comment numbers are provided in parentheses). This issue was determined to be of high significance, potentially affecting the model's ability to produce accurate results and serve its intended purpose.

1. The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy (Final Panel Comment 2).

3.4 Review of Assumptions

The SJNM Shorebird Model documentation describes some of the limitations and assumptions of the model. However, the description of the SJNM Shorebird Model limitations and assumptions is incomplete. The following specific issues related to the assessment of model assumptions were identified (relevant Final Panel Comment numbers are provided in parentheses). The first two issues are of high significance, potentially affecting the ability of the SJNM Shorebird Model to produce accurate results and serve its intended purpose. The last three issues are of medium significance, affecting the usability or level of performance of the model.

1. Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited (Final Panel Comment 1). This is related to the assumption that land use both upstream and within the project area, and consequently river stage conditions, will not change over time.
2. The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy (Final Panel Comment 2), as it is assumed that relatively coarse spatial resolution data can be used to make finer resolution predictions.
3. The model does not include variables for the amount of vegetative cover and vegetation height (Final Panel Comment 3). It is assumed that the very broad classification of vegetation type is sufficient to determine the availability of shorebird foraging habitat.
4. The model should weight suitable shorebird habitat for patch size (Final Panel Comment 4). Currently, it is assumed that habitat patches of all sizes have equal weight (i.e., are equally suitable for shorebird foraging).
5. Qualitative variables need to have quantitative boundaries (Final Panel Comment 7). The model correctly assumes that vegetative cover types have different suitabilities for shorebirds, but the qualitative descriptions of the general vegetative categories need to be defined quantitatively to provide guidance for correct Suitability Index (SI) determinations.

3.5 Review of Ability to Evaluate Risk and Uncertainty

The SJNM Shorebird Model has very limited ability to evaluate risk and uncertainty because the precision and accuracy of the outputs have not been determined. The following specific issues identified regarding the precision and accuracy of the SJNM Shorebird Model outputs affect the ability of the model to evaluate risk and uncertainty (relevant Final Panel Comment number is provided in parentheses). The first two issues are of high significance, potentially affecting the level of uncertainty in the model outputs and, consequently, the ability of the SJNM Shorebird Model to produce accurate results that can be interpreted with confidence. The remaining issues are of medium significance, affecting the understanding, usability, and level of performance of the model and the uncertainty associated with the model outputs.

1. Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited (Final Panel Comment 1). The short-term (5-10 years) changes in surrounding land use and, consequently, river stage conditions that will occur over time have not been studied sufficiently to be quantified, affecting the ability to determine risk and uncertainty.
2. The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy (Final Panel Comment 2). This creates greater uncertainty in the model ouptputs, reducing confidence in management decisions.
3. The model does not include variables for the amount of vegetative cover and vegetation height (Final Panel Comment 3). This increases the uncertainty in the ability of the model to quantify suitable shorebird habitat in a measurable way.
4. In general, the ability of the model to evaluate uncertainty is limited (Final Panel Comment 5). The Shorebird Model is a deterministic model with inputs that result in a single daily estimate of the amount of optimal shorebird habitat in the project area. No sensitivity analysis or measure of model uncertainty has been performed to understand how the model outputs respond to variation in inputs.
5. The ability to verify and validate the performance of the model is limited (Final Panel Comment 6). This is because the verification and validation of the SJNM Shorebird model will be based on comparison of the area predicted for shorebird habitat with shallowly inundated area identified in Landsat™ imagery, which has low resolution.

3.6 Review of Ability to Calculate Benefits for Total Project Life

The life of a project is typically evaluated through 50 years. The model reviewers agree that the SJNM Shorebird Model is not able to accurately project the impacts and benefits of project alternatives over this period of time. The following specific issues related to the assessment of the models' ability to calculate benefits for total project life were identified (relevant Final Panel Comment numbers are provided in parentheses). The first issue is of high significance, potentially affecting the ability of the SJNM Shorebird Model to produce accurate results and serve its intended purpose. The second issue was determined to be of medium significance, affecting the understanding, usability and level of performance of the model.

1. Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited (Final Panel Comment 1). This is primarily because there will be changes in land use both

upstream and within the project area, and consequently changes in river stage conditions, that are not accounted for by the model.

2. Qualitative variables need to have quantitative boundaries (Final Panel Comment 7). Otherwise, there will be limited understanding of model outputs and limited accuracy future projections of available shorebird habitat.

3.7 Review of Calculations/Formulas

The issues identified with the SJNM Shorebird Model calculations and formulas are strongly related to the variables selected for the model and how well the calculations can be used to determine and project available shorebird foraging habitat. The following specific issues related to the assessment of the model's calculations and formulas were identified (relevant Final Panel Comment numbers are provided in parentheses). The first issue is of high significance, potentially affecting the ability of the SJNM Shorebird Model to produce accurate results and serve its intended purpose. The other issues are of medium significance, affecting the usability and level of performance of the model.

1. Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited (Final Panel Comment 1). This is because the model does not account for changes in land use both upstream and within the project area, and consequently changes in river stage conditions, that will occur over time.
2. The model does not include variables for the amount of vegetative cover and vegetation height (Final Panel Comment 3).
3. The model should weight suitable shorebird habitat for patch size (Final Panel Comment 4).
4. Qualitative variables need to have quantitative boundaries (Final Panel Comment 7).

4.0 SYSTEM QUALITY ASSESSMENT

System quality refers to the quality of the entire system used to develop, use, and support the model, including the software and hardware platform. System quality is generally 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 Windows and MacOS, and the development of a problem-tracking database. Most of this is done through USACE internal review and tracking. However, some criteria can be, and have been, evaluated by external peer reviewers. In general, model reviewer evaluation of system quality can include assessing whether supporting software tools/programming language are appropriate for the model, programming is done correctly, software and hardware are available, the model has been tested and validated, and data can be readily imported into other software analysis tools, if applicable.

The system quality assessment for the SJNM Shorebird Model was based on an evaluation of the criteria described in Section 2.1. Most of the assessment criteria are not related to this review because the model is still in the development stage and there is not any software or a model spreadsheet to review. Therefore, the assessment of system quality for this review was limited to

a review of the proposed model testing and validation procedure. The results of the Model Review Panel's assessment of system quality are summarized in the following sections. Full Final Panel Comments are provided in Appendix B.

4.1 Review of Supporting Software

A review of supporting software is not relevant or applicable to the SJNM Shorebird Model review.

4.2 Review of Programming Accuracy

A review of programming accuracy is not relevant or applicable to the SJNM Shorebird Model review.

4.3 Review of Model Testing and Validation

Model testing and validation is key to ensuring that models perform as expected and perform well enough to serve their intended purpose. In the case of the SJNM Shorebird Model, model results would need to accurately and consistently determine or predict the availability of suitable shorebird foraging habitat. The following specific issues regarding model testing and validation were identified (relevant Final Panel Comment numbers are provided in parentheses). The first issue identified is of medium significance, affecting the understanding of the SJNM Shorebird Model performance. The second issue is of low significance, affecting the quality of the testing and validation results.

1. The ability to verify and validate the performance of the model is limited (Final Panel Comment 6). This is because the verification and validation of the model will be based on comparison of the area predicted for shorebird habitat with shallowly inundated area identified in Landsat™ imagery, which has low resolution.
2. The model could be strengthened if shorebird use of the habitat was considered during field validation (Final Panel Comment 8). This has not been proposed as part of the testing and validation process.

5.0 USABILITY ASSESSMENT

Usability refers to how easily model users can access and run the models, interpret 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 should be easy to interpret, useful for supporting the purpose of the model, easy to export to project reports, and sufficiently transparent to allow for easy verification of calculations and outputs.

The model usability assessment was based on an evaluation of the criteria described in Section 2.1. The SJNM Shorebird Model usability was assessed based on data availability, how easily results are interpreted and understood, and how well the documentation for the SJNM Shorebird Model supports and explains its application. The results of the Model Review Panel's assessment are summarized in the following sections. Full Final Panel Comments are provided in Appendix B.

5.1 Review of User Interface

A review of the user interface is not relevant or applicable to the SJNM Shorebird Model review, as no supporting software or spreadsheets were provided for the review.

5.2 Review of Data Availability

The following specific issues regarding data availability were identified (relevant Final Panel Comment numbers are provided in parentheses). The first issue is of high significance, potentially affecting the ability of the SJNM Shorebird Model to produce accurate results and serve its intended purpose. The second issue is of medium significance, affecting the understanding of the level of performance of the model.

1. The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy (Final Panel Comment 2). The data available could be used to develop a model that produces model outputs with greater accuracy.
2. The ability to verify and validate the performance of the model is limited (Final Panel Comment 6). The verification and validation of the model will be based on comparison of the area predicted for shorebird habitat with shallowly inundated area identified in Landsat™ imagery, which has low spatial resolution. Higher resolution data are available, although at a cost (there is no cost for Landsat imagery), and should be considered to improve verification and validation of the SJNM Shorebird Model.

5.3 Review of Results

The SJNM Shorebird Model produces a measure of available suitable shorebird foraging habitat that is the product of a SI score and area of habitat coverage. Although the rapid assessment approach is desirable for planning projects, the SJNM shorebird habitat assessment approach has its limitations. The following specific issues regarding the results of the models were identified (relevant Final Panel Comment numbers are provided in parentheses). The first two issues are of high significance, potentially affecting the model's ability to produce accurate results and serve its intended purpose. The other issues are of medium significance, affecting the understanding, model usability, or the accuracy of the model results.

1. Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited (Final Panel Comment 1). This is because land use both upstream and within the project area, and consequently river stage conditions, will change over time.
2. The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy (Final Panel Comment 2).
3. The model does not include variables for the amount of vegetative cover and vegetation height (Final Panel Comment 3). This limits the ability of the model to accurately determine or project the availability of suitable shorebird foraging habitat, and the availability of suitable habitat may be overestimated.
4. The ability to verify and validate the performance of the model is limited (Final Panel Comment 6). This reduces confidence in the accuracy of results produced.

5. Qualitative variables need to have quantitative boundaries (Final Panel Comment 7). Otherwise, the results produced will not be well-understood, and results could vary across users because of variability in user definition of SI scores.

5.4 Review of Documentation

The model documentation provides a good summary of the theoretical basis for the SJNM Shorebird Model. The model reviewers feel that the SJNM Shorebird Model documentation is currently sufficient for the St. Johns Bayou and New Madrid Floodway Project PDT; however, the documentations will need to be expanded to support planning decisions that are made and if the SJNM Shorebird Model is verified and validated and then released for more widespread use by a broader user audience. The following specific issues regarding the SJNM Shorebird Model documentation were identified (relevant Final Panel Comment numbers are provided in parentheses). These issues are currently of low significance, only affecting the technical quality of the SJNM Shorebird Model documentation. However, they could be of medium significance, affecting the understanding and usability of the model if the model is released for use outside of the PDT.

1. There is no user documentation for the model (Final Panel Comment 9).
2. If the model is released for more widespread use outside of the PDT, the model documentation should be improved by providing additional information (Final Panel Comment 10). Detailed recommendations are provided in the Final Panel Comment form in Appendix B.

6.0 MODEL ASSESSMENT SUMMARY

During the review of the technical quality, system quality, and usability of the SJNM Shorebird Model, the Model Review Panel determined that the conceptual approach is appropriate for the intended purpose of assessing changes in the availability of suitable shorebird foraging habitat that will result from the St. Johns Bayou and New Madrid Floodway Project. However, some issues were identified regarding the technical quality of the SJNM Shorebird Model and the usability of model outputs. Since models are only approximations of actual systems, all models have limitations. The Model Review Panel has made suggestions regarding how to address the limitations of the SJNM Shorebird Model. Testing and validation of the SJNM Shorebird Model must also be performed to clearly demonstrate its sensitivity, accuracy, and ability to support planning decisions.

In addressing and answering charge questions designed to focus the review of the SJNM Shorebird Model based on the model assessment criteria in the *Protocols for Certification of Planning Models* (USACE 2007), the model reviewers identified the following underlying issues or potential issues with the model.

- Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited (Final Panel Comment 1). This is related to the assumption that land use both upstream and

within the project area, and consequently river stage conditions, will not change over time.

- The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy (Final Panel Comment 2).
- Regarding the model parameters:
  - The model does not include variables for the amount of vegetative cover and vegetation height (Final Panel Comment 3). Vegetative cover and height strongly influence the suitability of habitat for shorebird foraging, and not including this in the model could lead to an overestimate of available shorebird foraging habitat.
  - The model should weight suitable shorebird habitat for patch size (Final Panel Comment 4).
  - Qualitative variables need to have quantitative boundaries (Final Panel Comment 7). This will improve how well model outputs are understood and consistency between users.
- The ability of the model to evaluate uncertainty is limited (Final Panel Comment 5). This is because the response of the model outputs to variation in input parameters and the accuracy of the input parameters has not been quantified.
- The ability to verify and validate the performance of the model is limited (Final Panel Comment 6). This is because the verification and validation of the model will be based on comparison of the area predicted for shorebird habitat with shallowly inundated area identified in Landsat™ imagery, which has low resolution.
- The model could be strengthened if shorebird use of the habitat was considered during field validation (Final Panel Comment 8).
- Regarding the model documentation:
  - There is no user documentation for the model (Final Panel Comment 9).
  - If the model is released for more widespread use outside of the PDT, the model documentation should be improved by providing additional information (Final Panel Comment 10).

7.0 CONCLUSIONS

The SJNM Shorebird Model provides a good basis for what could be an effective tool for determining changes in the availability of suitable shorebird foraging habitat at a coarse spatial scale (finer topographic variability is not taken into account). However, the accuracy of the model outputs should be improved for better-informed planning, and the performance of the model needs to be tested and verified before it is applied for decision-making. The Model Review Panel recommends the following actions to improve the technical quality and usability of the SJNM Shorebird Model.

- Estimate the effects of future changes in land use by projecting future changes based on a recent history of land-use changes in the study area, include current and anticipated land use and structural changes upstream when applying historical river-stage data to future

conditions, and review and modify the model every 10 years such that the most current changes in river stage and habitat conditions are incorporated (Final Panel Comment 1).

- Either use the highest-resolution LiDAR data for obtaining the highest model accuracies (preferred), or as an alternative, expand the use of the LiDAR-derived 2-foot contour map from the New Madrid Basin to the St. Johns Basin for obtaining improved model accuracies (Final Panel Comment 2).
- Conduct an examination of possible methods to distinguish vegetation coverage and heights at a finer scale. If this is not possible, provide an explanation of the limitations related to the broad scale definition of vegetation in the model documentation (Final Panel Comment 3).
- Include a minimum patch size in the definition of suitable shorebird habitat and provide justification for the choice of a minimum patch size (Final Panel Comment 4).
- Provide quantitative limits for all of the qualitative vegetation variables, including the development of an SI value for Conservation Reserve Program (CRP) and set-aside lands (Final Panel Comment 7).
- Use the model to evaluate ranges of some or all input variables so that the output is a range rather than a single point estimate (Final Panel Comment 5).
- Consider using higher spatial resolution imagery, such as Satellite Pour l'Observation de la Terre (SPOT) imagery (10 m pixel size), Quickbird imagery (sub-meter), or SAR imagery (such as TerraSAR-X [1-5 m pixel resolution]) to verify and validate the model (Final Panel Comment 6).
- Collect data on shorebird use of sites during field validation of the model to confirm shorebird use (Final Panel Comment 8).
- Expand the SJNM Shorebird Model documentation to:
    - Explain that historic river stages may not represent future river stages and that large scale land-use changes (e.g., changes in agriculture practices) and climate change may result in unforeseen changes to river stage, and include guidelines for how the model will address these changes (e.g., how will changes to inputs be incorporated into the model, what are the minimum levels of change that will require model adjustments, etc.). (Final Panel Comment 1).
    - Emphasize the importance of multiple model runs to assess uncertainty in model outputs (Final Panel Comment 5).
    - Include an additional section that explicitly details the steps that the users should take for effective application of the model (Final Panel Comment 9).
    - Provide a clear explanation of the potential impacts from project alternatives on shorebird foraging habitat (Final Panel Comment 10).
    - Provide a list of terms and their definitions (Final Panel Comment 10).
    - Include an explanation of the basis for HEP and how the Habitat Suitability Index (HSI) development process was integrated into the development of the SJNM Shorebird Model (Final Panel Comment 10).

- Include a description of a validation/modification process that will be applied during the early phases of model application (Final Panel Comment 10).
- Provide more information in the existing figures, such as scale and labels (Final Panel Comment 10).
- Provide additional figures to help explain the model better (Final Panel Comment 10).
- Include the rationale for why 2000 data were chosen for development of the model (Final Panel Comment 10).
- Include a complete and comprehensive list of assumptions and limitations in a single location (Final Panel Comment 10).

This list of actions summarizes the recommendations for resolution in the Final Panel Comments, and more specific detailed recommendations are provided in the Final Panel Comments presented in Appendix B in this report. The level of significance of most of the Final Panel Comments was assigned based on the assumption that the SJNM Shorebird Model is only intended for use by the St. Johns Bayou and New Madrid Floodway Project PDT, defined to include those who developed the model or know how it was developed; determined and/or understand the methods required to preprocess the data being input to the model and the precision and accuracy required of those data to generate useful model results; served in an advisory role during the development of the SJNM Shorebird Model; and others who served on the teams and without whom the teams would not be complete. If the model is released for general use to a diverse audience, the level of significance of some comments would be elevated, and all low-significance comments would be assigned medium significance because different users (e.g., public, technical committee and developers) have different levels of understanding, needs and requirements for documentation.

Three issues were identified that need to be addressed for immediate use of the SJNM Shorebird Model by the St. Johns Bayou and New Madrid Floodway Project PDT:

1. The SJNM Shorebird Model needs to consider changes in land use and resulting changes in flood stage conditions.
2. The SJNM Shorebird Model needs to be based on higher resolution geospatial data.
3. The SJNM Shorebird Model needs to be tested and validated to establish its accuracy and determine its sensitivity to variability in model inputs.

Although other issues do not need to be addressed in order for the SJNM Shorebird Model to perform at a very coarse geospatial scale, adopting the recommendations provided would significantly improve the accuracy of the model outputs and the ability to effectively project changes in the availability of suitable shorebird foraging habitat.

8.0 LIST OF PREPARERS

Information on the model reviewers selected for the Model Review Panel is summarized in Table 1. A short biography for each of the reviewers is provided below.

Table 1. Experts Selected for the SJNM Shorebird Model Review Panel

Name	Affiliation	Location	Education	Years of Experience
HEP Specialist				
Richard Stiehl	Independent Consultant	Tucson, AZ	Ph.D. in environmental science/biology	28
Avian Biologist				
Craig Davis	Oklahoma State University	Stillwater, OK	Ph.D. in wildlife sciences	20
Stephen Dinsmore	Iowa State University	Ames, IA	Ph.D. in fishery and wildlife biology	20
Geospatial Analyst				
Shimon Wdowinski	University of Miami	Miami, FL	Ph.D. in geophysics	25

Richard Stiehl (HEP Specialist). Dr. Stiehl earned his Ph.D. in environmental science/biology from Portland State University in 1978 and has over 20 years of experience with HEP, wildlife biology, avian ecology, and habitat and community modeling. He completed his original HEP training in 1981 with the U.S. Fish and Wildlife Service (USFWS) and wrote several sections of the current USFWS HEP Manual as the chief editor. To date, Dr. Stiehl has taught over 30 certified HEP workshops. He was the lead HEP authority at USFWS between 1992 and 2000. Other work with USFWS included revising and/or writing other HEP manuals, rewriting HEP and Habitat Suitability Index (HSI) software, and conducting wildlife research. He continued his HEP leadership role as a private consultant, constructing community HSI models for riparian, desert, and desert wetland habitats. He has developed software to evaluate long-term impacts to desert ecosystems for the Washington Department of Wildlife and the Columbia Basin Fish and Wildlife Agency. Dr. Stiehl has provided HEP expertise to 20 states and many federal agencies, including the USACE, Bureau of Reclamation, Natural Resources Conservation Service, and U.S. Environmental Protection Agency. He has led HEP teams on large, complex projects with high interagency interests, including HEP analyses for shorebird habitat, the impacts of weapons training for the U.S. Air Force in Utah, the Central Utah Project Uinta Basin Replacement Project, HEP software development for the Upper Mississippi River Project, and the Virginia

Department of Transportation SE Expressway Greenbelt Project. Other high profile HEP projects include consulting with General Electric for polychlorinated biphenyls remediation in the Upper Hudson River, NY for post-9/11 communications network evaluation, and the Theodore Roosevelt Conservation Trust for impacts from gas/oil field development in central Wyoming. Dr. Stiehl has experience in the Lower Mississippi River Valley, including being an assistant and associate professor of biology at Southeast Missouri State University (Cape Girardeau, MO) for 10 years and conducting extensive fieldwork in southeastern Missouri on fish and bird populations. Dr. Stiehl also has experience conducting restoration and mitigation analyses for USFWS and tribal lands.

Craig Davis (Avian Biologist). Dr. Davis earned a Ph.D. in wildlife sciences from Texas Tech University in 1996 and has 20 years of experience as an avian biologist. He is an Associate Professor and the Curator of Birds Collection in the Department of Natural Resource Ecology and Management at Oklahoma State University and is involved in research projects focusing on shorebird ecology and wetland habitat assessment. He routinely teaches graduate and undergraduate courses in ornithology, wetland wildlife ecology, wildlife research techniques, and wetland ecology and management. Dr. Davis also teaches a class on HEP and habitat evaluation techniques. The course reviews different HEP approaches as well as the development and application of HSI Models. Dr. Davis has served as a reviewer for the Whooping Crane HSI Model developed by USGS Fort Collins Research Center. Currently, Dr. Davis is serving as a principal investigator to assess landscape-level and climate change influences on shorebird distributions, community structure, and abundances in the central Great Plains. Prior to his position at Oklahoma State, he was the avian ecologist for The Platte River Whooping Crane Trust for four years. He served on the Technical Committee of the Platte River Cooperative Agreement and was involved with developing monitoring protocols and providing recommendations for habitat management for endangered and threatened birds that use the Platte River. Dr. Davis has authored or co-authored more than 20 publications on shorebird and wetland ecology in a wide variety of peer-reviewed journals and is currently co-editing a textbook detailing a variety of new Wetland Research techniques. Since 2003, Dr. Davis has served on the Playa Lakes Joint Venture Shorebird Planning Working Group. He has knowledge of Lower Mississippi River Valley bird populations through his past conservation efforts and as associate editor for Wetlands, for which he has reviewed papers relative to Lower Mississippi River Valley shorebird populations. Dr. Davis is currently a member of the Cooper Ornithological Society, American Ornithologists' Union, Society of Wetland Scientists, The Wildlife Society, and Wilson Ornithological Society.

Stephen Dinsmore (Avian Biologist). Dr. Dinsmore has a M.S. in zoology from North Carolina State University and a Ph.D. in fishery and wildlife biology from Colorado State University, both obtained through his research on the population biology of shorebirds. Currently, Dr. Dinsmore is an associate professor of wildlife ecology for the Department of Natural Resource Ecology and Management at Iowa State University with more than 20 years of experience in the field of avian ecology. In addition to his graduate work, Dr. Dinsmore has assisted with other shorebird migration projects in the Midwest, supervised four graduate students studying shorebird ecology, and taught graduate and undergraduate courses in ornithology, avian biology, and applied wildlife population ecology. Prior to his university appointments, he worked for federal, state, and private organizations. He is familiar with large, complex civil works projects with high public and interagency interests from his involvement in bird surveys for USACE (e.g., the

Saylorville Lake Project, IA) and from previous involvement in other model reviews. Dr. Dinsmore has demonstrated experience in evaluating the habitat suitability for migrating shorebirds. His M.S. degree examined the stopover ecology of shorebirds in North Carolina and included a component dealing with habitat suitability. He has also worked with habitat suitability for Mountain Plovers and other bird species. His knowledge of shorebird migration habitat in large floodplain rivers includes broad familiarity with the shorebird community and habitat use along the Mississippi River and his extensive four-year shorebird surveys in the Mississippi Delta region of northwestern Mississippi. He has a good working knowledge of HEP and teaches this topic in one of his undergraduate classes. He is also familiar with this topic from previous model reviews. He is familiar with spatial habitat modeling and used this approach in both his graduate degrees in shorebird ecology: his M.S. focused on migration/stopover ecology and his doctoral work emphasized population ecology. He has authored or co-authored over 30 peer reviewed journal articles and five books on avian viewing or ecology. Dr. Dinsmore has served as the Associate Editor for the Auk since 2006 and has been a member of the Cooper Ornithological Society since 1993.

Shimon Wdowinski (Geospatial Analyst). Dr. Wdowinski is currently a Research Associate Professor with the Division of Marine Geology and Geophysics in the Rosenstiel School of Marine and Atmospheric Science at University of Miami. He received his Ph.D. in geophysics from Harvard University in 1990 and has M.S. degrees in engineering sciences and geology from Harvard and Hebrew Universities. He has more than 20 years of experience working with geodetic data (global positioning system, InSAR, altimetry, and LiDAR) on a variety of projects and studies that have measured topography and its changes over time. Dr. Wdowinski has extensive experience conducting geospatial topographic analysis of various terrains at various scales and is involved in research projects focused on monitoring post-seismic crustal deformation in Haiti and forest and wetland 3-D vegetation structure, among others. Other topographic analysis experience has included monitoring crustal deformation across the Dead Sea Fault. Dr. Wdowinski has also studied space-based remote sensing of surface water hydrology and sea-level changes in the Everglades. As a result of this work, Dr. Wdowinski is very familiar with large, civil work projects with high public and interagency interest in the Everglades, including the Tamiami Trail Culverts, the Western C-11 water quality treatment and others. Over the past several years, he has been involved with the collection of LiDAR data in the Everglades for topography and vegetation studies. As part of his hydrological research of the Everglades, Dr. Wdowinski used several hydrological models, including MODFLOW, FLO-2D, and UNET, to simulate surface flow in wetlands and channels. The models' results were compared with stage data and space-based InSAR observations. Dr. Wdowinski routinely teaches courses in geophysics, natural disasters, and mathematical methods for geo-scientists. Dr. Wdowinski is currently a member of the Society of Wetland Scientists, American Geophysical Union, and Israel Geological Society.

9.0 REFERENCES

Cobby, D.M., D.C. Mason, and I.J. Davenport. 2001. Image processing of airborne laser altimetry data for improved river modeling. *ISPRS Journal of Photogrammetry and Remote Sensing*, 56(2): 121–138.

Davis, C.A. and J.R. Bidwell. 2008. Response of aquatic invertebrates to vegetation management and agriculture. Wetlands, 28:793-805.

Hodgson, M. E. and P. Bresnahan. 2004. Accuracy of airborne lidar-derived elevation: Empirical assessment and error budget. *ISPRS Journal of Photogrammetry and Remote Sensing*, 70: 331–339.

USACE. 2007. Protocols for Certification of Planning Models Under the Planning Models Improvement Program (PMIP). U.S. Army Corps of Engineers, July 2007.

USACE. 2005. Planning Models Improvement Program (PMIP): Model Certification. U.S. Army Corps of Engineers, Engineering Circular No. 1105-2-407, May 2005.

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APPENDIX A

Charge to the Model Reviewers

(as submitted to Model Reviewers on March 2, 2011)

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Final Charge Guidance and Questions to the Model Reviewers
for the
Model Review of the Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri (SJNM Shorebird Model)

BACKGROUND

Planning models are defined as any models and analytical tools that planners use to define water resources management problems and opportunities, to formulate potential alternatives to address the problems and take advantage of the opportunities, to evaluate potential effects of alternatives, and to support decision-making. The U.S. Army Corps of Engineers (USACE) Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of planning models used by 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.

Use of certified or peer-reviewed approved models for all planning activities is mandatory. Models developed for planning activities must be subjected to a model quality assurance review before being certified or approved by USACE. This policy is applicable to all planning models currently in use, models under development, and new models. District Commanders are responsible for providing high quality, objective, defensible, and consistent planning products. Development of these products requires the use of tested and defensible models. Models may be certified by USACE either for widespread use across projects or approved for limited use on a specific project or set of projects. National certification of planning models for widespread use will result in significant efficiencies in the conduct of planning studies and enhance the capability to produce high quality products.

The appropriate USACE Planning Center of Expertise (PCX) is responsible for model reviews. The goal of review is to establish that USACE planning products are theoretically sound, compliant with USACE policy, computationally accurate, based on reasonable assumptions, and are in compliance with the requirements of the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* (December 16, 2004). The use of a certified and/or peer reviewed approved model does not constitute technical review of the planning product. Independent technical review of the selection and application of the model and the input data is still the responsibility of the users. If a model is certified or approved, the PCX will work with model developers and managers to ensure that documentation and training in model use are available and that model updates comply with certification/approval requirements.

The primary criterion identified for model quality assurance review is technical soundness. Technical soundness reflects the ability of the model to represent or simulate the processes and/or functions it is intended to represent. The performance metrics for this criterion are related to theory and computational correctness. In terms of the theory, the model should (1) be based on validated and accepted "state of the art" theory; (2) incorporate USACE policies and

requirements; (3) properly incorporate the conceptual theory into the software code; and (4) clearly define the assumptions inherent in the model. In terms of computational correctness, the model should (1) employ proper functions and mathematics to estimate functions and processes represented; and (2) properly estimate and forecast the actual parameters it is intended to estimate and forecast. Other criteria for certification review or model approval review are efficiency, effectiveness, usability and clarity in presentation of results. A certified and/or peer reviewed approved model will stand the tests of technical soundness based on these evaluation criteria.

The Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri (SJNM Shorebird Model) Study Plan was developed to assess the spatial and temporal availability of shallow floodwater habitat in the St. Johns-New Madrid Basins in southeastern Missouri that may be used by migrating shorebirds for foraging. USACE is authorized to implement a flood risk management project in these basins. The proposed project would complete the levee surrounding the New Madrid Basin and install pumping stations in both the St. Johns and New Madrid Basins. The SJNM Shorebird Model will be used to assess potential impacts to shorebird foraging habitat that may result from implementation of the flood risk management project. The model may also be used for mitigation planning. The model is being developed by Dan Twedt, U.S. Geological Survey Patuxent Wildlife Research Center, in cooperation with the USACE Memphis District.

The scope of this work is to review the technical quality and usability of the SJNM Shorebird Model and, if appropriate, offer recommendations to improve the model. The model is being considered for approval/certification for use on the SJNM project.

OBJECTIVE

The objective of this work is to conduct a model quality assurance review for the USACE Ecosystem Restoration Planning Center of Expertise (ECO-PCX) to evaluate the technical quality, system quality (limited evaluation), and usability of the SJNM Shorebird Model. The original SJNM Shorebird Model was abandoned based on comments received during a previous model review, and a new model has been developed with the assistance of members from an independent external peer review (IEPR) panel for the SJNM flood risk management project. The new model is being reviewed as a separate and independent model.

The model quality assurance review of the SJNM Shorebird Model will be conducted in accordance with the Department of the Army, USACE guidance entitled *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, dated May 31, 2005) and the *Protocols for Certification of Planning Models* (July 2007). These documents provide information on USACE policy regarding the use of high quality planning tools and the assessment criteria used to evaluate the quality of planning models, respectively. The primary goal of this review is to assure the quality of the SJNM Shorebird Model for use by the SJNM Project Development Team (PDT) for planning purposes on the SJNM flood risk management project. However, additional recommendations for improving the model for more widespread application by a broader user audience are also welcome.

This review will consider the technical quality, system quality (limited evaluation), and usability of the SJNM Shorebird Model. The review will not include a technical evaluation of the application of the model on the SJNM flood risk management project, as that is the purview of a separate IEPR panel. The review will be conducted by subject matter experts (i.e., model reviewers) with extensive experience in U.S. Fish and Wildlife Service (USFWS) Habitat Evaluation Procedures (HEP), avian biology, and geospatial analysis. The model reviewers will be "charged" with responding to specific technical questions as well as providing a broad technical evaluation of the SJNM Shorebird Model. Model reviewers will be asked to provide recommendations for resolving any issues identified. However, they are not responsible for making decisions regarding how to improve the model; the model developers are ultimately responsible for deciding whether to adopt recommendations made by the model reviewers. The review is intended to help USACE identify any errors, deficiencies, or other issues with the model that could limit its ability to meet its intended purpose. The results of this review will be used by USACE to make any necessary revisions to the SJNM Shorebird Model and/or model documentation for application on the SJNM flood risk management project. Although the purpose of this review is to determine whether or not the model can be approved for the limited SJNM application, it is likely that the model could be used for future applications within the Mississippi Alluvial Valley. Information provided during the model review will be used to assess whether to certify the SJNM Shorebird Model for broader application and inclusion in the USACE planning toolbox.

DOCUMENTS PROVIDED

Table 1 is a list of documents and reference materials that will be provided for the review. Only the first document is subject to review. All other materials listed in the table are provided for reference only, and the model reviewers are not required to review these documents. Documents provided for reference only should be read at the reviewer's discretion. When appropriate, the table provides guidance regarding which sections of the reference documents are most relevant to the review of the SJNM Model.

Table 1. Documents provided for the SJNM Shorebird Model Review

For review
1. Twedt, DJ. 2010, Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri. Study Plan 2302-9S270. USGS Patuxent Wildlife Research Center, Vicksburg, MS. 26 pp.
For reference only
2. Model Documentation for Pre 2010 SJNM Shorebird Model. 18pp.
3. Battelle Memorial Institute. 2010. Final Model Certification Review Report for the Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley (see Appendix B for Final Panel Comments)
4. Battelle Memorial Institute. 2009. Final Independent External Peer Review Report, St. Johns Bayou and New Madrid Floodway, Missouri, Consolidated NEPA Document and Work Plan, Environmental, Economic, and Hydrologic and Hydraulic Review, Phase 1.
5. Battelle Memorial Institute. 2009. Final Panel Comments and Final USACE Evaluator Comments, Final Independent External Peer Review Report, St. Johns Bayou and New Madrid Floodway, Missouri, Consolidated NEPA Document and Work Plan, Environmental, Economic, and Hydrologic and Hydraulic Review, Phase 1.

For reference only
6. Battelle Memorial Institute. 2010. Addendum to Final Independent External Peer Review Report, St. Johns Bayou and New Madrid Floodway, Missouri Consolidated NEPA Document and Work Plan, Phase 2 Environmental, Economic, and Hydrologic and Hydraulic Review. (See Comments 1, 2 and 15)
7. EC 1105-2-407, Planning - Planning Models Improvement Program: Model Certification, 31 May 2005 http://140.194.76.129/publications/eng-circulars/ec1105-2-407/entire.pdf
8. EC 1105-2-412, Assuring Quality of Planning Models, 30 December 2009. http://inlandwaterways.lrh.usace.army.mil/_kd/Items/actions.cfm?action=Show&item_id=681&destination=ShowItem
9. Almodovar, L., D. Nolton, B. Carlson, J. Walaszek and B. Frechione. 2007. Protocols for the Certification of Planning Models. Planning Models Improvement Program. July 2007 (http://www.usace.army.mil/CECW/PlanningCOP/Documents/models/protocols_cert_7-02-07.pdf)
10. Office of Management and Budget Final Information Quality Bulletin for Peer Review dated 16 December 2004. http://www.whitehouse.gov/sites/default/files/omb/assets/omb/memoranda/fy2005/m05-03.pdf

SCHEDULE

TASK	ACTION	DUE DATE
Conduct Model Review	Review documents sent to model reviewers	3/2/2011
	Battelle/Model Review Panel kickoff meeting	3/4/2011
	USACE/Battelle/Model Review Panel kickoff meeting	3/4/2011
	Battelle convenes mid-review teleconference	3/15/2011
	Model Review Panel completes their review	3/25/2011
Prepare Final Panel Comments and Draft Model Review Report	Battelle collates comments from Model Review Panel	3/29/2011
	Battelle convenes model review teleconference	3/30/2011
	Battelle provides Final Panel Comment writing assignment directive to Model Review Panel	3/31/2011
	Model reviewers provide Final Panel Comments to Battelle	4/8/2011
	Battelle provides feedback to model reviewers on Final Panel Comments/model reviewers provide revised Final Panel Comments	4/15/2011
	Battelle provides draft Planning Model Quality Assurance Review Report to Model Review Panel for review	4/20/2011
	Model reviewers provide comments on draft Planning Model Quality Assurance Review Report	4/22/2011
	*Battelle submits draft Planning Model Quality Assurance Review Report to USACE for review	4/27/2011
Prepare Final Model Report	USACE provides comments on draft Planning Model Quality Assurance Review Report and responses to Final Panel Comments in the report	5/11/2011
	Battelle convenes teleconference to discuss USACE responses to Final Panel Comments and comments on the draft Planning Model Quality Assurance Review Report	5/13/2011
	Battelle provides final Planning Model Quality Assurance Review Report to Model Review Panel for review	5/16/2011

TASK	ACTION	DUE DATE
	Model reviewers provide comments on final Planning Model Quality Assurance Review Report	5/17/2011
	*Battelle submits the final Planning Model Quality Assurance Review Report to USACE	5/20/2011

* denotes a deliverable

CHARGE FOR MODEL REVIEW

Input from the model reviewers is being sought to help the USACE Ecosystem Restoration Planning Center of Expertise (ECO-PCX) determine whether the SJNM Model can be described as technically sound relative to its design objectives. In addition to the underlying theoretical, conceptual, and computational aspects of the model, reviewers are asked to comment on aspects of the model that affect its usability and the reliability to produce information that can be effectively used to influence planning decisions.

The charge questions and guidelines below are based on the model assessment criteria in the *Protocols for Certification of Planning Models* (July 2007) from the USACE Planning Models Improvement Program. The intent of these questions is to focus the review on the assessment criteria that need to be evaluated. Accordingly, please provide responses to questions on the scientific and technical topics listed below, but also feel free to offer other relevant comments focusing on your areas of expertise, experience, and technical knowledge as you perform a broad review of the SJNM Shorebird Model.

General Charge Guidance

1. Please answer the scientific and technical questions listed below and conduct a broad overview assessment of the model focusing on your areas of expertise and technical knowledge. **Use the Charge Response Form provided when answering the questions**.
2. Evaluate the soundness of the model as applicable and relevant to your area of expertise. Comment on whether the model reasonably represents the system being modeled and how the model may 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 the availability of suitable habitat.
5. Offer suggestions for future improvements that could be considered by USACE but are not necessary for immediate application of the model by the model developers at this time.
6. Panel members may contact each other during the review with questions and information requests, however, the Battelle Project Manager, Amanda Maxemchuk (maxemchuka@battelle.org), and Program Manager, Karen Johnson-Young (johnson-

youngk@battelle.org), should be copied on all correspondence. If determined necessary, communications with USACE or the model proponents will be facilitated by a Battelle representative.

7. In case of media contact, notify the Battelle Program Manager, Karen Johnson-Young (johnson-youngk@battelle.org), immediately.

Your name will appear as one of the members Model Review Panel. Your comments will be included in the final Planning Model Quality Assurance Review Report, but will remain unattributed. The final Planning Model Quality Assurance Review Report is expected to be released to the public by the USACE at some time in the future.

Please submit your comments in electronic form to Amanda Maxemchuk (maxemchuka@battelle.org) no later than *March 25, 2011*.

MODEL ASSESSMENT CRITERIA

General Questions

1. Are the model's design objectives and intended uses clearly communicated?
2. To what extent does the model meet the expressed design objectives?
3. To what extent is the model suitable for the expressed intended uses?

Technical Quality

4. Comment on the quality of the model's technical documentation.
5. Comment on the technical quality of the model relative to its expressed design objectives.
6. Comment on the temporal and spatial granularity with which the model is designed to be applied.
7. Comment on the geographic range/applicability of the model.
8. Comment on the degree to which the assumptions and limitations of the model are clearly communicated.
    a. Comment on the degree to which apparent limitations impact the ability of the model to be used for characterization of available shorebird foraging habitat.
    b. Comment on the degree to which apparent limitations impact the ability of the model to be used for planning and forecasting of project-related impacts.
    c. Please provide recommendations for resolving or overcoming identified limitations.
9. Is the model based on well-established contemporary theory?
10. Does the model adequately emulate or otherwise address the suite of critical ecosystem attributes necessary to characterize available shorebird habitat?
11. Does the model effectively allow for reasonable variation in the variables that are critical to the intended uses (i.e., application of the model during planning of water resource and restoration activities)?
12. Comment on the precision and accuracy of the model outputs and identify which variables/factors have the greatest impact on model precision and accuracy.
13. Comment on sensitivities of the model and identify the variables/factors to which the model is most sensitive.
14. Are the input requirements of the model evident to the user (i.e., types of data required as well as accuracy and precision)?
15. Is it evident to the user how the inputs are used by the model?
16. Are the assumptions that are critical to valid application of the SJNM Shorebird Model clearly identified?

17. Comment on the degree to which model assumptions might invalidate the model's use for specific applications.
18. Comment on the degree to which the model facilitates/accommodates uncertainty and risk analyses.
19. Comment on the degree to which the model can be used as a tool to forecast conditions anticipated to occur during the design lifecycle of a water resource and restoration activities project (i.e., from 1 to 50 years).
20. Comment on the degree to which the model delivers information adequate for the purpose of supporting determinations of compensatory mitigation.
21. Comment on the approach for calculating projected changes in available shorebird foraging habitat.
22. Comment on the degree to which the model is configured to accept modified assumptions and inputs regarding future global events such as, but not limited to, global climate change.

System Quality

23. Comment on the proposed approach for model validation and verification.

Usability

24. Comment on the model's ease of use.
25. Comment on the model's practicality and application/input requirements.
26. Comment on the availability of the data required by the model.
27. Comment on how useful the model is for characterization of near-term conditions.
28. Comment on how useful the model is for characterization of future conditions.
29. Comment on the usability of the model for selecting a course/plan of action.
30. Is user documentation user friendly and complete?

Key Issues

31. Please comment on what you think the key issues/concerns are with the SJNM Shorebird Model (if any). Provide clear, concise statements.

APPENDIX B

SJNM Shorebird Model Review Final Panel Comments

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Final Panel Comments

The following forms include the Final Panel Comments from the review of the Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri (SJNM Shorebird Model) Study Plan. These comments reflect the key issues identified during the assessment of the model review criteria described in the U.S. Army Corps of Engineers (USACE) *Protocols for the Certification of Planning Models*. Each form contains a concise statement of the issue (the comment), the model assessment criteria to which the issue is related, the basis of the comment, the significance of the comment, and recommendations for resolution. Significance levels are defined as follows:

> **High (H):** Describes a fundamental problem with the model that could affect the model's ability to serve its intended purpose
>
> **Medium (M):** Affects the completeness or understanding of the model, model usability, or the level of performance of the model
>
> **Low (L):** Affects the technical quality of the model documentation but will not affect the performance of the model.

The Final Panel Comments are:

1. Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited. (H)
2. The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy. (H)
3. The model does not include variables for the amount of vegetative cover and vegetation height. (H)
4. The model should weight suitable shorebird habitat for patch size. (M)
5. The ability of the model to evaluate uncertainty is limited. (M)
6. The ability to verify and validate the performance of the model is limited. (M)
7. Qualitative variables need to have quantitative boundaries. (M)
8. The model could be strengthened if shorebird use of the habitat was considered during field validation. (L)
9. There is no user documentation for the model. (L)
10. If the model is released for more widespread use outside of the project development team (PDT), the model documentation should be improved by providing additional information. (L)

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Comment 1:

Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited.

Relevant Model Assessment Criteria:

Review of:

- Model Assumptions
- Ability to Evaluate Risk and Uncertainty
- Ability to Calculate Benefits for Total Project Life
- Model Calculations/Formulas
- Results

Basis for Comment:

The projected timeline for evaluating the impact of the project on shorebird habitat is 50 years. According to the model documentation, USACE will provide estimates of daily river stages that are likely to occur under post-project conditions. It is not clear how these projected estimates will be determined except that they will be based on historical river stage data (1943-2009). For the near-term (5-10 years post-project), use of historical stage data will be adequate and appropriate for assessing impact on shorebird habitat, but likely will not be sufficient for future projections beyond 10 years. The model currently assumes land use and land cover classes have not changed since 1943 and will remain the same for the life of the project. Furthermore, changes in land use and cover classes upstream are not considered by the model. Zhang and Shilling (2006) indicated that land use change associated with changes in agricultural activities (conversion of perennial vegetation to seasonal row crops) that occurred in the Mississippi River basin during the last 60 years has resulted in increases in both base flow and stream flow. Therefore, this assumption appears to be unrealistic and may affect the accuracy of the model for future projections. Basing future projections on past stochasticity will likely not capture what future river stage conditions will be. For example, changes in land-use patterns and amount of land being managed under different land-use practices upstream of the project may be quite different in the future and could result in river stage levels not encountered during the 1943-2009 time period.

Additionally, the model does not consider the effects of land use changes in the project area on the quantity and quality of shorebird habitat. Although future projections in changes in land use in the project area is problematic, applying the rate of recent past changes in land use may provide a logical and defendable forecasting of future changes in land use. A recalibration of the model every 5-10 years such that it takes into consideration more recent changes in river stage that may be a result of recent changes in upstream land-use patterns will allow the model to more accurately portray future impacts on shorebird habitat conditions in the project area.

Significance – High:

By relying exclusively on historic river stage data, future projections of amount of available shorebird habitat may be inaccurate and, consequently, misleading.

Recommendations for Resolution:

1. Estimate the effects of future changes in land use by projecting future changes based on a recent history of land-use changes in the study area. (e.g., If "x" % of the agricultural land has been retired to the Conservation Reserve Program (CRP) in the past 10 years, it may be reasonable to assume that "y" ha will be retired in the next 10 years.)
2. Include current and anticipated land use and structural changes upstream when applying historical river-stage data to future conditions.
3. Review and modify the model every 10 years such that the most current changes in river stage and habitat conditions are incorporated into the model.
4. Explain in the model documentation that historic river stages may not represent future river stages and that large scale land-use changes (e.g., changes in agriculture practices) and climate change may result in unforeseen changes to river stage. Include a discussion of how the model will address these changes.

References:

Zhang, Y. K. and K. E Shilling. 2006. Increasing streamflow and baseflow in Mississippi River since the 1940 s: Effect of land use change.J. Hydro. 324(4):412-422.

Comment 2:

The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy.

Relevant Model Assessment Criteria:

Review of:

- Representation of the System
- Analytical Requirement
- Model Assumptions
- Ability to Evaluate Risk and Uncertainty
- Data Availability
- Results

Basis for Comment:

The model is very sensitive to topographic gradients. In low gradient areas, small stage variations translate to a large shallowly flooded area, whereas in high gradient areas, stage changes translate into small shallowly flooded areas. Therefore, it is important to use reliable topographic datasets, especially in areas with low topographic gradients (i.e., flat topography).

The model topographic input is 1-foot elevation contours, which were derived from two datasets with higher contour intervals. The elevation contours for the New Madrid Basin were obtained from a light detection and ranging (LiDAR)-derived map calculated with 2-foot intervals. The elevation contours for the St. Johns Basin were obtained from a mosaic of 24 digital elevation maps (DEMs) that were generated from 7.5 minute quadrangles with 5-foot contour intervals. The 1-foot elevation contour used by the model is an interpolation product of these two lower accuracy elevation datasets. The model then further interpolates the 1-foot contours into 0.1-feet contours in order to calculate the shallowly flooded areas. Thus, the model calculations are based on 0.1-foot elevation contours that were derived from a dual-interpolation of 2- and 5-foot interval datasets.

In 2004, an airborne LiDAR survey was conducted in the New Madrid Basin and most of the St. Johns Basin. The LiDAR data acquired by this survey were used to generate the 2-foot contour map of the New Madrid Basin, which is used by the model. These LiDAR data can provide the most accurate elevation dataset for the model. Typical root-mean squared error (RMSE) accuracy values for airborne LiDAR surveys range from a low of 17 to 19 cm in some land cover types (pavement, low grass, and evergreen forests) to a high of 26 cm in other land cover types (deciduous forests) (Cobby et al., 2001; Hodgson and Bresnahan, 2004). Such sub-foot accuracy that is derived directly from the LiDAR data will provide the most accurate topographic dataset and is needed for reliable model calculations.

Significance – High:

Because the model is very sensitive to topographic gradients, the 2- and 5-foot topography datasets used by the model significantly degrade its calculation accuracy compared with calculations that use a DEM derived from the original LiDAR data (elevation accuracy better than 1-foot).

Recommendations for Resolution:

1. Use the original LiDAR data for obtaining the highest model accuracies.
   a. Generate a DEM from the original LiDAR data, acquired in 2004. Expected uncertainties (RMSE) are about 0.5 foot.
   b. Use LiDAR-derived DEM (step 1) as an input for the model.
   c. Eliminate the 0.1-foot interpolation step of the model, as the DEM generation already includes an interpolation (smoothing) of the LiDAR data.
2. Otherwise, expand the use of the LiDAR-derived 2-foot contour map to the St. Johns Basin for obtaining improved model accuracies. This solution is recommended if recommendation 1 is too time consuming and costly. The model procedure of interpolating the LiDAR-derived 2-foot contours, which are also obtained by interpolation, does not take full advantage of the LiDAR dataset. Nevertheless, this procedure still has a good accuracy level that is much better than that of the quadrangles-derived 5-foot contour dataset. Thus, expanding the use of the LiDAR-derived 2-foot contour map to the St. Johns Basin can significantly improve the model's accuracy.

References:

Cobby, D.M., D.C. Mason, and I.J. Davenport. 2001. Image processing of airborne laser altimetry data for improved river modeling. *ISPRS Journal of Photogrammetry and Remote Sensing*, 56(2): 121–138.

Hodgson, M. E. and P. Bresnahan. 2004. Accuracy of airborne lidar-derived elevation: Empirical assessment and error budget. *ISPRS Journal of Photogrammetry and Remote Sensing*, 70: 331–339.

Comment 3:

The model does not include variables for the amount of vegetative cover and vegetation height.

Relevant Model Assessment Criteria:

Review of:

- Representation of the System
- Model Assumptions
- Ability to Evaluate Risk and Uncertainty
- Model Calculations/Formulas
- Results

Basis for Comment:

In the Assumptions and Rationale section, it is acknowledged that water depth and vegetation are critical variables that influence shorebird use of foraging habitat. However, water depth is the only variable that is used to differentiate suitable foraging habitat from unsuitable habitat. The amount of vegetation cover and height of vegetation is not considered in the model. Specifically, vegetation is considered at a very broad scale in which grassland and cropland habitats are considered suitable and forest/shrubland habitats are considered unsuitable. Yet, the height of the vegetation or actual coverage of the vegetation is not considered in the model. Without considering the height and coverage of the vegetation, the model may overestimate suitable habitat because, although a site may have a water depth that is characteristic of suitable shorebird habitat, the vegetation height may be too tall for shorebirds to use the habitat. Furthermore, successional changes in plant communities, both within a year and among years, could reduce the quality of foraging habitat. For example, croplands in the spring may provide suitable habitat following fall or spring tilling, but in the summer/fall, the crops may be too tall for the habitat to be suitable.

Ideally, field vegetation surveys would be conducted across the project area and throughout the year, as well as over several years to establish average vegetation height and coverage at various points in time that can be used to assign appropriate suitability index (SI) values to reflect suitability of habitat for shorebird foraging. Recognizing that this effort is extremely labor-intensive and may not be feasible, less time consuming alternatives should be explored and used if available. Some LiDAR observations acquired with newer sensors are capable of detecting vegetation height with sub-foot accuracy, although it is uncertain whether the 2004 LiDAR data used for the SJNM study has that capability.

Significance – High:

The broad scale classification of vegetation may result in an overestimation of suitable shorebird habitat.

Recommendations for Resolution:

1. Provide an explanation of the limitations related to the broad scale definition of vegetation in the model documentation.
2. Conduct an examination of possible methods to distinguish vegetation coverage and heights at a finer scale. If a geospatial method (e.g., LiDAR) or higher resolution imagery

is available to further distinguish vegetation height and coverage, it should be used to refine the model.

3. As an alternative, conduct field surveys of potential shorebird habitat to establish cover types and vegetation height during the spring and fall migration periods.

Comment 4:
The model should weight suitable shorebird habitat for patch size.
Relevant Model Assessment Criteria:
Review of: Representation of the System Model Assumptions Model Calculations and Formulas
Basis for Comment:
The model does not consider any thresholds for the minimum size of a habitat patch that is considered suitable for a migratory shorebird. Habitat is mapped at fine resolution (9^{-} square foot pixels), but a single pixel may not truly represent suitable habitat because of its small size and isolation from other patches of suitable habitat. A discussion on the limitations of the model is missing, especially in terms of the resolution of the micro-topography data and broad-scale vegetation classification that help define suitable shorebird habitat. In both of these cases, the amount of suitable shorebird habitat could be overestimated, especially if shorebirds are area-sensitive. Thus, the model should consider area effects of habitat patches (e.g., 100 1-hectare (ha) patches may not have the same habitat value to shorebirds as one 100-ha patch, even though the total areas are equal). The decision to not include patch size may limit this model's use to sites with fewer but larger patches of potential shorebird habitat.
Significance – Medium:
The limitations of the model with respect to the spatial resolution of habitat will likely over-estimate suitable shorebird habitat. Furthermore, the model may label habitat as suitable at spatial scales that are inappropriate (i.e., too small) for use by migratory shorebirds.
Recommendations for Resolution:
1. Include a minimum patch size in the definition of suitable shorebird habitat. 2. Provide a justification for the choice of a minimum patch size.

Comment 5:
The ability of the model to evaluate uncertainty is limited.
Relevant Model Assessment Criteria:
Review of: Ability to Evaluate Risk and Uncertainty
Basis for Comment:
The Shorebird Model is a deterministic model with many inputs that result in a single daily estimate of the amount of optimal shorebird habitat (in ha-days) in the project area. In general, it is difficult to evaluate the model's accuracy because it does not include a sensitivity analysis or any measure of model uncertainty. The two things that contribute most to model uncertainty are habitat patch size and inaccuracies in topographic characterization. There is a need to understand how the model responds to changes in multiple variables and how changing predictions/model inputs affect the model output (i.e., suitable shorebird habitat estimates). Without knowing the sensitivity of the model, it is not clear whether the model can make reasonable predictions to evaluate alternatives. There is also a need to evaluate the contribution of inaccurate topography to the model's uncertainty.
Significance – Medium:
The inability to directly measure model uncertainty may affect the interpretation of model outputs and, ultimately, the application of the model to assess project impacts.
Recommendations for Resolution:
1. Add a statement to the model documentation that emphasizes the importance of multiple model runs to assess uncertainty in model outputs. 2. Use the model to evaluate ranges of some or all input variables so that the output is a range rather than a single point estimate. For example, the model could be run using a) the approach described in the model documentation, and b) as described in the model documentation, but only including habitat that occurs in patches of a minimum size. This would result in two separate estimates of available habitat, which could be compared as a range of possibilities. This could be done for all model inputs.

Comment 6:

The ability to verify and validate the performance of the model is limited.

Relevant Model Assessment Criteria:

Review of:

Ability to Evaluate Risk and Uncertainty

Model Testing and Validation

Data Availability

Results

Basis for Comment:

The verification and validation of the model will be based on comparison of the area predicted for shorebird habitat with shallowly inundated area identified in Landsat™ imagery. The proposed method is good, but has the following limitations:

- The 30-meter (m) pixel resolution of Landsat imagery can limit the verification/validation procedure, because it is hard to detect the transition from dry to wet land across a single pixel. Typically the transition between wet and dry pixels can be determined over a width of about 2-3 pixels (60-90 m) because the transition area is not well defined, especially in vegetated areas. Such a level of uncertainty can lead to over- or under-estimation of the shallowly flooded area by 5-70%. Based on the USACE elevation map of the New Madrid Basin, high uncertainty levels are expected in intermediate flooding conditions (stage value 280-286 feet), where flooding occurs mostly along long and narrow low elevation features, such abandoned river meanders. In higher stage conditions (> 286 feet), flooding is expected to occur over larger and more equi-dimensional areas and, hence, the uncertainties along flooded area's boundaries represent smaller portion of the total flooded area. Higher spatial resolution imagery would allow a more accurate detection of the transition between flooded and dry areas and, consequently, would provide better constraints for the verification and validation procedure.

- The remote sensing analysis might be limited by the available cloud-free imagery. A robust verification/validation analysis should compare the model results with satellite imagery at variable stage (and flooding) conditions. However, availability of Landsat imagery at various flooding conditions might be limited due to cloud cover. Synthetic Aperture Radar (SAR) imagery, which is acquired at all weather conditions and is very sensitive to inundation conditions, can provide an additional source of observations for the verification/validation analysis.

Significance – Medium:

The use of Landsat imagery can limit the verification/validation procedure because of the imagery coarse resolution (30 m pixel) and the need to find sufficient number of cloud-free images with various flooding conditions.

Recommendations for Resolution:
1. Use higher spatial resolution imagery, such as Satellite Pour l'Observation de la Terre (SPOT) imagery (10 m pixel size), or Quickbird imagery (sub-meter). 2. Use SAR imagery, in particular high resolution ones such as TerraSAR-X (1-5 m pixel resolution).

Comment 7:
Qualitative variables need to have quantitative boundaries.
Relevant Model Assessment Criteria:
Review of: Model Assumptions Ability to Calculate Benefits for Total Project Life Model Calculations/Formulas Results
Basis for Comment:
The model attempts to incorporate vegetative variable weighting into the development of cover type SI scores. Although it is clear that forest or shrub cover types are not considered suitable shorebird foraging habitats, the use of qualitative terms (e.g., relatively sparse vegetation, portions of mature crops, very short to relatively tall and rank vegetation) needs to have quantitative descriptors associated with each term to provide guidance to correct SI determinations. Additionally, the model considers grassland cover type as suitable habitat, but discusses CRP or "set-aside" land as having "reduced suitability for shorebirds." The model must provide an SI value from zero to one for all such areas in the St. Johns and New Madrid Basins.
Significance – Medium:
Without quantitative limits associated with qualitative vegetative variables, the resolution of the model will have increased variability, as different users may apply dissimilar definitions to the variables and the value of CRP and set-aside lands for shorebird foraging.
Recommendations for Resolution:
1. Provide quantitative limits for all of the qualitative vegetation variables. Develop an SI value for CRP and set-aside lands.

Comment 8:
The model could be strengthened if shorebird use of the habitat was considered during field validation.
Relevant Model Assessment Criteria:
Review of: Model Testing and Validation
Basis for Comment:
The shorebird migration model correctly states that validation depends only on the presence of suitable shorebird habitat, and not on shorebird use of that habitat. However, the model reviewers agree that the model would be more strongly validated if counts of shorebird use were included in the approach. If field validation of the model is required with respect to flood levels and habitat availability, then this should be done so that shorebirds can be counted simultaneously.
Significance – Low:
The shorebird model can be validated using habitat evaluation procedure (HEP) theory by assessing only potential habitat, although including a measure of shorebird use during habitat field surveys would provide even stronger model validation.
Recommendations for Resolution:
1. Collect data on shorebird use of sites during the proposed field validation of this model.

Comment 9:
There is no user documentation for the model.
Relevant Model Assessment Criteria:
Review of: Model Documentation
Basis for Comment:
Although the model documentation implies how the model should be applied, it does not explicitly describe a step by step application of the model.
Significance – Low:
Without an explicit description of the procedure associated with application of the model, there is a potential for erroneous application by users.
Recommendations for Resolution:
1. Develop and include an additional section in the model documentation that explicitly details the steps that the users should take for effective application of the model.

Comment 10:

If the model is released for more widespread use outside of the model development team, the model documentation should be improved by providing additional information.

Relevant Model Assessment Criteria:

Review of:

Model Documentation

Basis for Comment:

The background information in the model documentation lacks several details including:

1. A clear explanation of the potential impacts from project alternatives on shorebird foraging habitat. This information is important to support the need for model development, as well as the approach.
2. Terms and definitions (e.g., the term 'river stages that are likely to occur' is misleading, as changes in the river stage won't affect the extent of flooded areas after levies will be built. Other terms are also poorly defined.)
3. A brief explanation of how the U.S. Fish and Wildlife Service (USFWS) HEP basis and the Habitat Suitability Index (HSI) development process were integrated into the development of the Shorebird Model. Although the SI scores for the cover types in the project area are arbitrary (per HEP protocol), a more in-depth explanation of the logic of how the SIs for the cover types were developed would provide valuable user documentation.
4. Clear and informative figures:
    a. Information such as scale and labels is missing from some figures. For example, Figure 1 does not show:
        i. Labels for the two basins
        ii. Correct scale
        iii. The location of levees along the Mississippi River
        iv. The location of the levee gap, and
        v. The location of the New Madrid stage station.
    b. Additional figures could help explain the model better, in particular, elevation maps of both basins (e.g., the LiDAR-based USACE elevation map of the New Madrid Basin).
5. A rationale for why 2000 data (Table 2) were chosen for development of the model.
6. Detailed information on assumptions and limitations.
    a. The model should only be applied directly to the SJNM Basin. The model has not been tested or validated and is being applied to a large area over a long time period. The model will likely need modification, and the early phases of model application would provide a good opportunity to test and validate the performance of the model.
    b. The limitations of not having additional vegetation variables (e.g., amount of vegetative cover and vegetation height, type of vegetation) should be acknowledged. Simply noting the presence/absence of vegetative cover will not adequately explain the value of a site to migratory shorebirds. Factors such as vegetation height and patterns of within- and between-year plant succession should also be considered. At

the minimum, an acknowledgment of the importance of finer resolution vegetation characteristics is required. Moreover, there should be an acknowledgment that sites deemed suitable based on appropriate water depths may actually be unsuitable if vegetation is too tall or cover is too expansive at the site.

c. The availability of suitable habitat does not necessarily translate into shorebird abundances. USFWS HEP is very clear in that it describes habitat potential, not species abundance.

d. It is assumed that all water level changes occur due to vertical changes in the river stage. However in reality, such changes occur due to lateral flow. This assumption is valid as long as there are no barriers along the basins. Possible barriers, such as levees and roads, can limit the extent of lateral flow and, hence, model results will not reflect actual conditions precisely.

e. It is assumed that if a habitat is flooded it will have abundant invertebrate populations to meet shorebird foraging needs. Crop fields may actually have low invertebrate numbers because of continuous tilling and herbicide/insecticide applications (Davis and Bidwell, 2008).

7. An explanation that the SJNM Shorebird Model is a simple model that depends on single variable – the water level measured at New Madrid stage station. However, the initialization of the model requires the assemblage of elevation data and land cover information, which might be more complicated and require more expertise. After the elevation and land cover information are assembled into the model, it should be straightforward to use the model.

Significance – Low:

A lack of detailed information on the model description and limitations and assumptions will prevent users from fully understanding the basis and capabilities of the model.

Recommendations for Resolution:

1. Provide a clear explanation of the potential impacts from project alternatives on shorebird foraging habitat.
2. Provide a list of terms and their definitions.
3. Include an explanation of the basis for HEP and how the HSI development process was integrated into the development of the SJNM Shorebird Model.
4. Include a description of a validation/modification process that will be applied during the early phases of model application.
5. Provide more information in the existing figures, such as scale and labels.
6. Provide additional figures to help explain the model better.
7. Include the rationale for why 2000 data were chosen for development of the model.
8. Include a complete and comprehensive list of assumptions and limitations in a single location that includes a discussion of those noted above.
9. Explain clearly that the SJNM Shorebird Model is a simple model and that the initialization of the model requires specific expertise.

References:

Davis, C.A. and J.R. Bidwell. 2008. Response of aquatic invertebrates to vegetation management and agriculture. Wetlands, 28:793-805.