ATTACHMENT 3

NAS Report 1 Abbreviated Implementation Plan: Ecological Modeling

	Recommended for Implementation	Program Component	Recommendation	Description	Fiscally Feasible	Implementation Strategy	Additional Comments
10	Done	Ecological Model	Develop an ecosystem-based conceptual model (92:3).	An ecosystem-based conceptual model is a series of models of increasing resolution that shows water quality and quantity, other biota, and restoration and mitigation activities are expected to interact with the indicator species, as well as with all covered species	Yes	N/A	Already Done - 2010 EARIP Influence Diagrams: facilitated by Jean Cochrane
11	Done - applied verification in the field is continual	Ecological Model	Improve the habitat suitability analyses for Texas wild rice (83:55).	Habitat suitability analyses can help to guide efforts to restore Texas wild rice by suggesting areas most suitable for replanting.	Yes - funds could be allocated in the Applied Research Program	N/A (**Immediate Implementation)**	*TWR has been extremely successful to date; therefore additional TWR work is not needed at this point. *The Meadows Center has been collecting this information as Applied Research imbedded in their TWR restoration work. Habitat suitability has taken the form of applied verification in the field.
12	Done - In progress	Ecological Model	Include intermediate products in the development of the fountain darter model (86:38).	Reporting of analyses that supports each of the major sub models of growth, mortality, reproduction, and movement. Such analyses should discuss how the effects of flow, temperature, and structural habitat on each of these major processes will be represented in the model.	Yes - funds could be allocated in the Applied Research Program	N/A	These analyses were being performed as the first steps in the Eco Model development.

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13	Done - in progress	Ecological Model	Develop a phased strategy for testing individual components in the submerged aquatic vegetation (SAV) model (83:24).	A phased strategy of first testing each of the components under known and predictable environmental conditions (e.g., growth under fixed light and temperature), then further testing each component under realistically varying conditions, and then finally calibrating and validating when combined with all of the other processes. Careful attention to formulating a calibration and validation approach that ensures confidence in model predictions for how they will be used in the fountain darter model, and that encompasses the range of conditions to be simulated in the fountain darter model, is needed.	Yes	Conduct Analysis	The Eco Model Team is already planning to perform this verification.
14	Done - in progress and continual	Ecological Model	Make the Applied Research program more robust with quantitative projections of Comal Springs riffle beetle (CSRB) habitat (87:27).	Essential CSRB research data is required by the models. An aquatic entomologist or freshwater invertebrate ecologist can help guide this research.	Yes - Applied Research budget	In 2015 and 2016, the Applied Research Program is focusing on the Comal Springs riffle beetle **(Immediate Implementation)**.	However, the CSRB is no longer a module in the Eco Model, therefore the data collected will only be utilized if the CSRB is added to the model at some point in the future.

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15	Done - in progress and continual; silt should be addressed through Applied Research	Ecological Model	Include more field studies in the Applied Research program to assess silt impacts and critical life history and habitat assessment of the CSRB (87:36).	Field studies to answer the following questions: • What is the basis for the assumption that silt deposition represents an important environmental effector of CSRB population densities? • How does siltation quantitatively affect the known habitats of CSRB, and are there habitats that may act as Refugia during times of heavy deposition? • Are there quantitative relationships between silt-free gravel and cobble area with beetle population densities? • How many generations occur throughout the year for the CSRB and how does variable flow and sedimentation affect food availability and the beetle's population biology? • Are there invasive predators or competitors in these systems that might apply biotic control on the population numbers? • What other factors are likely to affect the population biology and ecology of CSRB? • How reliable is the cotton lure sampling method for quantitatively estimating densities of both adult and immature life stages of the CSRB?	Yes - Applied Research budget	In 2015 and 2016, the Applied Research Program is focusing on the Comal Springs riffle beetle, including field and tolerance studies **(Immediate Implementation)**.	However, the CSRB is no longer a module in the Eco Model, therefore the data collected will only be utilized if the CSRB is added to the model at some point in the future. Need to address the concerns related to siltation through Applied Research program

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16	Done	Ecological Model	Develop a conceptual model that shows how water quality and quantity, other biota and restoration and mitigation activities are expected to interact with the indicator species (89:22).	A conceptual model is a series of models of increasing resolution, that show how water quality and quantity, other biota, and restoration and mitigation activities are expected to interact with the indicator species, as well as with all covered species.	Yes	N/A	Already Done - 2010 EARIP Influence Diagrams: facilitated by Jean Cochrane
17	Done - in progress	Ecological Model	Ensure proper interpretation of the ongoing effort to build an individual-based model for fountain darter (91:10).	The ongoing effort to build an individual-based model for fountain darter will require extensive data for model formulation, calibration, and validation.	Yes	N/A	The Eco Modeling team already plans to conduct verification testing.
18	Yes	Ecological Model	Develop a much deeper understanding of the CSRB (91:33).	If the CSRB is to be an adequate indicator of some of the other Covered Species, it is critical to have a much deeper understanding of the spatial distribution, range of potential habitats, and natural history of the CSRB.	Yes - Applied Research budget	In 2015 and 2016, the Applied Research Program is focusing on the Comal Springs riffle beetle **(Immediate Implementation)**.	The workshop participants generally supported more CSRB research. However, there was discussion about if the CSRB should be used as an indicator species, as it is assumed the CSRB simply retreats into subterranean habitat.

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19	Done	Ecological Model	In developing the fountain darter model, pay attention to movement, density dependence and other topics (85).	The Ecological model should address the following: How movement is represented Clear documentation and justification for how flow, temperature, and vegetation are included in the growth, mortality, reproduction, and movement relationships How density-dependence is included Using the model to generate predictions of the population responses to various combinations of years with scour events and droughts Calibration and validation, which are needed to ensure sufficient model credibility Careful tracking of uncertainty Expectations are high because much discussion has pushed things to the ecological modeling and the term “predictive” has been used. Clarification of what the darter modeling can do and cannot do would be wise.	Yes	Ask Eco Modeling team to address and consider all the points identified by NAS. Ensure they are or were considered by the Eco Modeling team **(Immediate Implementation)**.	These studies were conducted through the Applied Research Program and results were incorporated into the Ecological Model
20	Yes	Ecological Model	Clarify the goal of the submerged aquatic vegetation (SAV) model (90:36).	The goal of the SAV modeling, which is in its early stages, should be clarified. Whether the goal is to simulate SAV biomass dynamics or to simulate habitat for the fountain darter model will affect how many models are needed and how each model is formulated.	Yes	Require the Eco Modeling team to provide a clear and concise goal of the SAV model **(Immediate Implementation)**.	

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21	Done - applied verification in the field is continual	Ecological Model	Test the robustness of the current habitat suitability analysis for Texas wild-rice (91:1).	Given the absence of a planned ecological model for Texas wild rice, the current habitat suitability analysis should be treated as an hypothesis and tested for robustness throughout the San Marcos River.	Yes - funds could be allocated in the Applied Research Program	N/A **(Immediate Implementation)**	*TWR has been extremely successful to date; therefore additional TWR work is not needed at this point. *The Meadows Center has been collecting this information as Applied Research imbedded in their TWR restoration work. Habitat suitability has taken the form of applied verification in the field.
22	Done	Ecological Model	Use the habitat suitability analyses for the fountain darter as "back-up" to individual-based modeling (91:22).	The habitat suitability analyses done for fountain darter could act as a "back-up" to the individual-based modeling and provide additional quasi-independent results to support a weight of evidence approach for the fountain darter.	No - no current funding is identified for this additional work	N/A	*Conducting this exercise would not answer questions for Phase II, the model does that. *Implementing this recommendation would be taking steps backwards.
23	Done	Ecological Model	Revisit the estimation fountain darter suitability curves (77:35).	With the availability of the monitoring data and other information, a more formal estimation of the habitat suitability curves is warranted.	No - there are no funds allocated for this exercise.	N/A - step backwards	*These curves are the first step in creating the Ecological Model. If to be used for the development of the Ecological Model, we are past that point. *If the Fountain Darter module fails or does not calibrate, then suitability curves should be revisited.

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24	No	Ecological Model	Add nutrient limitation to the submerged aquatic vegetation (SAV) model formulation (82:40).	Nutrient limitation is not included presently in the model, but should be added if it is determined to be an important water quality factor affecting photosynthesis.	No - no funding to conduct the extensive research that would be needed.	N/A	*Nutrients are not a limiting factor, except to algae (presence/absence). Algae is not in the Eco Model. *The SAV model is tied to Fountain Darter habitat, so therefore this is not necessary.

Clarifying Statements

All aspects of this table are Science components
None of the recommendations are required for compliance
All recommendations are operationally feasible except #24
All recommendations are politically feasible
None of the recommendations are fatal flaws of the program
Only #11 and #21 support biological goals and objectives