Ecological Modeling Recommendations

Topic	Recommendation	Details
Ecological Model Scenario Testing	**There are several different scenarios and/or issues that should be investigated using the ecological model.**	**To explore how SAV habitat affects FD, the timing of the existing maps could be switched within simulations to determine whether simulated FD population dynamics are sensitive to sub-regional scale and interannual variability in the observed SAV (habitat) record.**
		A scenario could be run to force FD population reductions (simply remove individuals on a day in certain areas) and determine the time period that the population remains below a threshold and the subsequent rate of recovery of the population to a healthier value.
		Running the model under low flows and for flow protection measures to evaluate the impact on predicted SAV is a critical question for the FD model.
		Pushing the model to catastrophic scenarios – for example where SAV is only present in refugia – might reveal some insights regarding recovery following such an event.
		Examining simulated maps of SAV representative of "good" and "bad" years in various virtual time series should be done in a dynamic SAV model.
		A possible useful application of the model would be to better understand the degree of long-term maintenance that might be required to eradicate non-native species.
		The EAA should explore the diagnostic abilities of this mechanistic model to better understand the environmental forcings that influence vegetation, and to identify future applied research questions that might best serve management goals.
		An additional scenario could be designed to examine whether there are measureable thresholds of SAV acreage in a given reach that result in dramatic increases or declines in FD abundance.
		Historical flows outside of the calibration and validation time periods should be used to assess FD responses under a wider range of previously observed historical flow conditions.
		The effects of the EAA's so-called "bottom-up package" of flow protection measures should be imposed in the model and compared to FD population dynamics without the package.

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		A specific set of flow scenarios should be designed to determine what conditions of low flows lead to high risk for FD.
		A scenario could be designed that varies the growth, mortality, reproduction, and movement rates of the individual FD within the model under a suite of flows and other environmental conditions.
		Factors like low dissolved oxygen, sediment removal, algal blooms, gill parasites, and shifts in prey and predator composition can all be examined with the FD model.
		To explore how SAV habitat affects FD, observed SAV habitat maps could be retained in simulations, but adjust growth, mortality, or reproduction of the FD individuals to reflect when they are in the areas where SAV is expected to respond to the management actions.
		To explore how SAV habitat affects FD, existing SAV habitat maps could be used, and manipulated to reflect expected changes based on the management actions.
		A first effort to evaluate the impact of changed coverage by native versus non-native SAV species on FD populations could be useful given recent SAV AMP.
		The focus on using the FD model to predict the responses of FD abundance to alternative HCP flow control packages is useful, but there are other uses of such mechanistic models that should be considered.
		The conceptual and predictive ecological models should be used to evaluate the minimization and mitigation (M&M) measures, both in terms of appropriateness and efficacy.
		Scenario analysis should be used as part of a broader iterative process inherent in all ecological modeling.
		Scenarios should be defined based on the management needs, to advance our understanding, and to identify critical data gaps.
		All scenario questions should be well defined.
		The conditions under which the model was developed should be compared to the conditions for which the model will be used in scenarios, in order to determine the degree to which the model is within in its domain of applicability

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Definitions, Clarity, and Nomenclature in Ecological Modeling	Definitions of terms, clarity and transparency of model assumptions, and standardized language should be used in the ecological modeling program.	There should be an explanation of the expected effects of a scenario on and what and how these effects are represented in the model (either explicitly or implicitly).
		There should be confirmation that the major effects are represented in a reasonable way for each scenario.
		Sources of stochasticity represented in each scenario should be identified and acknowledged to account for expected variability.
		Dimensions of uncertainty in each scenario should be tracked and acknowledged to account for variability.
		The baseline conditions and dimensions of the predictions (temporal and spatial scales; absolute or relative terms) should be clearly stated as part of specifying each scenario.
		Predictions for scenarios should include, at some level, model-based explanations of why the predicted response occurred.
Administrative/Logistical Considerations Associated with the Ecological Model	There are some overarching logistical and/or administrative considerations that must be taken into account to ensure the mode is used appropriately.	General information regarding sensitivity analyses that should be used to inform the limits and expectations for model runs should be made available.
		A simple one-time transfer of the models from the developers to the EAA should be avoided because this can result in inefficient, and even possibly erroneous, use of the FD and SAV models.
		The temporal and spatial scales of the SAV and FD models are reasonable but the representativeness of selected reaches and the variance properties associated with the use of QUAL2E outputs as model inputs should be clearly documented.
		The issues and recommendations described in NAS' interim eco model report should be adequately addressed prior to running the scenarios.
		All model results should be carefully labeled according to the nomenclature described in Report 2.
		Sexual and vegetative reproduction should be represented in the dynamic SAV model.
		The EAA should continue with the conceptualization of the overall ecosystem by building on the FD and SAV conceptual models.
		The current habitat suitability analysis for TWR should be treated as a hypothesis and tested for robustness throughout the San Marcos River.
		The EAA should return to Report 1 for a thorough evaluation and recommendations on their earlier approach and consider new methods that have evolved to address some of the issues with the classical habitat suitability approach if the suitability analyses are pursued in the future.

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Directions for Further Development of the Ecological Model	The ecological model program would benefit from additional work to refine the model.	A better CSRB sampling approach is needed for determining ITP compliance, estimating the current CSRB population, and projecting future changes.
		The EAA should be prepared to develop detailed monitoring plans for the other covered species if the CSRB is abandoned as an indicator species.
		Explicit treatment of how actions directed at SAV would affect FD through the coupled models is recommended.
		The use of an individual-based approach imbedded within a 2-D spatial grid for full life-cycle simulations of FD population dynamics is a scientifically sound framework for the questions being asked, but there remain some important steps (related to how SAV) is represented) to link the FD dynamics to their habitat.
		The representation of the processes of FD growth, mortality, reproduction, and movement presently in the model are well-founded but may be too simple and not sufficiently linked to changes in habitat and flow to answer some of the important management questions.
		The SAV model is not yet far enough along in its development for detailed suggestions regarding scenarios.
		The historical time period used for calibration had relatively similar environmental conditions from year-to-year, which limits the range of conditions of scenarios feasible for exploration by the model.
		The representation of flow effects in the model seems too limited in potential effects due to reliance on having site-specific empirical evidence for the effects.
		Thresholds in process representations should be used cautiously because they can erroneously create nonlinear population responses and unrealistic sensitivities to changes in habitat & flow.
		The representation of density-dependence and how its effects on individuals manifest at the population level needs further evaluation.
		Calibration and validation of the FD model to date shows the model can reproduce the historical abundances, but additional confidence is needed to most effectively use the model for management purposes.
		As a top priority the EAA should develop an ecosystem-based conceptual model, or a series of conceptual 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.

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		The habitat suitability analyses done for the fountain darter should be used 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.
		A much deeper understanding of the CSRB's natural history should be obtained in order to be able to include the CSRB in a mechanistic model.

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