TO: SAM Work Group and MRRIC

FROM: Independent Science Advisory Panel (ISAP)

RE: ISAP thoughts regarding the draft "Effects Analysis Proposal Request," version dated 1 April 2013

DATE: 14 May 2013

The ISAP is in consensus that if an RFP process is to be used for soliciting an effects analysis, the RFP draft should be revised to lay out to potential offerors the context of the analysis, and how it fits into the larger Missouri River Recovery Management Plan. Proposals received then will likely be more responsive to the needs of the Recovery Program.

Our review of the draft proposal request generally revealed that a number of the tasks essential to conducting an effects analysis were not explicitly identified in the draft. We are aware of ongoing efforts to construct conceptual models for the three listed species. It is possible that some of the other tasks needed for an effects analysis have been completed or will be by the resources agencies. We may not yet be aware of those planning products. We have attempted to outline below what we believe to be a suitably comprehensive view of the activities that are integral to an effects analysis. Our objective in providing this information is to provide a basis for future discussion and collaborative efforts between ISAP, MRRIC, and the SAM Work Group. These thoughts are intended as suggestions for components of the analyses and adaptive management process to be discussed, not as prescription for any or all of it.

An analysis of the effects of Missouri River hydrodynamics and operations on pallid sturgeon, least tern, and piping plover is a crucial step in developing the adaptive management plan for the Missouri River Recovery Program. The effects analysis provides a conceptual and quantitative basis for assessment of risk to the three species. It also serves to: 1) help establish the recovery program's goals and quantitative objectives, expressed as numbers and distributions of individuals of the species and/or the quantity, quality, and persistence of their habitats; 2) set the reachable end points toward which the recovery program's management efforts are targeted; and 3) provide the explicit criteria against which program performance can be measured.

These purposes require a quantitative understanding of conditions relating hydrologic and fluvial processes of the Missouri River to the status and trends of the listed species and their habitats. Only with such an understanding can potential management actions vital for survival and recovery of the species be identified and can the appropriate combinations of management actions that promote effectiveness, efficiency, and accountability be implemented. A structured decision process concerning management actions (e.g., how many and what types of restoration actions, what sort of predator control efforts, how many hatchery sturgeon need to be released) will be informed by using conceptual and operational models that are developed during the effects analysis. These models should to the best of our knowledge reflect river-system hydrodynamics and dam operations, and the consequences of inter-annual variation in environmental conditions on the status and trends of the three listed species.

The Recovery Program's goals and objectives for the three species also must reflect the best of our knowledge including biological needs and species demographics. It is important to recognize that the population targets articulated in the existing recovery plans for the three species are neither supported by requisite demographic analyses – the recovery targets for the two birds are the outcomes of expert opinion exercises – and did not consider hydrological operations on the Missouri River in the criteria for survival and recovery. The MRRP must set its own more quantitative conservation targets, which draw from an understanding of the relationship between the Missouri River's dynamic flows and its fluvial geomorphology, and how those both sustain the specific landscape features and ecosystem functions that support the pallid sturgeon, least tern, and piping plover.

The development and implementation of an MRRP adaptive management plan by the Federal resources agencies can be organized into three categories of activities – model development, analysis and assessment, and adaptive mitigation and management (Figure 1). The first two of these categories include tasks that constitute an analysis of the effects of current and past Missouri River operations on the three federally protected species, pallid sturgeon, piping plover, and least tern. They also are structured to identify and evaluate potential conservation actions that may mitigate deleterious impacts to those species from river operations and contribute to their recovery.

The modeling and assessment tasks mostly occur in sequence, but in practice parts of the sequence are reiterated by returning to previous tasks as new information becomes available, new conservation approaches become apparent, and adaptive management is implemented. The earlier tasks in the figure are generally accomplished to inform the latter tasks; for example, operational models are developed and continually refined to meet the needs of the adaptive management planning that occur as monitoring of restoration and other conservation activities results in better understanding.

It is important to note that all of the work identified in Figure 1 must be preceded by an objectives-setting exercise, wherein programmatic goals and objectives, including legal obligations for river operations to be compliant with the federal Endangered Species Act (ESA), are clearly described and explicitly presented (to the extent practicable) in quantified or quantifiable terms. The stated program objectives must be accompanied by explicitly specified agreements on the breadth and level of detail that are appropriate for the effects analysis tasks.

Model Development

The Missouri River is a dynamic system. Its seasonal hydrograph and its channel morphology, and therefore the extent and quality of habitat it provides for the three listed species, change annually in ways that are not deterministic, but nonetheless are predictable in a probabilistic sense. Plant and animal populations respond to changes in their environments and integrate, over the long term, inter-annual variation in rates of survival and reproduction.

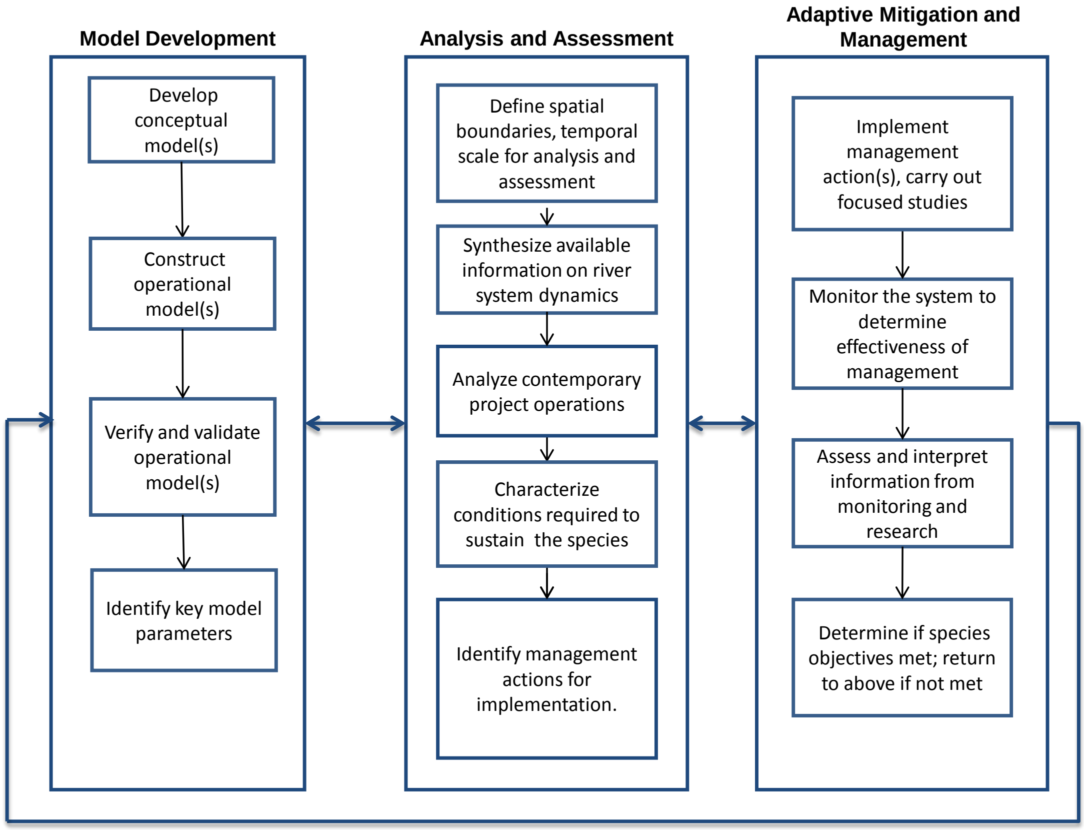

Figure 1. *Necessary elements leading to the development and implementation of an adaptive management process for the Missouri River ecosystem. The two left columns constitute the analysis of the effects of operations on the river on the listed species. Although a sequence is implied, there is interaction and parallel development between activities in the columns. Interactions between the sub-processes of model development, analysis and assessment, and adaptive mitigation and management are designated with arrows running between the columns of boxes.*

Models developed to represent this dynamic system are essential tools for systematically evaluating the impacts of Missouri River operations and the benefits of adaptive management for the three listed species and the ecosystems upon which they depend. Models provide a means of integrating the latest available scientific understanding and incoming monitoring data on a continuing basis for effective, efficient, and accountable decision making. They will, at agreed-upon scales and level of detail, reflect the characteristics of the system being studied. The models that the recovery program adaptive management process requires will accurately reflect contemporary understanding of the physical, chemical, biological, and ecological attributes of the Missouri River system.

Correspondingly, an effects analysis in support of the Missouri River Recovery Program will include the following elements (or steps):

Development of conceptual models – To represent adequately system dynamics in a modeling context, conceptual models for the three listed species must include several sub-models, including the following.

Hydrology – This component describes the annual runoff to and flows through the river. Annual variation in snowmelt, precipitation, and runoff influence the physical dynamics of the system. The annual hydrograph summarizes these dynamics and is typically defined by a probability distribution of discharge and flows derived from the period of record. The system's historical hydrology provides the physical context within which related biological and ecological attributes of the listed species developed. The current hydrology provides a context within which to evaluate the likely effectiveness of management actions that modify hydrology.

System Operation – This sub-model modifies the hydrograph based on inputs (*Hydrology* above) and the rules for operating the system of dams. These rules are detailed in the Master Manual. This model component, along with the hydrology component, has likely been modeled previously; the algorithms (if not the actual computer code) could be borrowed to incorporate system operation in the effects-analysis modeling effort. Management actions that involve changes in system operation can be examined in relation to historical and current hydrology to assess their likely impacts on population demographics or quality and distribution of habitat for the species of interest.

Habitat – Habitat serves as the interface between system dynamics and species demography. The term "habitat" in this context describes a user-defined set of variables that link changes in the hydrograph, system operations, and channel morphology to the population dynamics of the listed species. Examples of parameters that describe habitat state include flow velocity, water depth, substrate type, and water temperature for the pallid sturgeon, and sandbar area for the bird species.

Species demographics – This sub-model is analogous to the species "needs" model borrowed from Wildhaber and presented earlier to ISAP in the draft CEM for pallid sturgeon. Population dynamics reflect changes in vital demographic rates relative to changes in environmental variables that are believed to have a direct or indirect effect on the respective rates.

Construct operational models – Conceptual models serve as the blueprints for the development of operational models. The construction of an operational model requires formulation of unambiguous hydrological and ecological relationships that describe the interaction between model components. These relationships are typically mathematical in nature and, taken as a whole, should allow analysts to explore how implementation of a potential management activity (an operations or mitigation action) on the river is expected to affect the target species. There can be considerable interaction between development of operational models and the development of conceptual models. The conceptual model should guide the initial development of the corresponding operational model; the operational model should be a computational manifestation of the conceptual model. However, some evolution in modeling directives and model form will likely occur as new data and understanding become available, as data limitations are realized, or as species objectives are refined or revised throughout the restoration program.

Verify and validate operational models – This activity is conducted for (at least) two reasons: 1) to confirm that the operational model produces results that are consistent with the current understanding of Missouri River ecosystems and exhibits model behavior that is consistent with that intended by those who constructed the model, and 2) by using sensitivity analyses, to identify the variables (or parameters), that have a potentially significant impact on model outputs. This activity continues throughout the modeling process, but should also occur as a focused activity near the final stages of model building.

Identify key model parameters – Some parameter values used in the model building can be derived directly from previous studies and available data; other parameters may need to be based largely on professional opinion. It is important to identify those parameters that have values that are not well known, and for which small changes in assumed value have a relatively large impact on model results (sensitive parameters). These sensitive parameters are candidates for focused study, with the objective of improving the accuracy of the model and the reliability of future planning decisions based on model results.

These modeling efforts precede the analysis and assessment that is essential to an effects analysis.

Analysis and Assessment

Define spatial boundaries and temporal scale for analysis and assessment (and for application in building the model(s) above). Consistent with program goals and objectives, the spatial boundaries of the effects analysis must be identified and differences in the temporal scales of river operations and river ecosystem dynamics must be understood. Both spatial extent and temporal scales of the planning or management efforts might be incompatible in scales with the demography (including metapopulation dynamics) of the targeted, listed species. For example, key factors that influence population dynamics might be distributed well outside the management program's geographic extent or authority. The transient nature of large-river habitat features important to each species will challenge the design of effective management actions.

Synthesize available information on river system dynamics and dam operations (also for use in building the models). Identify, collect, and synthesize pertinent information on the hydrodynamics of the river system as well as operating rules for the six dams that operate on the system. Moreover, such information must be assembled for several bounding scenarios that should be evaluated; including historical river conditions, current river operations, and scenarios considering potential desired future conditions.

Analyze the contemporary operational conditions of the river (and for application in building the model(s) above). A comparison of the conditions expected with continued project operation with historical and desired future conditions serves as the basis of a measure of the net effects of the Missouri River project. It is the comparison between the available habitat/populations of the three listed species in today's river system, the habitat/populations of those species that likely occurred historically, and the identified constraints on population management into the future that determines the level of conservation necessary to mitigate the jeopardizing circumstances, and establishes the basis for setting species management objectives.

Characterize river conditions required to sustain the species (and for application in building the model(s) above). An essential element in the effects analysis is the assessment of river (habitat) conditions that are needed to sustain populations of the listed species. This may include a synthesis of historical conditions (above) and conditions based on species needs (determined by metapopulation modeling and scientific study). Such a synthesis can help define the desired future ecological conditions toward which river operations and the mitigation efforts are directed.

Identify and evaluate management actions for potential implementation in an adaptive management program. The preceding steps will provide the tools and data needed to evaluate current mitigation actions, generate novel ideas about potentially cost-effective management actions that could serve to countermand the jeopardy caused to the three listed species from ongoing river operations, contribute to the recovery of those species, and meet other, explicitly articulated conservation goals of the Missouri River Recovery Program. Identification of these mitigation/management actions and evaluation (using the models) of their likely effects provides the segue to selection (using a structured decision process) of a suite of actions to be continued or started new, and adaptive management of their implementation.