Independent Science Advisory Committee (ISAC)

Report on the Platte River Recovery Implementation Program (PRRIP)

Submitted to

PRRIP Governance Committee

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Executive Summary

E1. Introduction

The intent of this report is to synthesize the ISAC's conclusions on progress made by the PPRIP (the Program) since our 2009 report, in particular reflecting on the results of the AMP Reporting Session held on March 2-3, 2011. The first section of our report discusses the overall functioning of the Program. We then consider how well positioned the Program is to implement adaptive management, grouping our assessment and recommendations into five categories, consistent with the Program's Implementation Plan:

1. Problem Assessment,
2. Investigation and Implementation Design,
3. Management Action Implementation,
4. Monitoring and Data Synthesis, and
5. Performance Evaluation and Action Adjustment[1]

These five categories of adaptive management are like critical organs in the human body (e.g., brain, heart, lungs, kidneys, liver <not a 1:1 correspondence>); all must be functioning well for adaptive management to thrive.

E2. Overall Functioning of the Program

The Program has made excellent progress since 2009. In particular, the ISAC is pleased to see greater integration and focus, with contractors well focused on a set of Big Questions that the Program is attempting to answer, and structured thinking in both the Implementation Plan and Synthesis Report. With respect to the overall functioning of the Program, our key recommendations are to:

1. *Formalize learning*, through continued annual AMP reporting sessions with published summaries of results, revisions to Conceptual Ecological Models (CEMs), revised answers to the Big Questions and priority hypotheses, and further tweaking of the Big Questions and priority hypotheses (based on what's learned);
2. *Maintain sufficient funding and staff resources* to ensure staff retention in the EDO, rapid analysis and evaluation of data, and inter-disciplinary integration across studies by both the EDO and Program contractors, since investments in speeding up learning will save the Program money in the long run;
3. *Keep all contractors / AMP session presenters focused on the organizing frameworks* (Big Questions, CEMs, priority hypotheses) and the implications of their results for revising elements of these frameworks;
4. *Use the Elm Creek FSM pilot experiment to improve inter-disciplinary integration* across the cause-effect chains from water/sediment to habitat creation to bird response; and
5. *Support the creation of ad hoc work groups to tackle key emerging issues* (i.e., selected EDO staff and contractors that integrate horizontally across components and disciplines).

[1] The numbering of sections in the Executive Summary mirrors that in the full report.

E3. Problem Assessment

The Program has done an excellent job on this stage of the adaptive management cycle, responding well to the ISAC's recommendations from 2009. Noticeable progress includes revisions to CEMs, greater attention to potential influence of factors outside the central Platte on focal species, building strategic partnerships with whooping crane groups in Canada and Texas, prioritization of hypotheses, revisions to both the whooping crane management objective and the focus of associated studies, implementation of a staged approach to pallid sturgeon studies and development of strong organizing frameworks for the Program (Synthesis Report, Implementation Plan). The ISAC has the following recommendations for further progress on the Problem Assessment stage:

1. *Develop more detailed CEMs for scientists,* which should illustrate the degree to which factors inside and outside the study area are believed to affect each life history stage of the focal species, stimulate the further development of computer models and well-focused field studies for these species, and be annually reviewed based on new knowledge;
2. *Expanded partnerships for terns and plovers and increased banding,* which are both are essential to help explain trends in these species within the Central Platte;
3. *Consider multiple causative mechanisms when interpreting changes in bird populations within the Central Platte,* including changes in winter range conditions, interactions with populations outside the Platte and predation (i.e., not just changes in local habitat);
4. *Keep an open mind with respect to bird habitat selection,* beginning with all possible usable habitats, not only those which meet the minimum criteria in the AMP, and be prepared to revise your definitions of "suitable habitat";
5. *Meld the whooping crane monitoring and telemetry work,* using the Program's statistical advisors to maximize the combined benefits of these two Program components; and
6. *Continue to use a staged approach to pallid sturgeon work,* as described in our 2009 report, again being open to new evidence regarding what habitats sturgeon prefer.

E4. Investigation and Implementation Design

The ISAC was very pleased to see the progress made since 2009 on this stage, including developing and applying hydrology – hydraulics – sediment transport models to a number of questions, improving the rapid prototype models for terns and plovers, initiating the Elm Creek pilot test of FSM, writing the Synthesis Report and Implementation Plan, initiating a decision analysis framework and conducting important research on vegetation scouring. The ISAC's recommended improvements to Investigation and Implementation Design activities include:

1. *Greater application of 2D and 3D models, field monitoring and empirical analyses* to improve upon estimates of 1D models; better represent the river's lateral velocities, shear stresses, lateral erosion, and other attributes; more accurately determine the necessary and sufficient conditions for braided channels; and reflect the improved understanding of flow-vegetation interactions gained by Bankhead et al.;
2. *Continue to analytically and experimentally explore the very substantial challenges of implementing FSM,* including: year to year variability in sediment deficits; poor ability to scour vegetation at expected flows; vulnerability of nests to flooding; habitat sustainability; and the most effective methods of sediment introduction;

3. *Bring together the field biologists and bird population modelers* to intensively review and revise the assumptions contained in the rapid prototype models for terns and plovers, incorporating a wider set of tenable hypotheses and driving variables;
4. *Make progress on the Data Analysis Plan* (utilizing the Program's statistician Special Advisors) to articulate how data will be analyzed for each of the Big Questions, including the now quiet (but not forgotten) issue of FSM vs. MCM; and
5. *Work on the both the Data Analysis Plan and Elm Creek pilot FSM experiment should utilize concepts outlined by ISAC (2009) under the Mock Report idea,* namely simulating the range of outcomes of alternative management actions under different combinations of water years, hypotheses about key processes (e.g., sediment movement, habitat creation, bird response), and alternative approaches to monitoring and evaluation.

E5. Management Action Implementation

The ISAC were impressed with the excellent progress made on implementing the Land Plan and Water Plan, investigating alternatives to achieve the remaining flow objectives of the Water Plan, implementing the Cottonwood Ranch Off-Channel Sand and Water (OCSW) project, and developing a very thorough organizational framework (the Implementation Plan). Our recommendations with respect to implementing actions include the following:

1. *Take full advantage of natural high flow events* to both implement management actions (e.g., sediment augmentation, vegetation removal) and test priority hypotheses, particularly since it may be a few years before short duration high flows of sufficient magnitude can be generated by water managers;
2. *Estimate the long term maintenance costs and sustainability of the OCSW project;*
3. *Explore the potential for achieving economies of scale by combining complementary actions* (e.g., dredging sediment from the Cottonwood OCSW project and adding sediment to the river, using flows from reservoirs to transport stockpiled sediment);
4. *Use the Elm Creek pilot FSM experiment* to tackle challenges in both implementation as well as the experimental design of monitoring and evaluation; and
5. *Continue to tackle the challenging issue of how to manage Phragmites,* through systematic application and evaluation of different control approaches, and concurrent evaluation of the impacts of *Phragmites* on geomorphic processes (e.g., sediment transport, lateral erosion, sand island formation and removal).

E6. Monitoring and Data Synthesis

The ISAC were impressed with the 2011 AMP Reporting Session: the materials were very well organized (i.e., packet of executive summaries and powerpoint presentations for all talks); the Program contractors were clearly thinking hard about the Big Questions (including parts of the Program beyond their own component); and the Synthesis Report was a good step forward in summarizing results to date. The inter-disciplinary and inter-component integration which occurs at the AMP Reporting Sessions is essential to learning, and funded participation of key contractors in these sessions is vital to the continued success of the Program. Here are our recommendations for improving efforts at monitoring and data synthesis:

1. *Consider developing standard data analysis routines linked to the Program database*, to speed the annual evaluation and adjustment steps;

2. *Getting the Program database up and running is a very high priority,* and the fine-scale prioritization of database tasks should be driven by the Data Analysis Plan for the Big Questions;
3. *Graphs in version 2.0 of the Synthesis Plan need to be thoroughly reviewed with the Program's Special Advisors on statistics,* as the ISAC had serious concerns about the curve-fitting in Figures 3.4 to 3.7;
4. *Continue the excellent progress in redesigning forage fish studies to emulate the tern's perspective,* improving the statistical rigor of reported results, and standardizing fish densities by volume sampled rather than per net sample; and
5. *Maximize the benefit of various studies by combining data*, including integration of the rotating panel design with other studies (i.e., 1D and 2D modeling, habitat use), and using surveyed cross sections, Lidar and other work to test Bankhead et al.'s conclusions about vegetation, while also determining elevations of newly deposited bars.

E7. Performance Evaluation and Action Adjustment

The ISAC was pleased with Version 2.0 of the Implementation Plan, which is on the right track for structuring performance evaluations, particularly as related to short term decisions on implementation of actions and various studies. Our key recommendations for this important phase are as follows:

1. *Use the Data Analysis Plan and the Elm Creek Proof of Concept as a catalyst for defining the range of possible outcomes, the intended evaluation methods and the form of syntheses over the First Increment,* embodying the Mock Report and linked model concepts described in the 2009 ISAC report and summarized above under E4, point 5;
2. *Include within the Implementation Plan the decisions which will need to be made at the end of the First Increment*, to ensure that you will have the right monitoring data and evaluations to support these decisions; and
3. *Building on simulations of potential outcomes, proactively identify possible future adjustments under each scenario.*

In summary, the ISAC is very pleased with the progress that has occurred since our last report two years ago. The Program has excellent staff at the EDO office, and very capable and committed contractors. We hope that our recommendations are helpful in maximizing the performance of this very talented team in tackling the substantial but exciting challenges ahead.

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1. Introduction

The intent of this report is to synthesize the ISAC's conclusions on progress made by the Program since our 2009 report, in particular reflecting on the results of the AMP Reporting Session held on March 2-3, 2011. The Executive Summary contains our key findings.

Organization of this Report

The first section of this report discusses overall functioning of the program. The remaining sections consider the program's positioning with respect to the 7 AM steps outlined in the Implementation Plan and summarized in Appendix B:

6. Problem Assessment,
7. Investigation and Implementation Design (combined because both ISAC recommendations and Program activities often span these two steps),
8. Management Action Implementation,
9. Monitoring and Data Synthesis,
10. Performance Evaluation and Action Adjustment (also combined).

The ISAC's 2009 recommendations, as well as Program progress since then, have been organized into five sections as listed above. We have used a point form approach to our report, numbering each of our 2009 recommendations in roman numerals (i.e., i, ii, iii), and listed our assessment of progress since 2009 using the same numbering system, including our recommendations for future steps. Points within each category are also labeled for ease of reference (i.e., a, b, c). This allows the reader to see the progress that has been made over the last two years on each of our recommendations. We reference particular Program documents and presentations from the AMP Reporting Session using **bold blue text**.

Other reference material included in the Appendices provides context for this report, namely:

- Appendix A contains a summary of recommendations in ISAC (2009).
- Appendix B lists the AM steps in Draft Version 2.0 of the PPRIP Implementation Plan, which are used as an organizing framework for this document.
- Appendix C has another list of AM steps and elements from Marmorek et al. (2006), included as a checklist of what should be done at each step

Finally, there are a series of endnotes which follow the appendices.

2. Comments on Overall Functioning of the Program

2.1 Recommendations by ISAC in 2009 and 2010

The ISAC did not comment specifically on overall program function in our 2009 report, but at the Feb 2010 reporting session we stressed the need to involve contractors more deeply in the experimental design, organize their presentations around key questions, and have a better idea of how their project fits into the integrated whole[i]. The learning phase of AM requires a substantial component of horizontal integration because, at certain scales of the problem, this is where learning is optimized. Horizontal integration is very different from a typical vertical corporate structure that one sees in "command and control" organizations such as the military. In contrast, a horizontal corporate structure is more typical of university environments or any settings where structure is more "free-wheeling" to allow intellectual growth and scientific discovery to flourish, while still maintaining an overall focus on a few big questions.

2.2 PROGRESS MADE

The 2011 AMP reporting session presentations, materials and discussions clearly demonstrated that: 1) EDO staff listened to and implemented the suggestions we made in 2010, and 2) the Contractors are now thinking about the big questions and the overall Program.

Appendix C of the **AM Implementation Plan Version 2.0** nicely summarizes each study in terms of its objective, associated broad hypotheses, Tier I priority hypotheses, monitoring protocols, and methods of data analysis and synthesis, with hyperlinks to relevant documents.

In general, the program has done a good job at incorporating most of our 2010 comments on the overall functioning of the Program. However, we still would like to see specific program elements that address how learning obtained through AM is formally institutionalized into the corporate psyche. It's one thing to "learn". It's different and potentially more challenging to have corporate mechanisms that value learning and include the learning into program level responses to new information (the final steps of the AM cycle). One way to do this is to periodically update the Conceptual Ecological Models (CEMs). Another approach is to use the AMP Reporting Session to formally document how the answers to the Big Questions (and perhaps the questions themselves) change. Without specific, high priority program protocols to value, preserve, and implement learning there is temptation to safely store data in reports that sit on shelves. That is, programs, like people, have a tendency to senesce and ossify unless efforts are made to continuously renew and rejuvenate them.

A related question is: Will the program maintain its integrity and corporate knowledge with staff changes in both the EDO and key contractors? This is not really a science issue, but can become a serious issue in a program designed to last decades. It further emphasizes the need to have sufficient funding and staff resources (in both the EDO and contracted resources) to promptly analyze and evaluate each year's data, and clearly document what's been done and what's been learned. As the central organizing entity for the Program, it is vital that the EDO be allocated enough staff to not only manage the work, but also to formally document what's been learned each year. It's also essential that the EDO staff members are paid well enough that they'll stick around, and that Program contractors are adequately funded to attend the annual reporting sessions. This will help to ensure that the Program gets a good return on its substantial investment, and that the Program will be resilient to the inevitable changes in staffing within both the EDO and key contractors.

2.3 SUGGESTIONS FOR FUTURE DIRECTIONS

At the 2012 AMP reporting session, it would be good to have each presenter include summary slides in their presentations (and headings in their handouts) regarding:

- the parts of the overall conceptual model that their study addresses;
- implications of their results for other Program elements (i.e., specific studies as well as implementation, monitoring or evaluation);
- changes to one or more conceptual models based on their findings; and
- specific information that they need from other parts of Program for further analyses or decisions (specifying spatial / temporal scale and units).

It would help everyone involved in the Program (especially the GC and public, but also other participants) to see how all studies fit onto the overall CEM. Perhaps this could be done by having a poster with the conceptual model in the middle and boxes positioned around the outside with the name of each study, with arrows linking them to each part of the CEM. An electronic version could be created on the PRRIP website.

As mentioned above in point c, it's essential that each presenter propose changes to one or more CEMs based on their data/analyses. This would help ensure that program learning gets archived in a way that makes it immediately useful for other program participants and the EDO. It might also be useful to consider the priority hypotheses during this phase – do they need to be updated, revised, or deleted? Do new priority hypotheses emerge as learning progresses?

What would really help to bring together all of the people and tools is a focused, **inter-**disciplinary effort at designing an FSM management experiment (and associated monitoring / evaluation) through all the cause-effect chains from water to sediment / vegetation to habitat creation to bird response. This is being implemented this summer for the Elm Creek area.

We can think of the overall Program as a hierarchy of questions and studies, with single-disciplinary approaches at a lower hierarchical level than multi-disciplinary approaches. Organizationally, the science Program has three levels: the EDO, individual studies (contracts) and the AMP reporting sessions. There will be emergent properties observed at the multi-disciplinary level that cannot be uncovered at the single-disciplinary level of organization. Restated, the synergies that result from true multi-disciplinary approaches are more than the sum of what happens at the single-disciplinary level of organization. Given the critical nature of learning in AM, true multi-disciplinary coordination may be the single greatest source of system-level understanding. It may be wise to also have a couple of *ad hoc* program strata to address specific questions that force inter-disciplinary integration (e.g., workgroups of contractors, EDO staff, and special advisors to work on key issues that integrate across flow, sediment, bird population issues).

3. Problem Assessment

3.1 Recommendations by ISAC (2009) which pertain to this step (see Appendix A, Sections 2.1 and 2.6):

i. revision of conceptual models to be more comprehensive, including potentially confounding factors outside of Program control, while keeping the CEMs modular in structure and easily understood

ii. development of strategic partnerships based on the expanded conceptual models

iii. further prioritization and sequencing of hypotheses

iv. add management objectives: gain understanding of bird meta-population dynamics; develop strategic partnerships to address impacts outside Program area

v. modify whooping crane management objective (*contribute to improved survival* rather than *improve survival*) and add time budget performance measures

vi. use a contingent, incremental approach for the sturgeon objective, only progressing to more detailed studies once initial questions on stage sensitivity have been answered (i.e., if there's a significant change in flow, then consider sturgeon telemetry studies).

3.2 Progress Made and Suggestions for Future Directions

i. Conceptual Models:

a) The Program has done an excellent job in responding to our recommendations. CEMs have been revised as recommended in a format that's easily understood, as shown in the Synthesis report. These high level CEMs are very helpful for illustrating the intended system responses to project management actions, and provide a very useful overview of what the Program is trying to accomplish.

b) While necessary and helpful, the high level CEMs are not sufficient as guiding frameworks. They don't capture detailed interactions among management actions, processes and responses or the relative importance of them (i.e., the arrows and their widths on a typical box and arrow CEM). Non-project factors are acknowledged in the "Other Important Factors" box, but not clearly identified as to how they will be considered. Therefore, in addition to the high level CEMs, several ISAC members recommend also developing species-specific CEMs organized around the complete life history of terns and plovers, with arrows connecting boxes both within and outside the Platte region (like the whooping crane CEM included as Figure 2 in ISAC 2009). The arrows could be of varying thicknesses proportional to the strength of the linkage, with dashed, single or double lines reflecting the current level of understanding.[2] This will aid scientists working on detailed pieces of the problem, and facilitate the development of

[2] CEMs using this format were developed by the CALFED Science Program for the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP), and are described at: http://www.science.calwater.ca.gov/drerip/drerip_index.html

quantitative simulation models with the appropriate model structure, dimensionality, time and space scales, and state variables. The two types of CEMs need to be internally consistent, but don't need to be formally linked. With annual reexaminations of the two types of CEMs, the big questions and associated hypotheses, the Program and its scientists will have a very solid scientific foundation. The more detailed CEMs should be developed in consultation with species recovery teams.

c) Investigation studies and efforts to evaluate monitoring data (as in the draft Synthesis Report) may lead to further redefinition of the big questions and CEMs. That's healthy. This kind of revision is probably best done a collaborative workshop setting with multiple participants, perhaps as part of the annual AMP reporting session.

ii. Partnerships:

a) During our first meeting in March 2009 several ISAC members were concerned about two disturbing attributes of the Program: 1) the Program did not consider the contribution of non-Program lands to either the solution or the problem; and 2) the Program did not substantially consider system level dynamics in their species recovery plans. We are very encouraged to see substantial progress over the last two years. Both of these issues have been largely resolved, particularly attribute 1 leading to strategic partnerships. We hope that the Program continues to recognize the importance of looking outside the immediate Program area to understand what's happening inside of it.

b) Partnerships with Canada and Texas whooping crane researchers are excellent through the Whooping Crane Conservation Action Plan. It's important to also establish similar partnerships with tern and plover groups (e.g., the Missouri River), sufficient for getting covariates on annual population trends, which will be important for explaining observed numbers in the Platte. It would also be valuable to establish partnerships with entities looking at terns and plovers on the Mississippi, Red, Arkansas, Niobrara, and Loup Rivers, as well as Missouri River reservoirs.

c) Increased banding of terns and plovers is essential for understanding the movement patterns of these populations between different regions, and the factors which appear to correlate with these patterns. We understand that the USFWS is concerned about the effects of banding. We hope that these concerns can be addressed, as the information gained is very valuable.

iii. Prioritization and sequencing of hypotheses:

a) The Technical Advisory Committee completed a hypothesis sequencing workshop to determine 13 Tier I Priority Hypotheses out of the original set of 42 (see Table 3.2 in Version 1.0 of Mock Synthesis Report). This sequencing is laudable, practical and helps to focus the Program.

b) Version 2.0 of the 2007-2010 Synthesis Report (Smith et al. 2011) has useful frameworks for organizing information relevant to Tier 1 hypotheses (i.e., Table 2.2 in the Synthesis Report) as well as relating these hypotheses to uncertainties, management objectives and goals (Figure 2.2 in the Synthesis Report).

c) Hypotheses come from the paradigm of empiricism, not from the paradigm of determinism, which is just as important when hydrology and hydraulics are a key part of the cause-effect chain from management actions to species' responses. Therefore, hypotheses should also be considered as a pointer to deterministic tools – that is, hypotheses should be of a form that will help the EDO select the best modeling approaches for simulating the physical environment. That way, the EDO can mobilize the power of both the empiricism and deterministic paradigms to achieve Program goals.

d) Benchmarks in Table 2.2 of the Synthesis Report (e.g., one bird nesting pair / 1.5a increase in habitat) are tricky to interpret. If you see that happen, it could be for a variety of reasons:

- habitat was limiting local population and increased habitat raised carrying capacity, allowing more birds to nest; or
- habitat wasn't limiting local population, but increased habitat attracted larger % of meta-population to land in the Platte (perceived as a good place to nest); or
- habitat wasn't limiting local population, but meta-population increased and Platte got more birds as a result (but same proportion of meta-population) ; or
- habitat wasn't limiting local population, but improved survival in fenced sand pits and OCSW habitats caused improved fledging rates and population increase.

e) Performance criteria like the number of nesting birds address whether the desired outcome occurred, but not whether it occurred as a result of program actions. More detailed validation monitoring is required to assess cause-effect mechanisms; that type of understanding is essential for adaptive learning. This is why a range-wide CEM for terns and plovers is necessary – to understand interactions at the metapopulation level and how actions at the Platte, Niobrara, Missouri, Kansas and other rivers interact. It is not the sole responsibility of the Program to develop range-wide CEMs, or to test associated hypotheses. However, the species recovery teams and the Program should engage in collaborative efforts to understand larger scale processes which may have a strong effect on the effectiveness of Program actions.

f) The Program's Big Questions (Section 2 of the Synthesis Report) are very useful as a succinct summary. Big question #5 (How do central Platte tern, plover, and whooping crane populations relate to overall population recovery objectives?) demonstrates that the Program is looking beyond the immediate study area. However, the ISAC has a few suggestions for further improvements:

- Be careful not to be circular in examining proportional use (i.e., you need to look beyond areas which meet AMP habitat criteria to determine whether the birds are indeed selecting areas which meet AMP criteria – the large blue square in Figure 1 below);

- Make the big questions as self-contained as possible, so that the reader does not need to look up specifics of the Program to understand the questions; and
- It might be helpful to put some explanatory text adjacent to the questions in a table.

g) The issue of utilization and availability first arose in fish habitat studies, wherein habitat was very narrowly defined by a couple of easily measured hydraulic variables (e.g., average depth and average velocity). However, habitat for wildlife is based on much more broad range of variables and can include just about anything – as we have seen. As a consequence, what exactly is being utilized is difficult to determine and, similarly, what exactly is available is also vague and difficult to determine. If you go down this road, then you put yourself in the position of creating definitions and categories that in the long-term are irrelevant. The least biased approach is to just observe what is being used and categorize it in terms of spatial domains. That is, habitat complexes are operational definitions. There is no such thing as "minimum" habitat criteria, only areas that aren't habitat complexes. It's difficult enough just to determine adequate habitat without worrying about creating a concept of optimum habitat and a concept of minimum habitat. The larger blue area (type 1) is not listed in big questions 1, 3, and 4, but needs to be considered in analyses relevant to those questions, since the birds may use habitats that biologists thought were unsuitable.

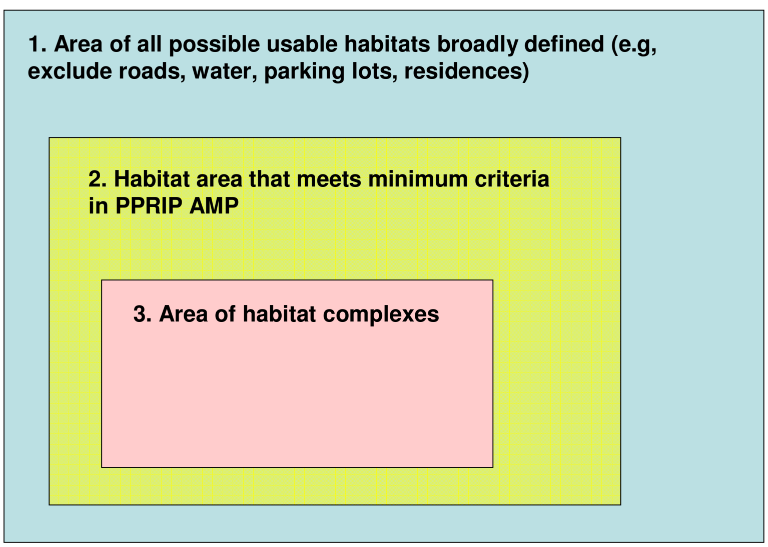

Figure 1: Hierarchy of types of "habitat" to be considered when looking at preferential selection of habitats. Though the main focus of the program is creating habitat types 2 and 3 (green and pink boxes), what's of broader interest for understanding habitat is the proportional distribution of birds across habitats 1, 2 and 3 relative to the areas of habitats 1, 2 and 3.

iv. Additional management objectives:

a) It appears that the ISAC's suggested additions to the management objectives did not get added. As long as the Program pays attention to meta-population dynamics and develops strategic partnerships, that's more important than having formalized objectives. Banding terns and plovers to understand meta-population dynamics is a high priority. We understand that there have been some challenges in getting permission to do this banding, which hopefully can be overcome soon.

b) The means objectives for the Program, including definitions of suitable habitat, were set based on the current understanding at the time the AMP was written. The means objectives and definitions of suitable habitat should be re-examined as habitat use data are evaluated. Based on the presentations that we heard, it will be very important to constantly reinvent and improve these relationships between physical habitat attributes and target species behavior.

In other programs, an approach based solely on habitat criteria has not been particularly successful in understanding how individuals of a population relate to the physical environment. If statistical approaches to link behavior and habitat are unsuccessful, then it may be worth considering approaches based on cognition. Building models of animal cognition is not easy, but this possible eventuality should be acknowledged.

v. Whooping crane management objective and performance measures

a) The management objective has been suitably modified. To optimize the ability to evaluate whooping crane use of the Central Platte, the sampling design for the **whooping crane monitoring work (Gary Lingle)** needs to be merged with the sampling design of the **whooping crane telemetry work (Walter Wehtje)**. This will require some thoughtful statistical advice from the Program's statistical advisors.

vi. Sturgeon work

a) The **Lower Platte River Stage Change Study (Pat Engelbert; Bob Mussetter)** was well done, and presented convincing evidence that physical habitat conditions for sturgeon are unlikely to change significantly due to the Program in the modeled reach. Including a longer reach would be wise to confirm the generality of these findings, but it is not a high priority given the convincing results obtained for the simulated reach. The Program is awaiting the selection of an expert peer review panel to review the above study.

b) Pallid sturgeon captures on the Lower Platte demonstrate that the question of linkages between program actions and sturgeon continues to be relevant, in particular the timing of flow pulse and size on spawning migrations of pallids. The linkage from hydraulic modeling presented in the stage change study to effects on sturgeon is through understanding the sensitivity of habitat attributes to discharge. However, we continue to have poor understanding of how sturgeon use available habitat on the Platte River. If review of the stage-change study confirms any connection between program water management and hydraulics, the question of what IS sturgeon habitat – especially for migratory behavior -- will resurface. The workshop on pallid sturgeon (proposed but not held) might shed some light on these issues, and help the Program to be proactive in considering them. Any further work associated with sturgeon movement patterns should be structured around specific hypotheses regarding the effects of stage changes. Still, the ISAC would not assign high priority to resolving this question given other science information needs.

4. Investigation and Implementation Design

4.1 RECOMMENDATIONS BY ISAC (2009) WHICH PERTAIN TO THIS STEP

i. Work on coupled hydrology, hydraulics, sediment transport and vegetation / habitat response models to assess management actions (Section 2.3 of ISAC 2009)

ii. Work on rapid prototyping models (Section 2.3 of ISAC 2009)

iii. Explore ability to test Flow-Sediment-Mechanical (FSM) vs Mechanical Creation and Maintenance (MCM), utilizing a gradient of conditions and paired experimental design (Sections 2.2 and 2.4 of ISAC 2009)

iv. Development of mock report (driven by linked models) to assess range of possible outcomes of management actions and estimate the feasibility of testing high priority hypotheses. The linked models should reflect uncertainties in implementation of actions, climate, ability to create habitat, species response to habitat and sampling error (Section 2.4 of ISAC 2009)

v. Directed research on vegetation scouring and associated flow effects on island geomorphology, as well as sediment transport modeling in support of sediment augmentation actions (Section 2.2 of ISAC 2009)

vi. Work on invasive species (Section 2.5 of ISAC(2009))

4.2 COMMENTS ON PROGRESS MADE AND SUGGESTED FUTURE DIRECTIONS (RESPONDING POINT BY POINT TO ABOVE RECOMMENDATIONS)

i. **Coupled hydrology, hydraulics, sediment transport and vegetation / habitat response models**

The Program has developed 1D and 2D hydraulic and sediment transport models for various questions. Overall, the ISAC is very impressed by the progress that has been made. Specific comments on different model applications are included below.

a) The **Lower Platte River Stage Change Study (Pat Engelbert; Bob Mussetter)** is discussed above in section 3.2 (vi);

b) **Andy Selle's conceptual design for flow consolidation at Cottonwood Ranch,** which applied the HEC-RAS 1D model as part of his assessment of the feasibility of using large wood to move flow from the south channel to the main channel;

c) **Tom Riley and Bob Mussetter's studies of sediment augmentation,** which used a 1D sediment transport model to examine how the sediment deficit varies from year to year with flow, and the implications for sediment augmentation strategies;

d) **Steve Smith and George Oamek's analyses of the risk of nest inundation**, using the Platte HEC-RAS 1D model.

Steve Smith's analysis consisted of two parts: scour and inundation. While the 1D approach was useful for rapid prototyping, it is important that stakeholders understand its limitations, especially the effect of 1D assumptions on scour. Lateral velocity distributions in HEC-RAS are synthesized by a rule set that does not explicitly model conservation of mass, energy, or momentum in the way that most 2D and 3D models do. Hence lateral velocity distributions from 1D models need to be viewed as estimates that will be substantially improved when using multidimensional models. To the extent that lateral erosion operates to scour vegetation, it becomes even more important to model lateral velocity distributions adequately. This is not to say that Smith's models are wrong (they are quite useful), but they are less accurate than a 2D model would be – and analysis should not stop at this stage.

As an illustration of this concept, the plots below (**Figure 2**) show depth & velocity fields for a 2D model of a complex Missouri River channel at Yankton, SD at two different discharges. At the lower discharge there is great variability, and in some parts of the channel there is a systematic *inverse* relation between velocity and depth. The complexity and inverse relation diminish with increasing discharge as the channel simplifies. The Yankton example is the most complex channel readily available and yet is substantially *less* complex than the braided Platte. A 1D model can't capture this complexity, and it is probable that the extremes of the complex distributions are responsible for braid bar dynamics.

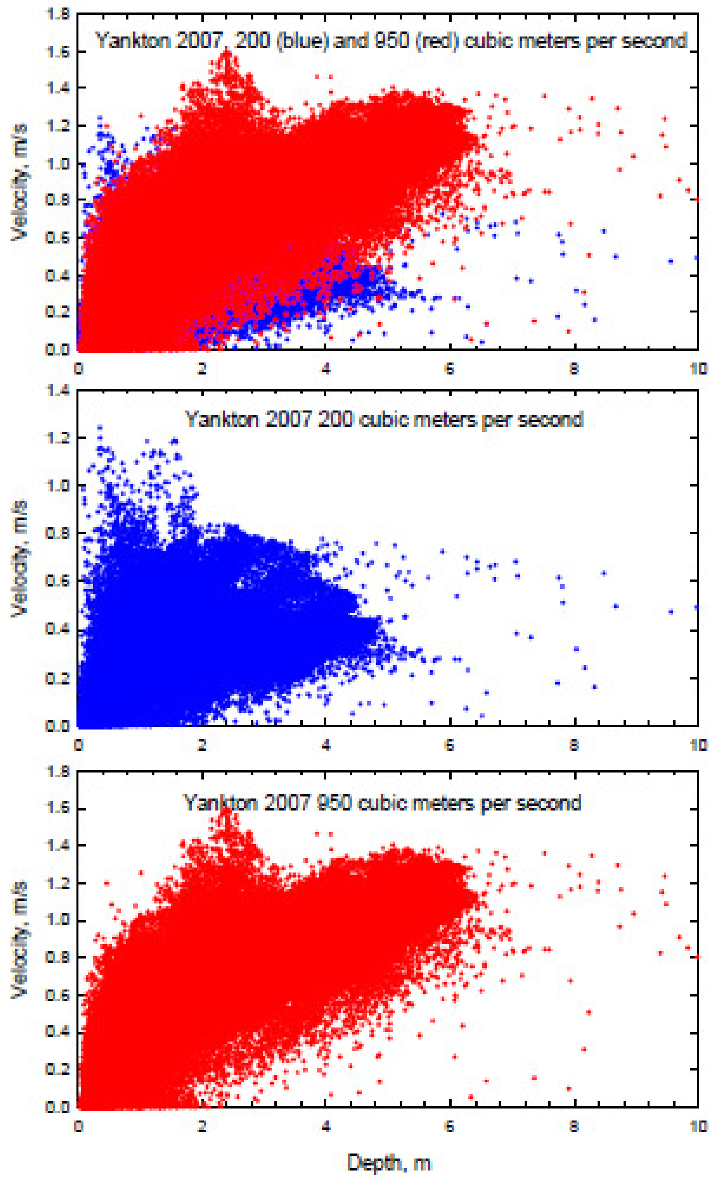

Figure 2: Depth and velocity fields for Missouri River channel.

e) **Chester Watson's analyses of stream power and channel braiding** (partly empirical based on studies of other sand rivers, but also used Platte HEC-RAS 1D model to estimate flow, width, depth and slope for a range of discharges);

As described both above (section d) and below (section g), the ISAC is concerned that 1D models are not sufficient to capture the physical complexity of the Platte River geomorphology.

f) **Natasha Bankhead's directed vegetation research** on the forces required to remove reed canary grass, Phragmites, cottonwood seedlings and willow seedlings;

The ISAC were very impressed by this work. It's a wonderful example of how a more or less deterministic approach supplemented the large hypothesis driven AM approach of the Program. It should serve as a guiding light for other complementary deterministic/empirical studies.

g) **Jason Farnsworth's exploration of the Q1.5-driven nesting habitat paradigm** using analyses of empirical data from the Lower Platte, and HEC-RAS 1D model output

The assumption that sandbars would be built up to the Q1.5 discharge was central to the problem diagnosis and restoration planning process. It is understandable that parties accepted this assumption as it is entrenched in the fluvial geomorphology and stream restoration literature. However, Jason has demonstrated that the assumption needs to be challenged and probably replaced with something more robust. Basically, construction of sandbars to a bankfull elevation appears to be a valid assumption for meandering streams where secondary currents in bends contribute to transport and deposition on point bars. The hydraulics are not the same in braided bars, but there is little theory or empirical evidence to demonstrate what the elevation should be. The LiDAR and modeled water-surface elevations obtained by the Program may provide a robust dataset for addressing this issue.

Summary Comments: In general, the ISAC is very encouraged by the above-described uses of hydraulic and sediment transport models to explore questions critical to implementation design. These model applications are revealing some tough challenges in the feasibility of accomplishing the FSM approach (e.g., year to year variability in sediment deficit, poor ability to scour vegetation at the expected FSM flows (and even 100-year flows), flooding vulnerability of nests on islands that are created at the contemplated flows), all of which is forcing some hard thinking on how to implement FSM.

In cases where spatial heterogeneity may strongly affects results, it would be wise to confirm the preliminary results obtained with 1D models by applying 2D or 3D models. This is because 2D (or 3D) models are needed to capture the spatial variability in the velocity and shear-stress fields. Scour of vegetation may be spatially concentrated at places of flow convergence or intense turbulence, and 1D models simply cannot capture these distributions. Ultimately, we may have to accept that hydraulic modeling is limited in its ability to predict vegetation scour and bar deposition in braided, sandbed rivers. Multidimensional modeling needs to be coupled with detailed monitoring in order to calibrate model predictions against measured reality.

An alternative to complex 2D and 3D modelling would be to develop nomographs or nomograms based on field measurements to predict the outcome of a physical process. It seems like there are enough potential field sites on the river that vary in terms of channel width, local slope, and elevation range where the necessary data could be collected for analysis. Maybe empiricism will trump determinism for this question. Certainly it's worth attempting to apply both empirical and deterministic approaches.

While considering empirical approaches, some consideration could be given to testing different methods and rates of introduction of sediments. It seems that the physical entrainment of sediment into the water column may take more finesse than depositing the sediment and waiting for it to be "eroded" into suspension—this requires more energy to get the sediment moving than entrained sediments and it may require more energy than the stream may have most of the time. Entrainment could use a slurry pump, a mechanical "slinger," a conveyor belt, etc.

ii. **Rapid prototyping models**

The Program has further developed **rapid prototyping models** with work by **Jamie McFadden and Drew Tyre.** Comments from the ISAC follow:

a) McFadden's modeling work suggests that population is not currently habitat-limited (i.e., the modeled population increases 10-fold without any change in amount of habitat, yet biologists working on monitoring the terns and plovers (e.g., Dave Baasch, Jim Jenniges) believe that they **are** habitat limited, and this is the general principle behind various Program actions (i.e., build it and they will come). Are the model assumptions reasonable? Is survival more limiting than habitat? Field biologists (Dave Baasch, Jim Jenniges, Mark Sherfy) need to get together with the modelers (Jamie McFadden and Drew Tyre) and examine the assumptions in the rapid prototyping models. Perhaps historical data from the sand pits could be used as a quasi-test of model assumptions (i.e., would model have predicted past trajectories of sandpit nesting?).

b) This is really the primary scientific question being addressed by the program and the resolution of this question is paramount (i.e., Does more riverine nesting habitat lead to more nesting by terns and plovers, and greater reproductive success? – a simpler version of Big Question 3). Of course, we don't know the answer to this question, but we do know that maximum scientific rigor and data of the highest quality must be thrown at this problem. It concerns us that a model (which is supposed to convey what we know about basic processes) is inconsistent with the opinions of field staff and the data upon which their opinions are based. This part of the Program should get some major attention. There are clearly some alternative hypotheses and parameter values which need to be explored through further modeling (e.g., carrying capacity, minimum habitat area per nesting pair, the effects of nesting in colonies, metapopulation effects, the links between habitat and predation), active debate at workshops with tern and plover experts, and further sensitivity analysis.

c) To help the Program move forward, the rapid prototype models need to embody a larger set of tenable hypotheses and driving variables, and evolve into more operational models (consistent with species-specific CEMs based on the overall life history) that make testable predictions. Dan Catlin, the Corps tern and plover person on the Missouri River, is beginning to develop a metapopulation model for piping plovers, so progress in this area is forthcoming. Then data should be collected to distinguish among those hypotheses which most affect the Program management actions. Empirical analyses of a larger set of ecologically relevant covariates (that could potentially affect nest and chick survival) should generate more credible predictive relationships that can be incorporated into a revised model. It would indeed be unfortunate if the valuable though preliminary rapid prototype modeling by Tyre and McFadden were taken out of context, and used to undermine the excellent work being done by the Program (i.e., by claiming **incorrectly** that the prototype models prove that habitat restoration is unnecessary).

d) Jamie McFadden was using a habitat availability function developed on the Lower Platte by Jim Parham (2007) (**Figure 3**) without re-calibrating to the lower discharges of the Central Platte. The shape of the Lower Platte curve is probably correct but the discharges are far above what would be expected in the Central Platte. Moreover, the model could be tightened up considerably by using the excellent data available in the Central Platte. Hence, in addition to the recommended improvements on biological relationships (discussed above under points b and c) a key revision to the model is to improve its physical foundation – acres of exposed sand as a function of discharge. The Program has the capabilities of developing precise discharge-sand area curves from LiDAR and modeled water-surface elevations.

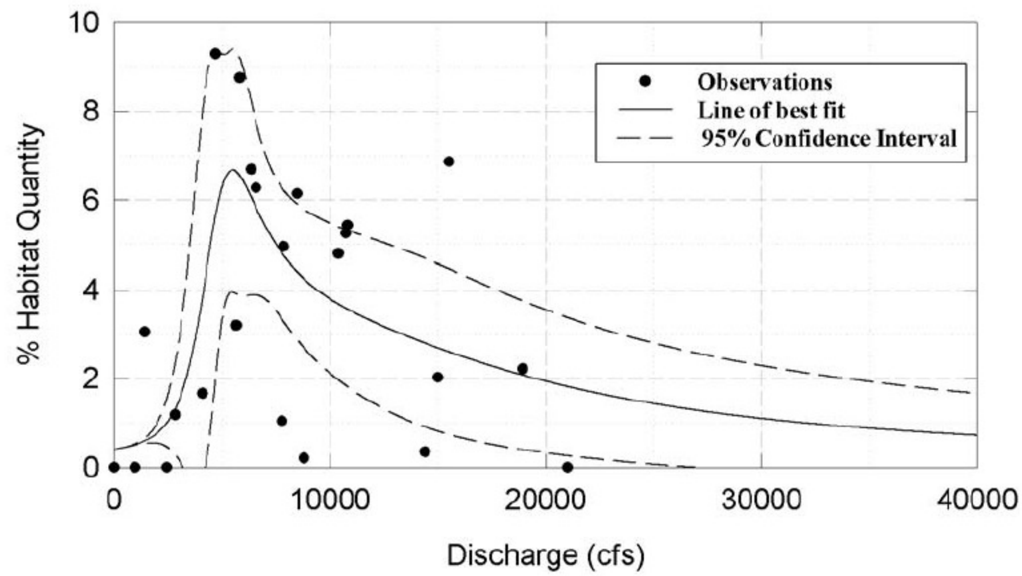

Figure 2.10. Modeled relationship between discharge (cfs) and percent habitat quantity for the lower Platte River (Equation 2.2). Habitat for Least Terns and Piping Plovers is defined as large, exposed sandbars that were disconnected from the shoreline.

Figure 3: Modeled relationship between discharge (cfs) and percent habitat quantity for the Lower Platte River. Source: Parnham (2007)

iii. **Explore ability to test FSM vs MCM**

a) The Program has been moving away from this specific issue (which was polarizing), and instead focusing on the priority hypotheses and Big Questions, as outlined in the **Synthesis Report**. The TAC concluded that there were no major uncertainties with creating MCM habitat (just go out and build it), though it's clear from Jason Farnsworth's work that there are uncertainties regarding the best diversity of heights of islands to construct. Building islands of different heights and sizes will be helpful to see what birds respond to, which can be then compared with what is learned at FSM proof of concept sites (i.e., if water and sand can build what the birds use). The various hydraulic and sediment transport modeling investigations listed above are getting at uncertainties regarding the ability to implement FSM, which is embodied in Big Questions 6, 7 and 8. Since the program is generally moving forward well with the Big Question and hypothesis approach (rather than FSM vs MCM), it seems best to continue with that framework (i.e., if it ain't broke, don't fix it). The ISAC generally likes the Big Question approach, with some suggestions above in section 3.2 iii f).

b) While it makes sense to focus on the Big Questions, the FSM vs MCM question (which isn't one of them) may return at the end of the First Increment (i.e., how do we create self-sustaining habitat? do we need more water?). The Program can't be constantly constructing new bars, so an analysis of longevity under various flow scenarios and design criteria is needed with the objective of reducing maintenance costs and increasing sustainability of both form and function.

c) Assuming that FSM can be implemented and creates usable islands (still a very big assumption!), how would the data be analyzed to determine the relative preference and performance of birds nesting on FSM vs MCM habitats? The data being collected by **Dave Baasch's Tern and Plover Monitoring & Research**, **Mark Sherfy's Foraging Habits Study,** and the **Geomorphology / Vegetation Monitoring (Bill Spitz and Joan Darling)** should be analyzed to explore both the Big Questions relating to habitat use (Q 1-4), as well as how the FSM vs MCM question would be addressed. This could be done by examining nest success, fledgling rates and habitat use in sandpits, OCSW, river islands, and other habitats. The Program definitions of suitable habitat should be re-examined as habitat use data are evaluated (see Figure 1). With respect to bird success, the analytical approach would be similar for an FSM-created river island as for an MCM-created island. It's worth evaluating usage per acre of habitat, total area of habitat, and population sizes relative to recovery objectives (i.e., integrating across multiple regions).

iv. **Develop mock report (driven by linked models) to assess implementation uncertainty, range of possible outcomes of management actions, and feasibility of testing high priority hypotheses**

a) At the Dec 2010 meeting, Chad Smith presented the **Mock Synthesis Report Version 1.0.** (Smith et al. 2010). Feedback from the ISAC and TAC led to this report morphing into the **Synthesis Report Version 2.0** (Smith et al. 2011). Version 2.0 of the Synthesis Report is much easier to understand by the GC and is better organized than version 1.0.. However, it isn't really a replacement for the mock report. The ISAC's recommendation to use linked models to simulate alternative outcomes of management experiments, and the ability to test key alternative hypotheses, is still worth pursuing, logically with the assistance of the Program's statistician Special Advisors, and should logically be part of the work on the **Data Analysis Plan**. Some of the ISAC recommendation is gradually being implemented (piece by piece) through the hydraulic and sediment transport models, the rapid prototype models for terns and plovers, some initial uncertainty analyses (**George Oamek's work**), and the **decision analysis framework** developed by **Chad Smith**. However, pair-wise linkages between some of these modeling efforts are just beginning, and need to be further pursued to convincingly simulate the management experiment and the monitoring process, as described in ISAC (2009) and Alexander et al. (2006).

b) The decision analysis framework, while only in its preliminary stages, offers an excellent structure for linking all the pieces together. Perhaps the Elm Creek management experiment could provide a pilot application of this framework, as alternative sediment augmentation actions are explored, and the range of possible outcomes is simulated for each sediment augmentation action and each combination of hypotheses about sediment transport, river island habitat creation, and bird response). This will force some hard thinking about how to link together various models.

v. **Direct research on vegetation scouring and sediment transport modeling**

a) The ISAC was very impressed by the quality of work completed by Natasha Bankhead and her colleagues. Her work however has sobering implications, since they imply that: a) scouring of vegetation from banks and bars using river flows is very unlikely; and b) mechanical removal of vegetation and sediment augmentation will likely be required indefinitely. These findings are not surprising, since the river probably did not evolve with these plants' stabilizing effects. Removing and or permanently managing Phragmites may be required. Biological controls should also be investigated.

b) The parameters estimated by Bankhead et al. should be incorporated into the sediment transport models being used by the program. Lateral erosion is a process requiring further research. In particular, modeling and field studies should address the extent to which complex 2- and 3-dimensional processes contribute to vegetation removal through concentration of shear stress and lateral erosion of vegetated bars.

Chester Watson presented an analysis supporting the work by Bankhead et al. and indicating that slope and discharge conditions along the Central Platte would favor a braided planform if bank strength were less; vegetation was implicated as the factor responsible for increasing bank strength. What isn't clear from this analysis is the role of sediment supply and whether correcting the sediment deficit is a <u>necessary</u> or <u>sufficient</u> condition for braiding, <u>with</u> or <u>without</u> diminished bank strength.

There is also a question of scale. At the scale of the entire cross section of the river, vegetation-induced bank strength helps to consolidate within-channel flows and increase shear stresses on braid bars, thereby increasing the potential for vegetation scour. At the scale of individual braid bars vegetation inhibits scour and probably lateral erosion – the dynamic processes that make braided rivers braided. A river morphology can be envisioned in which the main channel is wide enough to accommodate braiding, narrow enough to maintain braid bar dynamics, and wide enough to provide sight distances needed by terns, plovers, and whooping cranes.

How does sediment supply interact with these dynamics? Qualitatively, the more sediment in the system, the more likely it is that mid-channel braid bars will form, flow will diverge around them, and lateral shear stresses will be applied to banks and bars. Without a balanced sediment supply, diminished bank strength (through spraying of cutting vegetation) may result in a widened channel, but it may lack bar dynamics. The critical uncertainties about the interactions among sediment supply, bank strength, and discharge need to be assessed with detailed field studies; the Elm Creek Pilot study promises to provide the opportunity.

vi. **Work on invasive species**

a) The Program-funded work on invasive species by Natasha Bankhead and colleagues was a valuable step forward in addressing the issue of shear stress. It would be good to see an updated summary of current knowledge regarding other questions raised by the ISAC in Section 2.5 of their report (i.e., What factors control expansion? What are the most effective management measures? Will *Phragmites* spreading will be accelerated by AMP experiments?). *Phragmites* remains the 800 pound gorilla in the room regarding the feasibility of FSM, and continuing maintenance costs.

b) The Bankhead et al. assessment was comprehensive in the vertical dimension. There remain significant questions about the role of vegetation in stabilizing bars that are subjected to lateral erosion and cutbanks. The documented depth of *Phragmites* roots diminishes the prospects for lateral erosion to destabilize bars; nevertheless, the role of lateral erosion should be evaluated.

5. Management Action Implementation

5.1 Recommendations by ISAC (2009) which pertain to this step

i. The ISAC's recommendation on a *mock report* (Section 2.4) included the following suggestion relevant to implementation: develop alternative land and water scenarios (e.g. number of willing sellers, water use, climate), which reflect the uncertainty in implementing actions (Peterman 2004); and

ii. The ISAC also recommended simulating the expected range of contrast in conditions (over space and time) under the proposed experimental design.

iii. ISAC (2009; Section 2.5) recommended early identification and implementation of effective measures to control *Phragmites* so as to increase the likelihood of achieving Program outcomes

iv. ISAC (2009) stressed the need to have **big** changes in the system to be able to properly test hypotheses, and see benefits.

v. ISAC (2009) noted the importance of systematically addressing implementation uncertainty.

5.2 Comments on Progress Made and Suggestions for Future Directions (responding point by point to above recommendations)

i. **Alternative land and water scenarios:**

a) As described by **Jason Farnsworth** at the 2011 AMP Reporting Session, excellent progress has been made on **implementing the Land Plan** (80% of the way towards the First Increment milestone of acquiring 10,000a); everyone involved in that process should be commended.

b) **Beorn Courtney** presented investigations of the **ability to implement the Water Plan**. So far, the Program is about 53-60% of the way towards reducing target flow deficits (i.e., 3 initial projects provide 80,000 AF; need another 50-70,000 AF). The Water Plan investigations appear to be very thorough and systematic, but also reveal some serious challenges (loss of conveyance due to both vegetation and sedimentation, expensive re-regulation of reservoirs at CNNPID, uncertainties in groundwater recharge). Overall, the approach to these considerable implementation uncertainties seems sound. It's important to manage everyone's expectations with respect to how soon it will be possible to obtain short duration high flow events, and to recognize this in the linked analysis of potential outcomes (decision analysis framework discussed above). In the meantime, the Program would be wise to take full advantage of natural high flow events, both to implement management actions (e.g., piggyback sediment augmentation on high flows, remove dead vegetation) and to obtain useful contrasts in conditions. This is acknowledged on pg. 31 of Version 2.0 of the **Implementation Plan** (Farnsworth et al. 2011).

c) The **Off-Channel Sand and Water (OCSW)** habitat project at Cottonwood Ranch, described by **Dan Bigbee**, is impressive, and should generate some interesting information. It would be useful to estimate long-term maintenance costs for this project. Redistribution of sediment from the island to the moat will require some maintenance over time, which may affect its sustainability.

d) A number of the tasks that the ISAC heard at the March 2011 AMP Reporting Session were concerned with either short duration flow pulses and sediment augmentation or removal. For example, the program can't get rid of sediment at the OCSW site at Cottonwood Ranch because of cost with the result that the island is perched too high (potentially) and maintenance dredging is acknowledged. However, at the same complex, sand is being purchased and heavy equipment is being leased to place the sand in the channel. It seems logical that the OCSW projects be considered within the context of sediment augmentation. Also, the solutions to flow augmentation were to create reservoirs near the Platte. It also seems logical to consider flow augmentation in the same framework as sediment augmentation. That is, perhaps flows from the reservoirs could serve to transport stockpiled sediment into the main channel. In general, we recommend that all tasks (and their supporting contractors) that are associated with similar measures be considered for a higher level of coordination to make sure that "economies of scale" are not missed where separate tasks could be complementary.

ii. **Simulate expected range of conditions**

a) As discussed above under section 4.2 iv a), the ISAC would still like to see the Program move forward with linked models to simulate the overall experiment. The proposed focused effort on Elm Creek in July 2011 will help to iron out various experimental design issues on a manageable scale, and provide valuable input to the Data Analysis Plan.

iii. **Early identification and implementation of effective measures to control *Phragmites***

a) At the December 2010 meeting, the ISAC learned that Phragmites has been controlled with herbicides and bulldozers throughout many parts of the Study Area, but that canary grass is coming in to replace it. As discussed above in sections 4.2 v and vi, it's important for the Program to systematically evaluate and implement various control options for *Phragmites*, including biological measures.

iv. **Big changes to yield detectable effects.**

a) Are the land and water actions being implemented large enough to potentially cause major changes and test the hypotheses of interest? This question is worthy of further analyses by the EDO through the linked set of models discussed previously, as part of the work in developing the Data Analysis Plan.

v. **Implementation Uncertainty**

a) Version 2.0 of **The Implementation Plan** (Farnsworth et al. 2011) is an excellent foundational document for the Program, and includes useful decision flowcharts, summary information on the Program, hyperlinks to key references and other material. The decision flowcharts make explicit some key implementation uncertainties.

6. Monitoring and Data Synthesis

6.1 RECOMMENDATIONS BY ISAC (2009) WHICH PERTAIN TO THIS STEP

i. from Section 2.4 of ISAC 2009 concerned with data analysis, synthesis and reporting:

a) analyze data quickly (within one season or year of data collection), share syntheses at annual meetings, and adjust priorities based on learning.

b) don't duplicate agency databases (e.g. USGS, USFWS, BoR), but rather skim key variables & metadata into centralized PRRIP database, while ensuring strong data quality procedures and consistent spatial / temporal references.

c) Reviewed data and reports should be made available to all in the spirit of transparency. If participating agencies or institutions do not freely distribute published reports to the public, the Program should make such reports available to stakeholders through an online library system.

d) to improve the value of information for decisions, develop *mock* syntheses reports

ii. from Section 2.6 of ISAC 2009: design the forage fish approach based on the terns' perspective, not the fishes' perspective.

iii. implement a rigorous sampling design for assessing changes in geomorphic condition and habitat over time

iv. develop mock data synthesis reports

6.2 Comments on Progress Made and Suggestions for Future Directions (Responding point by point to above recommendations)

i. **Data analysis, synthesis and reporting:**

a) The annual reporting sessions (and executive summaries) are a great way to ensure that data get analyzed quickly. The **2011 AMP Reporting Session** was much improved over the 2010 Reporting Session, and the 2010 session was pretty good. The main improvement, as described above in section 1, is that the Contractors were really thinking about the big questions, and the other parts of the Program. Making progress on the **Data Analysis Plan** will help to speed up the analysis process. Ideally, standard data analysis routines (e.g. status and trends of various performance measures) can be added to the Program database, and churned out quickly, organized around the priority questions and hypotheses.

b) The ISAC hasn't reviewed the Program database, so we can't really comment on how well it's working. We understand that the Program database is not yet up and running. This is a very high priority, but should not get in the way of progress on the Big Questions (i.e., make progress on publishing summaries of results as in the AMP Reporting Session, revise CEMs, hypotheses and study plans based on these results).

c) Similarly, we can't comment on the availability of data and reports because we haven't reviewed this. The ISAC is very pleased at how well organized materials were for the 2011 AMP Reporting Session.

d) **Version 2.0 of the Synthesis Report** (Smith et al. 2011), while only a preliminary document with many gaps, is a good step forward and appears to be a sound structure for reporting to the GC and the public. ISAC members have some serious concerns about the curve-fitting in Figures 3.4 to 3.7, which should be reviewed with the Program's Special Advisors on statistics. Many other curves could be fit through these points. It would be good to have other examples of data syntheses included in the Synthesis Report (e.g., better structured graphs addressing questions 1, 2 and 3). This will also force progress on the Data Analysis Plan. We understand that a complete Version 2.0 will be sent to the ISAC for their review, based on inputs from the statistics Special Advisors.

ii. **Re-design of forage fish studies to emulate tern's perspective**

a) This appears to have been greatly improved, as evidenced by the work presented at the 2011 AMP Reporting Session (i.e., **Tern and Plover Foraging Habits Study by Sherfy et al.**). Standardized fish sampling at sandpits and the river using surface trawls is a major improvement over previous fish monitoring (see comments in 2009 ISAC report). However, like other areas the results have yet to be statistically compared. Giving means without at least reporting the standard deviation or showing error bars (as in the Sherfy et al. Powerpoint presentation) does not tell us if the 35 fish/sample (sandpits) is different than the 82 fish/sample (river) if variability is high. Such tests are relatively simple and should be presented in future summary reports and powerpoint presentations routinely (e.g., piping plover peck rates, least tern plunges, invertebrate abundance data, fish abundance data). Also, the ISAC would like to have access to full reports (rather than just Executive Summaries) to verify if the sampling effort was in fact the same between sandpit and river habitats.

b) It would be more accurate to report the number of fish per volume of water sampled rather than per net sample. For example water depth likely varies between sandpits (deep) and river (shallow). If the net is 1 m deep and pulled 10 m in a 0.5 m deep river, then the total volume sampled is 5m. But if the same net is pulled through a 2 m deep sandpit the volume of water sampled in the sandpit is 10m, two times that sampled in the river. Of course this would make the catch per volume even greater in the river, but at least the results would be accurate and comparable.

iii. **Rigorous sampling design**

a) The rotating panel design for geomorphic condition and vegetation (20 fixed points, 5 random points each year) appears to be working well, and can provide some good data for habitat assessments, as demonstrated at the **2011 Reporting Session** by **Joan Darling** in a useful pilot analysis. It's not clear how this status and trend monitoring formally integrates with the 1D and 2D modeling, or the studies of habitat use.

b) The surveyed cross sections showing deposition from 2010 high flows provide a unique opportunity to assess where erosion and deposition took place. This information is very valuable to: a) test Bankhead et al. conclusions and b) indicate elevations of newly deposited bars. For the latter, it will be essential to distinguish natural from constructed sandbar surfaces on the cross sections.

c) The above comment is a good example of the concept discussed earlier (section 2.3) about creating *ad hoc* work groups to synthesize information across contracts. The surveyed cross sections, DEM from Lidar and geomorphic studies are all interrelated and could be managed as an *ad hoc* program stratum. Right now the program structure is of two basic strata – task and program. However, to optimize learning we recommend an intermediate stratum which multiple related tasks are considered as one entity.

iv. **Mock data synthesis reports**

a) As discussed above, the Synthesis reports serve the valuable purpose of summarizing progress in a form easily understood by the GC. However, work needs to continue on the core idea behind the mock data report, that is, simulating the range of potential outcomes of the Program, the ability to answer key questions and test primary hypotheses, and the types of responses which would occur given different outcomes. The Elm Creek pilot test would be an excellent opportunity to further develop this concept. As noted above, it would make sense to utilize the Program's statistical Special Advisors for some of this task.

7. Performance Evaluation and Action Adjustment

7.1 Recommendations by ISAC (2009) which pertain to this step

i. ISAC (2009) recommendations regarding performance evaluation are described in the previous sections. The primary recommendation (Section 2.4 in ISAC 2009) was the use of mock performance evaluations during the implementation design process (i.e. what would you conclude / decide if *this* happened, or if *that* happened?), so that actual performance evaluations are well thought through in advance, and necessary design tweaks made to avoid ambiguous conclusions. Those performance evaluations would be decision-focused.

7.2 Comments on Progress Made and Suggestions for Future Directions (responding point by point to above recommendations)

i. The **Implementation Plan Version 2.0** appears to be on the right track for structuring performance evaluations, particularly as related to short term decisions on implementation of actions and various studies (i.e., the action diagrams in Figures 6 to 10, and Figures 13 to 16). As the Synthesis Report and Data Analysis Plan evolve, they'll sharpen the details of exactly *how* and *when* various evaluations will be completed, and the form of these evaluations (e.g., mock graphs and charts). Completing the Elm Creek Proof of Concept (including design, implementation, monitoring and evaluation) will serve as an excellent catalyst for defining evaluation methods and the form of syntheses.

   What seems to be missing from the Implementation Plan is a listing of the decisions which will be made at the end of the First Increment. Perhaps the GC doesn't want to specify these now. But without laying out these decisions, how can you be sure to have the right evaluations available for the intended decisions? Some of these decisions were posed in Version 1.0 of the Synthesis Report (Smith et. al. 2010) and need to be revisited, perhaps first developed by the EDO and then reviewed by a subgroup of the GC.

   The EDO needs to identify most of not all possible outcomes of the program for two very important reasons. First, that is the essence of adaptive management – i.e., you have identified all the outcomes and have a pathway forward no matter what the outcome. Second, this is also very strategic from a program management standpoint. Failure of the program damages the EDO, the GC, and the extended clientele and stakeholders that the program represents. Certain outcomes may require intervention by the GC or even reconstituting the agreement. These types of outcomes must be identified as early as possible because the institutional changes they inspire will be likely very difficult and time consuming to implement.

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Appendix A. Summary of Recommendations in ISAC (2009)

2.1 CONCEPTUAL ECOLOGICAL MODELS (CEMS) AND PRIORITY HYPOTHESES

Main findings on CEMs:

1. Existing CEMs for target species describe beliefs about how program actions may affect processes, responses, and species. This is very helpful to the Program.
2. The Program needs to understand enough of the whole system (including factors outside of its control) to explain what happened during the management experiment. See examples for the Trinity River (Figure 1) and whooping cranes (Figures 2) below.
3. It is essential to add human actions & external "driving forces" to Program CEMs (even if outside Program control) because they potentially affect the effectiveness of actions within Program control, e.g.:
    - Water withdrawals / diversions or land-use change within the contributing Platte River watershed or outside of it
    - Climate variability and trends
    - External influences on abundance / condition of birds arriving in Platte
4. Adding the above-described boxes to make the CEMs more comprehensive changes neither the actions the Program undertakes nor what is monitored.
5. More comprehensive CEMs will motivate strategic partnerships (coordination of actions; data sharing) that can improve action effectiveness, understanding and ultimate outcomes.
6. This effort *might* reduce the scope of Program monitoring (e.g. if it becomes clear that external factors outside Program control overwhelm or confound the ability to detect the effects of Program actions), though tracking these covariates will still have great explanatory power.
7. To keep the CEM format understandable we recommend using a modular or nesting approach (e.g. a simple overall CEM for each species, with components expanded on separate pages).

Main Findings on Prioritizing Hypotheses:

1. The Program has made excellent progress on reducing the number of priority hypotheses down to 42, and the tables in Appendix E of the AMP (2006) are very helpful.
2. Further prioritization / sequencing is warranted, since some priority hypotheses have "low detectability, sensitivity, feasibility" (e.g. WC3, 4, 4a; PS1, 5, 7, 9, 11; SED #1, 4 in AMP Appendix E).

3. For these challenging hypothesis tests, the Program should proceed in sequential manner, with clear decision rules, applying the principles of good project management (i.e. critical path, sequencing). Example decision rules would be:
   - **IF** through research the feasibility of testing a "low feasibility hypothesis" is improved to a level where effects of interest are detectable, **THEN** continue to monitor.
   - **IF** a ***primary hypothesis*** test shows a triggering result (e.g. spawning by pallid sturgeon) **AND** management priorities support the next sequenced investigation **THEN** test the next ***contingent hypothesis*** (e.g. larval recruitment).
4. Prioritize hypotheses according to the following hierarchy: 1) hypotheses directly relating to Program management objectives for T&E species, and mortality sources; 2) hypotheses concerning impacts to the system of habitats that supports these species; and 3) hypotheses that improve the Program's understanding of key processes affecting the outcomes of management actions. The third level (applied understanding of ecosystem processes) is critical both to designing appropriate actions, and to avoiding taking actions based on single species analyses (which could benefit one species at the expense of another).
5. Complete quantitative estimates of the feasibility of testing all hypotheses with a simple model that generates/analyzes mock data (discussed under Section 2.4).
6. The Program should not postpone or discard work on really tough but important questions, because sometime later the Program will likely need to answer those questions. It may be necessary to test techniques or do more basic research before actual hypothesis testing can proceed.

2.2 EXPERIMENTAL DESIGN

Main Findings on Experimental Design:

1. The "means objectives" (e.g. achieving a sediment balance above Cottonwood Ranch) seem reasonable, reflecting current understanding of species habitat requirements, but should be regularly reassessed based on biological responses.
2. The proposed paired design is better than alternatives, given current understanding of central Platte system. It is important that the Program:
   i. recognize that flow will create a gradient of FSM conditions; monitoring should include a suite of potential explanatory variables that reflect this gradient;
   ii. choose appropriate sample sizes, depending on both the variability of performance measures (PMs) and the amount of change in PMs that leads to different decisions ("critical effect sizes");
   iii. use existing data on variability in tern/plover performance measures to

compute statistical power, and assess the effects of 4 vs. 5 sites with paired FSM and MCM treatments.

3. Directed research should be applied to the following processes, which are fundamental to the overall habitat restoration strategy:
    i. understand vegetation scouring and associated flow effects on island geomorphology that may create diverse, functional habitats;
    ii. improve sediment budget estimates to refine sediment augmentation actions; this will require improved sediment transport modeling and monitoring.

4. Current species monitoring is good for detecting whole-system responses, including those not on Program lands (but see Section 2.4 on Data Analysis, Synthesis, and Reporting).

2.3 MODELING

Main Findings on Modeling:

1. The Program should continue to use coupled hydrology, hydraulics, sediment transport, and vegetation/habitat response models (e.g. models with SEDVEG-like capabilities) to assess management actions.
2. The Program needs to increase the credibility of the above models through:
    - documented performance assessment (for example, through ability to replicate historical conditions); and
    - documented sensitivity analyses (to assess which inputs are critical to predictions and to improve parameter estimates).

3. The Program should add rapid prototyping models for other system components (e.g. possible water & land scenarios, threatened and endangered species, sampling error), so as to:

    - increase the Program's ability to understand, visualize, and predict system responses;
    - better coordinate and integrate field studies;
    - simulate design of management experiments (Section 2.4); and
    - enable stakeholders to explore model behavior (even if they are just looking at the stored results of previously run scenarios).

2.4 DATA ANALYSIS, SYNTHESIS AND REPORTING

Main findings on Data Analysis, Synthesis and Reporting:

1. The reliability of the hypothesis test to assess Flow-Sediment-Mechanical

(FSM) vs. Mechanical Creation and Maintenance (MCM) depends on factors inside and outside of Program control. The interaction of these factors needs to be fully explored (Figure 3).

2. We recommend that the Program develop a *mock report* based on *mock (simulated) data*, which will help to organize the data analysis plan and reprioritize hypothesis tests (see #6 below).
3. The Program should analyze data quickly (within one season or year of data collection), share syntheses at annual meetings, and adjust priorities based on learning.

4. The Program should not duplicate agency databases (e.g. USGS, USFWS, BoR), but rather skim key variables & metadata into centralized PRRIP database, while ensuring strong data quality procedures and consistent spatial / temporal references.
5. Reviewed data and reports should be made available to all in the spirit of transparency. If participating agencies or institutions do not freely distribute published reports to the public, the Program should make such reports available to stakeholders through an online library system.
6. To improve the ultimate value of information for decisions (Figure 2), the Program should develop a *mock report* based on *mock data* (i.e. the type of data you expect to acquire over the period of the First Increment). This would involve the following steps, which build upon protocols developed by the US Environmental Protection Agency (EPA 2000) for defining data quality objectives:
   a. Define the decisions that you want to make at different times (e.g. assessments of action effectiveness, revisions of actions).
   b. Develop alternative land and water scenarios (e.g. number of willing sellers, water use, climate), which reflect the uncertainty in implementing actions (Peterman 2004).
   c. Simulate the expected range of contrast in actions under the experimental design.
   d. Simulate the effectiveness in producing habitat, given various alternative hypotheses.
   e. Simulate species' responses to habitat changes, including confounding factors.
   f. Add the expected sampling error in estimating performance measures.
   g. Combining steps b to f will generate *mock data*.
   h. Analyze the mock data as you would the real data.
   i. Write up a mock report & draw conclusions for the key decisions outlined in step a.
   j. Gain insight on the feasibility of hypothesis tests and ability to apply new information to management decisions.
   k. Revise (as required) the CEMs, experimental design, hypothesis priorities, sampling plan, and data analysis plan.

2.5 INVASIVE SPECIES

Main findings on Invasive Species (focused on the invasion of the common reed, *Phragmites australis,* into the Platte River*)*

1. Immediate negative impacts
    - Constrains channel and floodplain conveyance
    - Increases erosion resistance
    - Influences local and system sediment transport dynamics
2. Potential long-term negative impacts
    - Stream bed incision
    - Altered landscapes affect execution and effectiveness of experimental design
3. Questions to be answered
    - What factors control expansion?
    - What are effective management measures? (Identify based on literature review and experimentation.)
    - Will spreading be accelerated by AMP experiments?
    - What shear stresses are required to scour infestations?
4. Mapping spatial extent in Central Platte over time
    - Document effectiveness of management measures
    - Forecast rate and locations of spreading
5. **Identification and execution of effective measures early in the program avoids foreclosure of future options and increases the likelihood of achieving intended Program outcomes.**

2.6 AMP MANAGEMENT OBJECTIVES

Main findings on AMP Management Objectives and Performance Measures

1. The existing four management objectives (see Appendix B, Section F) are generally excellent, although minor modifications to the whooping crane objectives should be considered (see 3 below).
2. The following two management objectives should be added:
    - **Objective 5:** Gain an understanding of whooping crane, least tern and piping plover population dynamics outside the Program area, using a meta-population dynamics approach
    - **Objective 6:** Develop strategic partnerships to address impacts and opportunities outside Program area, based on a nested set of CEMs including both system and species levels.
3. Change management objective 2 (*Improve survival of whooping cranes during*

migration) to *Contribute to improved whooping crane survival during migration.* This reflects what is realistic and reduces the Program scope. Many factors external to the Program (e.g. power line mortality in north Texas, forage quality at other stopovers) affect migration mortality of whooping cranes. The whooping crane CEM should be revised to reflect these factors.

4. The existing whooping crane performance measures are appropriate (e.g., increase WC use days), but others should be added (e.g. weight gain while at Platte, time budgets (% of time spent feeding, resting, preening, defending, moving)).
5. Use a contingent, incremental approach for the sturgeon objective, only progressing to more detailed studies once initial questions have been answered (see **Main Findings on Prioritizing Hypotheses** in Section 2.1). The stage sensitivity study will document the hydrologic sensitivity of lower Platte to central Platte flow management. If there is a change in flow which could be significant to sturgeon, then the next logical step would be to use a sparse, stationary telemetry framework to define migrations of sturgeon in/out of the Platte. If the telemetry results suggest that sturgeon are using the Platte for spawning, then consider studies of larval recruitment. One ISAC member has suggested that sparse telemetry studies *could* be done as a first step to determining the level and location of use of the Platte by pallid sturgeon, but to do such studies as part of the Missouri River Restoration Program (in coordination with the PRRIP).
6. Design forage fish approach based on the terns' perspective, not the fishes' perspective (See Q28 in Section 3.6).

2.7 RECOMMENDED SEQUENCE OF ACTIVITIES FOR ADDRESSING OUR RECOMMENDATIONS

We would suggest the following sequence:

1. Work on *Mock Report* (Section 2.4), to facilitate:
   a. More comprehensive CEMs for each species (Section 2.1)
   b. Form strategic partnerships as guided by expanded CEMs (Section 2.1)
   c. Clear data analysis plan (Section 2.4)
   d. Additional rapid prototyping models for other system parts (Section 2.3)
   e. Reprioritized hypotheses (Section 2.1)
   f. Improved experimental design (Section 2.2), performance measures (Section 2.6) and sampling efforts, as required
2. Update sediment transport assessment (Section 2.2(3) and 2.3), including consideration of *Phragmites* (Section 2.5)
3. Establish ongoing data management, synthesis and reporting procedures (Section 2.4)

Appendix B. AM steps

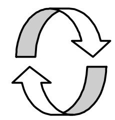
(from Version 2.0 of PPRIP Implementation Plan, pg. 6-7)

AM Step	Definition in Version 2.0 of PPRIP Implementation Plan
Problem Assessment	Problem assessment is the first step in implementation of the AM process and provides the context for all subsequent actions. As the name implies, this step is the formal identification and characterization of the potential outcomes and uncertainties associated with implementation of management actions designed to address a resource problem or issue. The Program has invested a significant amount of time in problem assessment during AMP development. However, most of that work focused on the uncertainties associated with implementation of the FSM management strategy. This is reflected in the priority hypotheses which largely do not address MCM.
Investigation	Investigations function as an extension of the problem assessment process and are useful in reducing critical uncertainties that are related to management action performance but are not conducive to being tested as part of a management experiment. Typically, these uncertainties are identifiable as **data that are needed to inform management experiment design**. Fundamental physical process relationships like vegetation scour thresholds are an example of critical Program uncertainties that can be addressed through investigations. Several forms of investigation may be utilized including literature reviews, model development, and directed research projects.
Implementation Design	Implementation design is the step of the AM cycle where management options and uncertainties identified in the problem assessment step are developed into a full AM experimental design that includes construction, monitoring, analysis, and action adjustment components. **The design step is arguably the most important in the AM cycle as it clarifies management action performance expectations and provides a framework for monitoring, synthesis and action adjustment under the range of possible outcomes.** *Further elaboration on design constraints on pg. 6 of Implementation Plan.*
Management Action Implementation	Implementation of management actions lies at the heart of the process of "learning by doing." During this step of the AM cycle, management treatments are implemented or constructed within the context of the implementation experimental design. Implementation will typically be contracted, often to construction contractors who have not been involved in the design process. The potential need for design modifications during construction necessitate that experiment design team remain engaged through implementation.
Monitoring and Data Synthesis	Monitoring plan and protocol development is a vital part of implementation design with special emphasis on monitoring to collect "need to know" information that will be used to evaluate management action performance. Monitoring will fall into three categories: o Implementation monitoring –Monitoring to determine if management actions are being implemented according to design requirements and

AM Step	Definition in Version 2.0 of PPRIP Implementation Plan
	standards. o Effectiveness monitoring –Monitoring of physical habitat performance indicators to determine if management actions are achieving, or moving towards, management experiment performance criteria. o Validation monitoring –Target species use and selection monitoring to determine if target species are responding to management actions and/or Program is making progress towards achieving management objectives. In order to facilitate timely decision-making, data synthesis should occur annually. Program monitoring and data synthesis will typically be conducted by contractors working with the Executive Director's Office (EDO) to synthesize and integrate results of multiple monitoring protocols. The Program will also host annual monitoring reporting sessions that will bring together all Program contractors to present the results of their monitoring efforts. This collaborative sharing of experience and information will be vital in fostering joint understanding of Program objectives, actions and outcomes.
Performance evaluation	Performance evaluation provides the path from data to management decision-making. Implementation designs will identify performance criteria and actions to be taken under various outcomes. Analysis, evaluation, and reporting of monitoring data provide the information needed to build performance evaluations that policy makers will use to close the AM loop and adjust actions. The Program will use mock performance evaluations (using synthetic data) during the implementation design process to ensure that actual performance evaluations generate the kind of information that decision-makers want or expect.
Action Adjustment	Two types of action adjustments are contemplated in this plan. The first type is management action adjustments that are dictated by management experiment performance. These adjustments are contemplated during the implementation design process and are critical to successful implementation of AM. These adjustments could be as minor as changing the date when annual sediment augmentation operations commence or as significant as repurposing Program flow releases. The second type of action adjustment is suspension or termination of actions due to impact triggers. During management experiment implementation, negative impacts caused by Program actions may occur on or off of Program lands. Implementation design will include impact triggers associated with implementation and effectiveness monitoring. If indicator values surpass impact trigger thresholds, management action implementation activities will be suspended and a viability assessment will occur. That assessment will provide Program decision-makers with mitigation and/or management action modification options

Appendix C Steps and Elements of AM[2]

AM Steps	Ideal Elements within each Step
Step 1. Assess and define the problem	a. Clearly stated management goals and objectives b. ID key uncertainties (what are the management questions?) c. Explore alternative management actions (experimental “treatments”) d. ID measurable indicators e. ID spatial / temporal bounds f. Build conceptual models g. ID uncertainties about how actions affect indicators h. Articulate hypotheses to be tested i. Explicitly state assumptions j. State how what’s learned will be used k. Involve stakeholders l. Involve scientists m. Involve managers



AM Steps	Ideal Elements within each Step
Step 2. Design	a. Active AM b. Contrast, replication, controls c. Statistical advice d. Predict outcomes e. Consider next steps under alternative outcomes f. Data management plan g. Monitoring plan h. Formal AM plan (for the remaining steps, besides monitoring) i. Peer review of design j. Multi-year budget commitments k. Involve stakeholders
Step 3. Implementation	a. Contrasting treatments b. Implemented as designed (or document unavoidable changes) c. Implementation monitoring
Step 4. Monitoring	a. Implemented as designed b. Baseline ("before") monitoring c. Effectiveness monitoring d. Validation monitoring
Step 5. Evaluation of results	a. Monitoring results compared against objectives b. Monitoring results compared against assumptions, uncertainties, hypotheses c. Compare actual results against model predictions d. Receive statistical or analysis advice e. Data analysis keeps up with data generation from monitoring activities
Step 6. Adjustment / revision of hypotheses and management	a. Meaningful learning occurred (and was documented!) b. This was communicated to decision makers c. This was communicated to others d. Actions or instruments changed based on learning

[2] 1 **Marmorek, D.R., D.C.E. Robinson, C. Murray and L. Greig.** 2006. Enabling Adaptive Forest Management – Final Report. Prepared for the National Commission on Science
2 for Sustainable Forestry by ESSA Technologies Ltd., Vancouver, B.C. 94 pp. Available from www.ncseonline.org/NCSSF/ {under 'Synthesis and Survey Projects'}

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Endnotes

[i] **Galat** (from Feb 2010 AMP notes): It is clear that the contractors are a dedicated group of professionals who are committed to PRRIP's success. Consequently, program integrity can be enhanced by involving them more deeply in the experimental design aspects (goals, objectives and priority hypotheses) articulated in the AMP so that they: (1) are made aware of how their projects fit into the overall picture; (2) how their piece is critical for AMP success, and; (3) have the understanding and buy in to more effectively accomplish their charge… To further enhance the team approach:

- The AMP/TAC should distribute a flow diagram (and update as necessary) that illustrates how each of the research and monitoring (R&M) projects is linked to AMP objectives and priority hypotheses. This will also aid the AMP to identify those projects that are poorly tied to their objectives and suggest redirecting resources.

- Have all contractors' progress reports follow same format that includes in both the Executive Summary and report body their objectives, and how they relate to AMP program goals and relevant priority hypotheses.