Save Our Bosque Task Force
Adaptive Management Workshop II
September 25-27, 2007
Sevilleta National Wildlife Refuge (NWR)

WORKSHOP SUMMARY

Tuesday, September 25, 2007

Welcome and Opening Remarks
Doug Boykin, New Mexico State Forestry and Save Our Bosque Task Force President welcomed participants.

Gina Dello Russo, Ecologist, Bosque del Apache NWR and Technical Advisor to the Save Our Bosque Task Force thanked attendees for participating and initiated a round of introductions.

Participants
For a list of workshop participants, see *Appendix 1.*

Initiatives on the Middle Rio Grande
Dr. Erik Webb of U.S. Senator Domenici's office noted that there are many programs focused on specific aspects of restoration on the Middle Rio Grande, and recognized the Save Our Bosque Task Force (SOBTF) for addressing issues in an integrated way. He reviewed the following initiatives in the area:

- *2003 Biological Opinion (BO)* –Failure to meet the BO will likely result in litigation, which could make it difficult for groups to meet and work together to continue to make progress on support for the two species addressed in this document.
- *Salt Cedar and Russian Olive Management Demonstration Program* –Funding is expected in 2009. Senator Domenici is trying to secure funding for 3 river systems in NM.
- *Middle Rio Grande Endangered Species Collaborative Program (Collaborative Program)* – This program began in 1999 and has received approximately $50 million total funding since its inception. The majority of this has been used to purchase and store water. Remaining funds have been used for habitat restoration, population management and monitoring, and program functions.
- *Middle Rio Grande Bosque Initiative* – Proposals are accepted and small contracts are awarded annually for habitat restoration, monitoring and research, and outreach and environmental education.
- *Wildfire Restoration* – These activities cover the Middle Rio Grande area primarily in Albuquerque, were initiated in response to the 2003 fires, and are funded at about $4million/year.
- *Research* – There are numerous partnerships between the federal and state agencies and local universities to conduct research.

- *Rio Grande Levee restoration* – This program deals with replacing spoil levees along the river with constructed Corps levees. Assessing levees throughout the reach will trigger approximately $100 million of levee restoration, including vegetation work.
- *Water Resources Development Act (WRDA)* – This has been passed by the House and Senate and includes 2 authorities:

1) *Middle Rio Grande (MRG) Bosque Restoration Authority*, from Cochiti to Elephant Butte. The Corps has done some feasibility assessments in preparation for getting this authority.
2) *Rio Grande Environmental Restoration* – This is a broad authority for CO, NM and TX. Currently there are no targeted projects in NM in this authority.

- *Agriculture and Conservation Bill* - will include new programs.
- *The NM Aquifer Assessment Act* - If passed, this Act would increase funding for USGS groundwater assessment from $5 million/year to $10-15million/year.

Agenda Review and Introduction to the Collaborative Adaptive Management Network (CAMNet)

Jennifer Pratt Miles, Meridian Institute, reviewed the purpose, goals and agenda for the workshop and invited comments. Hearing none, she provided a brief introduction to CAMNet, including the Network's goals and opportunities for involvement in CAMNet. For more information about CAMNet, please visit www.adaptivemanagement.net

Overview of First SOBTF Adaptive Management (AM) Workshop

Steve Davis, Ibis Ecosystem Associates, related that the first AM Workshop began with an overview of AM by Steve Light, Adaptive Strategies, Inc., and resulted in participants outlining the components of a Conceptual Ecological Model (CEM) of the San Acacia reach of the Middle Rio Grande. He explained that a CEM provides a common understanding about the ecosystem. It depicts linkages between stressors in the system and attributes of the system. A CEM serves as a tool for communication between scientists and managers. The draft CEM for the San Acacia reach is "broad brush" and is meant to be a holistic picture to which both scientists and managers can understand and relate. Mr. Davis stated that the next step is to draw out from this visual framework a number of working hypotheses – statements that are actually testable, in the field or in the lab. He then invited those who had participated in the first workshop to add to this overview, provide their assessment of the first workshop, and offer their thoughts about what would be most helpful in this second workshop to support their efforts in the San Acacia reach.

Participants shared that the overview of AM at the first workshop was well done, and that the definition of AM that came out of the first workshop was helpful, since the term is used loosely sometimes. They noted that ending with a product – the CEM - that can be used as the Task Force works on the system – was positive. It was observed that at the end of the workshop, when ideas from each of the breakout groups were synthesized, there were four similar descriptions of the ecosystem. This provided a common starting point for the development of the CEM.

Participants stated that the CEM visually ties together attributes and issues along the river, and that this is helpful because these issues and characteristics of the system are interconnected, even though management tends to be compartmentalized. Participants stated that having the CEM as a framework will aid the group's efforts to take an ecosystem approach. In addition, the CEM helps give individuals a sense of where their agency can play a role and where others are playing a role, so a road map can be created for how everyone in the basin can contribute and work together.

Overview of CEM of the San Acacia Reach of the Middle Rio Grande

Steve Davis reviewed the draft CEM that was prepared based on input from participants in the first SOBTF AM Workshop. He described the top row of blue boxes as drivers in the system, or human-induced changes to the system. The second row of red boxes depicts stressors in the system and result from the drivers. The third row of light green boxes contains descriptions of linkages between the stressors and the bottom row of green boxes, which represent the system attributes. The attributes are characteristics of the natural system that have been affected by the stressors. Mr. Davis noted that the system encompasses two major habitats: river channel and floodplain. He asked participants for feedback on this draft depiction of the ecosystem.

Questions & Discussion

Several suggestions were made to add arrows to show relationships and feedback loops. Steve Davis suggested that feedback loops tend to make the diagram more confusing and that it is important to keep it clear since it is intended to serve as a tool for communication with managers. He stated that many of these relationships can be depicted in the sub-models that will be developed as products of the small group work sessions that will take place during the workshop.

Other comments included:

- Clarify the relationship between the linkages and the attributes.
- Add "density" to the blue box on introduction and spread of vegetation.
- Use different colors, thicknesses of lines or dashed lines to indicate strength/importance of linkages or degree of certainty regarding relationships.
- Remove the word "habitat" from the River Channel and Floodplain boxes.
- Consider adding beaver. (It was noted that while they are certainly present, they are not having a huge role in the backwater and floods. Big floods and sediments have been the main drivers. Flycatcher and minnow are in there because they are "show stoppers". Additional species can be added to the sub-models.)
- Add transport of sediments and scouring.
- Need to capture habitat quality for animal communities.
- Change "perennially flowing river" to "change to flow dynamics".
- Add high ammonia and high sediment to the box that includes high temperature and pH and low DO. Recognize that some of these are natural characteristics of a desert river. Note that minnow have an astounding capacity to live in low DO environment (< 1ppb DO) and have a high tolerance of ammonia.
- Remove water quality as a driver; keep degraded water quality as a stressor.

- In this stretch of the Rio Grande, there is very little connection between the chemicals coming off farm land and the river. There is pumping that takes water from a large canal that runs parallel to the river and pumps it back into the river and there is discharge from the farms into the canal. Surface and groundwater are very interconnected in the valley. Some wells have high salinity level. Agricultural use brings salts to the surface for irrigation; some of that might be put back into the river.
- Are we missing effects of non-native vegetation?

Please refer to *Appendix II* for an updated version of the CEM based on input provided by participants at the workshop.

Hydrology

Paul Tashjian provided an overview of the historic hydrology of the river and explored the question: *Was the Rio Grande from San Acacia to Elephant Butte historically perennial?* A copy of his presentation is available at http://www.sobtf.org/

Mr. Tashjian stated that the river featured a braided, avulsive channel, and that records beginning in 1880 show that the river was intermittent then, with over 125,000 irrigated acres (more than today). He noted that the structure of the river was different in the 1930s when photos show a dry riverbed; there were wetlands, backwaters and groundwater to buoy flows during dry times. There is historic documentation (Scurlock 1998) to suggest that the San Acacia stretch was perennial prior to major diversions. Scurlock's record indicates that the river was perennial until Las Cruces, where it was intermittent during drought. He presented information from the late John P. Taylor, who looked at groundwater hydrographs and suggested data that shows that in winter when ET is low, groundwater comes up above the surface.

Discussion

There was a question about whether the Middle Rio Grande was in fact perennial, and whether this can be determined based on the information available. Specifically, a question was raised about how big the diversions in the early 20th century were, and how they compare to what diversions do today, in terms of their ability to draw water off. Another question was raised regarding the location of the wetlands in comparison to location of the diversions historically. It was noted that there is a distinction between what existed historically, and what is needed from management in the future. These may be different, and it is important to document both.

Geomorphology

Tamara Massong, U.S. Army Corps of Engineers, provided a geomorphic summary of the river from the San Acacia to Elephant Butte Reservoir which was developed while she was employed by the Bureau of Reclamation. Ms. Massong discussed how the quantity and size of sediment control how it moves, when it moves, and if any is stored. These factors also influence incision or aggradation, planform and habitat features. In terms of trends, the lower section of the San Acacia reach is aggrading and therefore

there is a more connected floodplain. There has been a systematic migration of the river and point bar formation.

Please visit http://www.sobtf.org/ for a copy of Ms. Massong's powerpoint presentation.

Attributes of Floodplain Vegetation Communities – Implications for Restoration in the San Acacia Reach

Todd Caplan, Parametrix, stated that the floodplain is important because in provides habitat that is between aquatic and terrestrial, and that almost 50% of bird species rely on riparian areas for a part of their life cycle. He noted that water availability is influenced by soil texture and salinity.

Mr. Caplan noted that there are two important functional stages of the hydrograph: the spring, snowmelt and the summer monsoon rain events. If the declining slope of the spring hydrograph is too steep, water recedes before plant seeds can get established. If it is too gradual, inundation means seeds float and don't get established.

He identified the following data gaps in terms of floodplain vegetation communities:

1) salinity tolerance of riparian plant communities along the MRG (coyote willow thought to be fairly intolerant, yet stands at Bitter Lake NWR are healthy at salinity levels higher than the literature would indicate)
2) soils

For a copy of Mr. Caplan's full presentation, please refer to http://www.sobtf.org/

Discussion

- How often would management of the descending limb of a hydrograph be required for promoting riparian establishment?
  - Periodically, once every 10 years, whenever there is a really wet period, to prolong the descending limb of the hydrograph
- How do we incorporate something like this into a management plan?
  - Through monitoring, so we can get an idea of when we might need to alter management, and understand what the institutional constraints are
- Have you looked into nutrient cycling and over-bank flooding?
  - No; however, Manuel Molles et al at UNM have published a paper on this.
- Some current climate change models show NM drier and having less snowmelt/runoff. Will this help salt cedar expansion?
  - Sure. As water becomes more and more constrained, whether from climate change or population growth, we will have less and less flexibility with water management for ecosystem services, such as riparian vegetation recruitment. If people believe it is critical to restore native vegetation, investments can be made and actions can be taken to address this. If people decide it is not a priority to maintain native vegetation, then we need to learn to live with salt

cedar. We need to prioritize where establishment of native vegetation is most important.

Adaptive Management MRG ESA Collaborative Program

Valda Terrauds, Bureau of Reclamation, began by noting that adaptive management is a circular, iterative and never ending process, and that it is important to explain "up the chain" and to stakeholders that there is not a "final" answer.

She stated that the Collaborative Program articulated the problem they are addressing as: The current Biological Opinion is not hydrologically sustainable. Ms. Terrauds explained that the Collaborative Program decided to examine what native Rio Grande flows will support and how often they would meet the Biological Opinion flow targets.

She then explained that the source of supplemental water in the MRG is the San Juan/ Chama (SJ/C) Project and emergency agreements that would allow NM to relinquish Compact credits. It is estimated that 8,000 acre feet/year (AFY) are available for future water leases. This supplemental water is used to support minnow spawning, keep the river wet until June 15, enable a managed recession after June 15 (trying to get away from date and toward more biological parameters), and meet late season targets.

In August 2006, the Collaborative Program reviewed three options for developing a long-term sustainable Biological Opinion with 8,000 AFY of supplemental water.
A) Adding a critically dry year scenario to BO,
B) Maintaining a quality reach (Isleta),
C) Using adaptive management with baseline requirements, banking some supplemental water for drier years to enhance wetter years with AM principles applied to the allocation of supplemental water.

Ms. Terrauds described how computer simulation modeling of options A& B showed these could only meet the requirements of the Biological Opinion through June, so the group opted to pursue an adaptive management approach, including the following steps:

- Determinations of ecosystem management goals and objectives
- Determination of the ecosystem baseline
- Development of conceptual models
- Selecting future restoration or management actions
- Implementing actions
- Monitoring and ecosystem response

In 2007, the Collaborative Program conducted experimental activities and monitoring to answer three questions:

1) What are minimum biological water needs during critically dry times?
2) What refugial options do the species have when there is inadequate water supply?
3) What are long-term recurrence intervals for certain flows that maintain long-term population and ecosystem viability?

In February 2008 a decision will be made about whether to pursue a new Biological Opinion by March 2009, or to conduct another year of monitoring prior to pursuing a new Biological Opinion. Ms. Terrauds shared that one lesson learned from the experience so far is that creating an atmosphere among participants to design and execute experiments while "making it safe to fail" is difficult.

Questions and Discussion

- Where did the 8,000 AFY parameter come from?
  - Most of SJC water is allocated to contractors. In the past the City of Albuquerque was not using their contracted water and leased a lot of their water for environmental uses. With development, they will be using their water for municipal services. 8,000 AFY is the amount of water estimated to be available for environmental uses based on the amount of water that is not currently under contract.

- Is San Juan/Chama (SJ/C) water contracted in perpetuity? If there is a re-contracting process, is there a possibility to require some for environmental uses?
  - Participants were not familiar with the terms of the contract, so could not answer this question.

- People wish they could commit a percentage of conserved water to the river. Is there a mechanism to do this?
  - This should be discussed with water rights holders (municipalities).

- How does this adaptive management approach differ from the strategic water reserve approach?
  - The strategic water reserve creates the potential for storage space, which creates the storage for leased or conserved or donated water.

- Models for allocating water that should be examined include:
  - The Murray Darling Basin in Australia and the EU are setting up water reserves. They are designating ecological systems as a priority. We should look at limiting urban water use, rather than asking Tribes to lease water.
  - In South Africa, they designate a certain amount of water to the environment and senior water rights holders. Another pool of water is designated for other uses and is applied for through a permitting process.

- Did you develop hypotheses to be tested prior to testing? Do you hope to develop the hypotheses more thoroughly, do replication?
  - Yes, we did. Absolutely. We did the best we could in a tight timeline and everyone recognized that there is more to learn.

Developing Working Hypotheses

Scott Shors, NM Institute for Mining and Technology shared the following guidance for developing working hypotheses and designing projects:

- Clearly state the hypothesis (not just surveys)
- Review existing data to see if questions can be answered with that information before doing field work ("2 years in the field will save you 2 hours in the library"). There may be opportunity to build upon past work. Sometimes past work was not finished due to lack of technology at the time, or the researcher simply moved on to other work.
- Visualize the graphics that will be the outcome of field work and monitoring in advance. People have the habit of thinking they can go back and fill in the gaps, and they end up duplicating fieldwork unnecessarily.
- Collect preliminary field data to inform hypotheses.
- Develop multiple approaches and fallback plans, because hypotheses rarely work out.

In summary, hypotheses should be:

- Clearly stated
- Focused
- Testable
- Doable

Dr. Shors invited participants to consider what other sciences could contribute to this effort, and offered to facilitate a discussion between the Task Force and NM Tech to identify what NM Tech could contribute to this effort. In addition, he offered NM Tech to provide peer review of Task Force proposals.

Wednesday, September 26, 2007

Small Groups – Identifying Plant Community and Species Needs & Developing Working Hypotheses

On Wednesday morning, participants reviewed a proposed framework for breaking into small groups, and agreed to work in the following areas to identify the ecosystem needs of the San Acacia reach and to identify working hypotheses to be tested:

- Aquatic Habitat
- Woodland and Dense Shrub
- Wetlands, Saltgrass Meadows, Savanna
- Floodplain Edge

Ms. Pratt Miles reviewed the charge to the Small Groups, which included the following four tasks over the course of the day:

1. Describe what the focus plant community/species need to survive and sustain a level of health and persist for multiple generations.
2. Discuss site preparation and maintenance required for establishment.
3. Document, categorize, and prioritize hypotheses that may require testing based on gaps in information or uncertainties about plant/species needs.
4. Explore opportunities for monitoring and hypotheses testing.

Groups were provided with a worksheet detailing a suggested approach for completing each task. It was suggested that in addition to the questions outlined in the worksheet, Small Groups should consider the function of the plant community/species being addressed.

At the end of the day, the Small Groups shared the proposed working hypotheses they had drafted and refined these with input from the full group. A participant observed that in addition to documenting ecosystem needs, it would be wise to consider how climate change might affect the geographic extent of native riparian species and plant communities.

The worksheet used to document Small Group work is attached in *Appendix III*, and the results of the Small Group work sessions are documented in *Appendix IV*.

Thursday, September 27, 2007

Welcome and Review of Working Hypotheses Drafted by Small Groups
Participants were provided a one-page compilation of the working hypotheses from each of the Small Groups. Following review of this document, attendees proposed working hypotheses for the Saltgrass Meadow/Savanna ecotype, since this had not been completed the previous day. The list of working hypotheses that resulted from this exercise follows.

Working Hypotheses
Regarding Ecosystem Needs of the San Acacia Reach of the Middle Rio Grande

Aquatic Habitat

- The water storage and diversion dams/altered flows have been responsible for changes in annual river flows and affects other fish species and other parts of food web. Range of variability, timing, duration and frequency of annual river flows; level of flooding; and return period control desired channel heterogeneity characteristics including:
    a. multi-threaded,
    b. sediment size diversity and richness
    c. higher width/depth ratio (wider and less deep is better)
    d. dynamic/avulsive, surface water/ground water connectivity
    e. backwaters, woody debris, habitat patches
- Habitat size and spatial and temporal configuration of habitat affect the incremental increase in population growth rates of multiple aquatic species. *(Note: Sampling of species diversity that exists currently has been done – M. Hatch).*
- Desired channel characteristics (see above) support aquatic fauna species diversity.
- There has been a water quality shift in the LFCC pumping and SW exchange.

Woodland, Dense Shrub

- Both a hydrograph peak sufficient for soil wetting in late May to mid-June, and a descending limb of the hydrograph that results in a maximum rate of decline in the groundwater depths of 2-4 cm per day through the growing season are necessary to achieve successful recruitment of cottonwood and willow seedlings. *(see Small Group Worksheet notes regarding soil and salinity)*

- An area that overbank floods within a 5 year interval and has a depth to groundwater range of 3-6 feet may be prepared (for example, but not limited to removal of non-natives) to naturally recruit and sustain cottonwood and willow communities.
    - Completely prepared
    - Partially prepared

- Local landscape alternations could be made to improve surface and groundwater connectivity in order to establish and sustain cottonwood and willow communities.

Saltgrass Meadow, Savanna and Seasonal Wet Meadow

- Competition with Salt Cedar: A saltgrass meadow can successfully compete with salt cedar recruitment and re-invasion at X hydrology, X soil texture and chemistry.
- Saltgrass can be established and re-established in an area with the following characteristics: rhizomes, X hydrology, X soil chemistry, X salinity, X groundwater level, X sediment texture. Test which methods work best (plugging, seeding, rhizomes etc.)
- Mosaic: What is the importance of patch size (4-20 acres) for salt grass meadows?
- What are the ranges of site conditions for re-establishment of savanna?
- Minimizing site disturbance during exotic species control supports savanna establishment
- Burned areas because of the level of soil stimulation are more difficult to establish savanna grass cover than unburned areas.
- An area that is intermittently flooded at X interval will establish a wet meadow habitat.
- Spikerush is an indicator that a wet meadow is transitioning to another eco type.

Marsh

- Marsh Creation: An episodic flow event that scours or causes channel avulsion (e.g. 7,000 – 10,000 cfs for 1 week) is needed to naturally create all three types of marshes (active channel marsh [below bankfull discharge], groundwater- and surface water-fed marsh, groundwater-fed marsh).

- Marsh Maintenance: To maintain marsh productivity in groundwater- and surface water-fed marshes and groundwater-fed marshes, water levels must fluctuate a minimum of 3 feet in a single growing season at least once every 3 years
- Marsh Longevity: In the absence of disturbance (episodic flood events, fire, drought, etc.) marsh species richness and productivity will decrease.
- Marsh Longevity: In the absence of major disturbance, groundwater fed marshes have a lifespan of 20 years.

Floodplain Edge

Clarification is needed on how the floodplain edge is defined before hypotheses can be tested. Proposal: The floodplain edge plant community can be defined as a range of depth to groundwater of 10 - 15 feet.

- Removal of exotic plants will result in the natural re-establishment of native plant communities.
- Optimal re-establishment of natives requires:
    - X Depth to water and X recession rate
    - Precipitation
    - Flooding
    - (Wind) seed dispersal and presence of pollinators
    - Defer/manage grazing
    - Infrequent fire
    - Removal of exotic plants

The following observation was characterized as a best management practice (BMP): Maintenance of plant and animal species diversity requires both removal of exotics and re-establishment of natives. An improved understanding of different types of exotics and the optimum temporal and geographic scale of floodplain edge that should be restored (exotics removed, native plants established) without impacting overall animal community structure and composition would be helpful for the prioritization of exotic control and restoration projects. *(See SOBTF Conceptual Restoration Plan as an example to begin with and improve.)*

In reviewing the full complement of working hypotheses, it was observed that discharge rates represent a common theme among several statements.

How Do the Working Hypotheses fit in the CEM?

Steve Davis explained that the CEM shows relationships between stressors and attributes in the landscape. It serves as a tool that can support discussions with policy makers and stakeholders. He stated that the hypotheses drafted by the group identify the more specific relationships that could be tested in the field by modifying stressors in the system, either intentionally or due to weather or other factors, and observing how the system attributes respond. As part of the follow-up to the workshop, Mr. Davis will create sub-models from high priority hypotheses/sets of hypotheses, and will refer to how these sub-models fit into the overall CEM.

What Will We Do with the Hypotheses? What Might CAM Look Like on the San Acacia Reach?

Steve Davis outlined the next steps for transforming the working hypotheses developed during this working into testable hypotheses, as well as the remaining steps required to develop an Adaptive Management Plan for the San Acacia reach. Jennifer Pratt Miles proposed next steps for workshop products and communication and collaboration that will be needed to implement collaborative adaptive management (CAM) on the San Acacia reach. Erik Webb offered specific suggestions for how the Task Force can integrate this work into other related restoration efforts in the MRG, and for seeking funding the implement the monitoring that will be required to test the hypotheses developed at the workshop.

Next Steps for Hypotheses Development and Development of an AM Plan

Steve Davis, Ibis Ecosystem Associates, recommended the following next steps for developing the AM Plan for the San Acacia reach of the Middle Rio Grande:

1. Transform working hypotheses into testable hypotheses.
    a. Develop performance measures/indicators for each hypothesis.
    b. Develop response curves and graphs for each performance measure.
    c. Develop a restoration target(s) for each performance measure.
    d. Identify opportunities for both active and passive field tests (active: deliberately alter an input; passive: take advantage of weather)
    e. For all of the above, be geographically specific.
2. Develop a statistical monitoring plan.
3. Establish a monitoring and assessment program.
4. Develop an annual report card to communicate results of monitoring and assessment.

Next Steps for Workshop Products, Communication and Collaboration

Jennifer Pratt Miles, Meridian Institute, proposed the following next steps in terms of developing workshop products, communication, and collaboration:

1. a. Meridian will draft a summary of the key points and outcomes from the workshop.
   b. Ibis Ecosystem Associates will update the CEM and develop sub-models based on input from participants and the work of the small groups.
   These products will be distributed to participants within three weeks to review for accuracy.
   c. Meridian and Ibis will incorporate comments as appropriate and re-distribute the final workshop report and models to all those who were invited to attend the workshop.
2. The SOBTF should meet with policy/decision makers to review the results and proposed next steps of this workshop and to get input on any additional hypotheses that should be tested from the policy perspective.
3. The SOBTF should identify and engage other key individuals and groups who need to be involved with the next steps for developing an AM plan.
4. Small Groups should identify leads for each eco-type.

5. The SOBTF should work with scientists and decision makers to outline the process for how learning will feed into and inform decisions.

Erik Webb from Senator Domenici's Office then suggested the following next steps for how the CEM could underpin and support a number of restoration programs in the area:

1. The Task Force should explore the following opportunities for collaboration with the MRG Collaborative Program:
    - The Collaborative Program should invite the SOBTF to present the AM workshop outcomes to their Executive Committee.
    - In October, the SOBTF should present an unsolicited proposal for how to merge the outcome of this workshop with the Collaborative Program's population viability assessment. *Comment: One first step might be to have several participants from the SOBTF workshop participate in the Collaborative Program's Dec. 4-7 Habitat Workshop.*
    - Incorporate concepts of AM into the Collaborative Program's process (perhaps a subset of participants from this workshop could participate in the Collaborative Program). A focused dialogue is needed about what AM represents, and how it is currently inserted into BOs and legal challenges. It is important to make the next BO less vulnerable to legal challenges.
2. The SOBTF should present the outcomes of their AM Workshops to other forums to share thinking as well as to mine those programs for potential field test opportunities.
3. The SOBTF should review and refine its 2007 proposal to include the AM framework to consider the results of all the field tests and monitoring. This would position the SOBTF to seek BOR funding in FY 09 through the Russian Olive & Salt Cedar Act, since that includes funding for monitoring.
4. The SOBTF should invite Corps staff to explain the Corps planning process and prepare an unsolicited proposal to the Corps to start a project under the Rio Grande Environmental Restoration authority by January 2008.
5. The SOBTF should work with a Department of Agriculture affiliated institution to review the Farm bill Conservation Title and identify which provision(s) is related to AM, and consult with Sen. Domenici's office regarding next steps related to this by February 2008.
6. Invite Isleta Pueblo to participate in SOBTF.
7. Engage decision makers! At the next workshop, work through how the AM plan could be incorporated into a decision making process. For example County Commissioners and City Council Members can include conditions in permit requirements for development. They could also include a requirement to collect information that would be useful to the SOBTF. The Corps 404 permitting process is another opportunity to engage others in assisting with the collection of information needed to address the hypotheses developed by the SOBTF.

Workshop Evaluation
Participants provided the following feedback about what worked well in this workshop and what improvements could be made in the future.

What Worked Well

- Food
- Presentations
- Productive discussions
- Review of species and focus on community types streamlined later discussions
- Focus on ecosystem needs was an educational process
- Identification of unanswered questions
- Perspectives from outside the basin

Suggested Improvements

- Provide a summary of presentations in advance
- Provide example hypotheses
- Provide more written guidance on how to form a hypothesis
- Define ecosystem types up front
- Set up the worksheet so one can see both the initial input and the ultimate outcome
- Record initial information on flipcharts or use a projector so everyone from the group can see it

Appendix I

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Participant List

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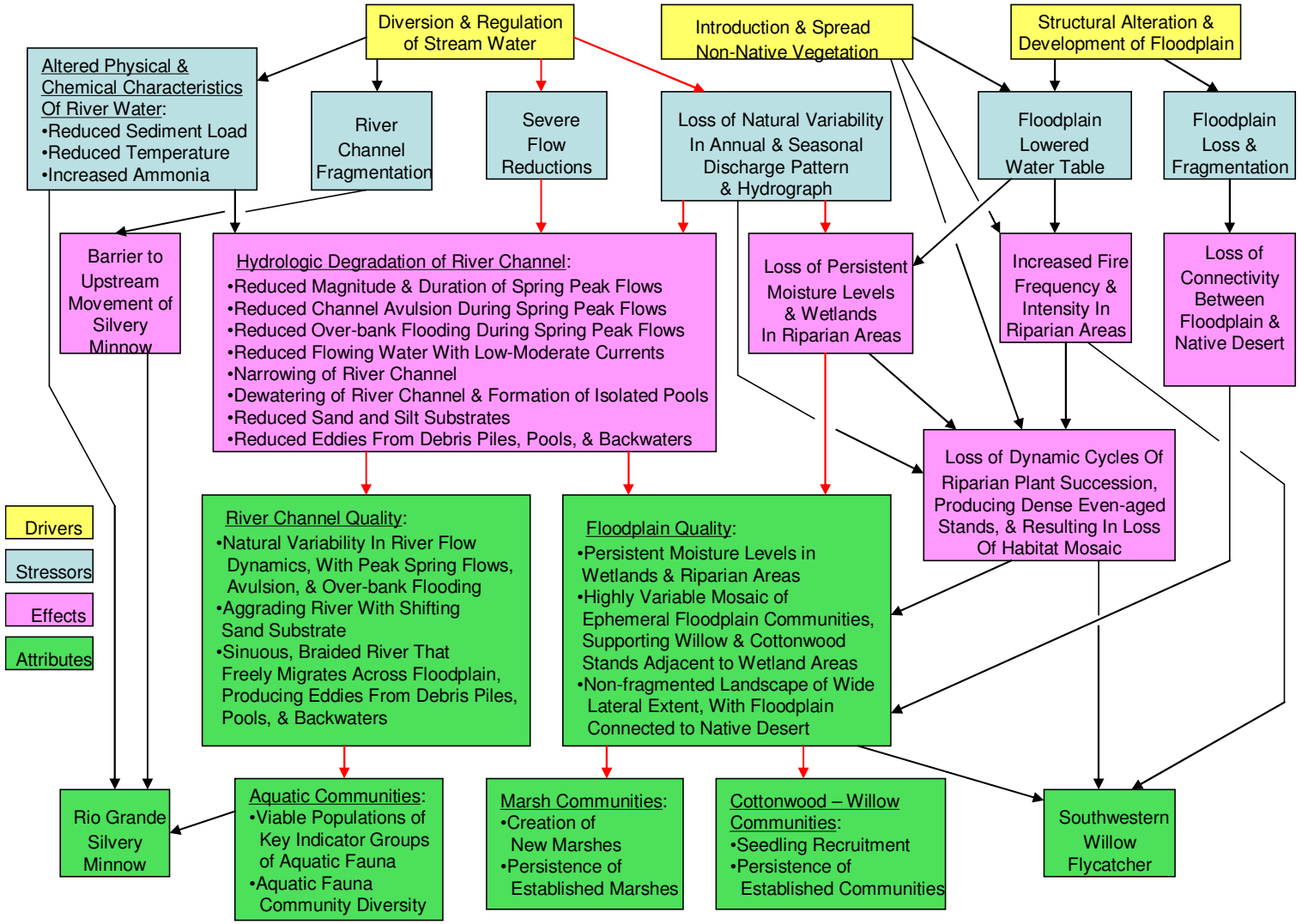
Appendix II

Conceptual Ecological Model of San Acacia Reach of Middle Rio Grande River – 10/07 Draft



Appendix III

Small Group Worksheet for Identifying Plant Community and Species Needs and Drafting Working Hypotheses Based on Ecosystem Needs

Save Our Bosque Task Force
Adaptive Management Workshop II
September 25-27, 2007

DAY 2 SMALL GROUPS – DETERMINING PLANT COMMUNITIES AND SPECIES NEEDS

WORKSHEET

_____

(Indicate above which plant community/species this small group will focus on.)

Small Group Work Session Goal:

The goal of the small group work sessions is to document what is known and what further information is needed about the needs of plant communities and species in the San Acacia reach of the Middle Rio Grande in order to develop a holistic understanding of the ecosystem needs.

Small Group Work Session Desired Outcome:

A prioritized set of proposed hypotheses about plant communities/species/ecosystem in the San Acacia reach of the Middle Rio Grande (including documentation of the information and assumptions that led to these hypotheses).

Small Group Process:

Each small group should identify a recorder to document the outcomes of the discussion, and a spokesperson to report the group's results to the large group. The following worksheet may help you document the results of your small group discussion.

Small groups are asked to complete four tasks over the course of the day:

5. Describe what the focus plant community/species need to survive and sustain a level of health and persist for multiple generations.
6. Discuss site preparation and maintenance required for establishment.
7. Document, categorize, and prioritize hypotheses that may require testing based on gaps in information or uncertainties about plant/species needs.
8. Explore opportunities for monitoring and hypotheses testing.

Notes:
It is suggested that small groups aim to complete task 1 and begin task 2 during the morning work session and complete tasks 2-4 during the afternoon session.

If you find that your group is not easily able to find consensus on some of the answers in Part I, you may consider developing a hypothesis to test the issue in Part III.

This worksheet is intended as a guide to help achieve a level of consistency among group and to help each small groups achieve the desired outcome. Please feel free to modify the suggested format as needed.

Part I – Plant Community/Species Needs. Please answer all applicable questions.

Describe what is known and what is not known about the following needs of the plant community/species on which your small group is focusing:

For plants:

- Minimum and maximum groundwater depths required for this species
- Location where the species usually occurs on the floodplain, describe landforms
- Expected salinity tolerance (for plants) (low/moderate/high)
- Typical soil texture, soil chemistry and other descriptors typical of plant locations
- Disturbance required or sensitivities
- Regeneration requirements
- OTHER

For terrestrial species:

- Nesting structure requirements
- Food source requirements
- Types of habitat avoided
- Time of year the species is utilizing habitat and how
- Types of disturbances to which the species is sensitive (other questions related to birds?)
- Possible predators or exotics utilizing the same habitat
- OTHER

For aquatic species:

- Water column depth requirements by age classes (min/max/mean)
- Water chemistry requirements, temperature, other
- Water velocity requirements by age class_(min/max/mean)
- Substrate requirements
- Food resource requirements
- Type(s) of habitat preferred and avoided (through the year, at what life stage, how)

- Types of disturbances to which the species is sensitive
- Possible predators or exotics utilizing the same habitat
- OTHER

For all:

- How has management of the river affected these plants/species?
- What maintenance requirements

Be sure to note timing during a year, estimated recurrence interval needed, if there are thresholds or critical boundaries for sustainability and improvement (these may differ).

Add any other comments or information you think would be valuable to understanding the needs of this plant community or species.

Part II – Site Preparation & Maintenance

What site preparation would have occurred historically or be required in an altered system for establishment? Consider projected trajectories, succession, sustainability of established plants (including natural regeneration).

_____

_____

_____

What maintenance in an altered system might be required? Consider goal of different age classes, mosaic of habitat features, and other factors like occasional flooding, other.

_____

_____

_____

OTHER:_____
_____
_____
_____

Part III – Prioritization of Questions/Hypotheses

- Use the results of Parts I and II to distinguish between current scientific information, accepted assumptions, and questions that haven't been addressed. Where is there no clear agreement on what is assumed? Are these questions or unknowns important enough to managing the ecosystem, the restoration community, water managers, or other stakeholders that a research project should be developed to attempt to get more information about a particular aspect of the system?
- Develop working hypotheses based on the above discussion.
- Begin to organize these questions in terms of priorities.

You may want to use a table like the following to organize your report out to the large group.

Working Hypotheses Regarding Plant Community/Species			
	Clear Agreement on What is Assumed? (Y/N)	Important enough to conduct research?	Priority (H,M, L)
Current Scientific Information			
Accepted Assumptions			
Questions that Have Not Yet Been Addressed			

Part IV - Opportunities for Monitoring and Testing Hypotheses

- What is currently on the landscape in the San Acacia reach that supports the conditions your group determined as favorable for these communities and/or species?

  _____

  _____

  _____

- Is there monitoring or the opportunity to monitor existing examples where these communities and/or species occur to improve our information on them?

- At what locations are there opportunities to test hypotheses?

OTHER considerations?

Appendix IV

Small Group Worksheets:
Plant Community and Species Needs, Unanswered Questions, and Draft Hypotheses

AQUATIC Worksheet

Part I – Plant Community/Species Needs.

A comparison of historic and contemporary occurrences of fish species in the Rio Grande Basin within the historic range of the Rio Grande silvery minnow (adapted from Sublette et al. 1990).

FAMILY	SPECIES*	HISTORIC	CONTEMPORARY
ACIPENSERIDAE	*Scaphirhynchus platorynchus (n)*	X	-
ANGUILLIDAE	*Anguilla rostrata (n)*	X	-
CATOSTOMIDAE	*Carpiodes carpio (n)*	X	X
	Catostomus (Catostomus) commersoni (e)	-	X
	Catostomus (Pantosteus) plebeius (n)	X	X
	Cycleptus elongatus (n)	X	-
	Ictiobus bubalus (n)	X	X
	Moxostoma congestum (n)	X	-
CENTRARCHIDAE	*Lepomis (Chaenobryttus) cyanellus (e)*	-	X
	Lepomis (Lepomis) macrochirus (n)	X	X
	Micropterus dolomieu (e)	-	X
	Micropterus punctulatus (e)	-	X
	Micropterus salmoides salmoides (e)	-	X
	Pomoxis annularis (e)	-	X
	Pomoxis nigromaculatus (e)	-	X
CHARACIDAE	*Astyanax mexicanus (n)*	X	-
CLUPEIDAE	*Dorosoma cepedianum (n)*	X	X
	Dorosoma petenense (e)	-	X
CYPRINIDAE	*Carassius auratus (e)*	-	X
	Cyprinella lutrensis (n)	X	X
	Cyprinus carpio (e)	-	X
	Dionda episcopa (n)	X	-
	Gila pandora (n)	X	X
	Hybognathus amarus (n)	X	X
	Macrhybopsis aestivalis aestivalis (n)	X	-
	Notemigonus crysoleucas (e)	-	X
	Notropis jemezanus (n)	X	-
	Notropis orca (n)	X	-
	Notropis simus simus (n)	X	-
	Pimephales promelas (n)	X	X
	Pimephales vigilax (e)	-	X
	Platygobio gracilis (n)	X	X
	Rhinichthys cataractae (n)	X	X
ICTALURIDAE	*Ameiurus melas (e)*	-	X
	Ameiurus natalis (e)	-	X
	Ictalurus punctatus (e)	-	X
	Ictalurus furcatus (n)	X	X[1]
	Pylodictis olivaris (n)	X	X

[1] *I. furcatus* was last stocked in the Rio Grande Basin of New Mexico (Elephant Butte Reservoir) in 1977. Recent collections of the species in the basin could be attributed to this introduction.

LEPISOSTEIDAE	*Lepisosteus osseus (n)*	*X*	-
PERCICHTHYIDAE	*Morone chrysops (e)*	-	*X*
	Morone saxatilis (e)	-	*X*
PERCIDAE	*Perca flavescens (e)*	-	*X*
	Percina macrolepida (e)	-	*X*
	Stizostedion vitreum (e)	-	*X*
POECILIIDAE	*Gambusia affinis (n)*	*X*	*X*
	Poecilia latipinna (e)	-	*X*
SALMONIDAE	*Oncorhynchus mykiss (e)*	-	*X*
	Oncorhynchus ssp. X *clarki hybrid (e)*	-	*X*
	Oncorhynchus clarki virginalis (n)	*X*	-
	Salmo trutta (e)	-	*X*
SCIAENIDAE	*Aplodinotus grunniens (n)*	*X*	-
	Totals:	**27**	**40**

- The parenthetic "*e*" and "*n*" respectively refer to an exotic or native occurrence in the Rio Grande of New Mexico.

Arid southwest, areas prone to drying

San Acacia is a groundwater dam

Species' losses for a century

Need to survey specific species experts

Species feeding groups: successional progression down the basin, group by feeding group types; reproductive guilds:

Fish: RGSM (pelagic), smallmouth buffalo (psammophil), green sunfish (guardians, nest), flathead catfish (cavity), flathead chub (epilithyc)

Inverts: flies, clams

Algal: hugo's help

Birds: heron, swwfl, eagles, hawks, cranes

Mammals: beaver

Herps: spiny soft shell turtle, western garter, rg toad

- Survivorship vs. age class graphic - mike
- N t+1 = Nt + birth + immigration – death – emigration
- B + I – D – E = R = geometric growth rate

- **Water column depth requirements by age classes** (min/max/mean)
  - during river drying: bigger deeper pools, better for fish refugia

- channel characteristics for species diversity: multi-threaded, sediment size diversity and richness, higher width/depth ratio: wider than deeper better, dynamic/avulsive, GW/SW connection

- **Water chemistry requirements, temperature, other**
  - Need for suspended sediment; sediment occludes sight and effects feeding for different species
  - Natural conditions would stay in confines of temp; DO and sunrise/sunset; physiologic flexibility within limits
  - Stagnant pools will deteriorate and kill fish
  - Salinity tolerance
- **Water velocity requirements by age class** (min/max/mean)
  - Backwaters from overbank
  - Recruitment:
    - Recruitment level flows: early spring/summer spawning
    - RGSM adaptation: fish would move to margins to spawn; overbank flooding promotes retention of eggs and larvae; magnitude and duration both important; larval stage to swimmability needs 7 days; every 3rd year greater than 15 days desired
    - Today vs. yesterday: hydrologic records: rare 5-day overbanking; overbanking desired for > 10 days
    - Define overbanking in terms of historic floodplain; overbank habitat; differentiate between getting out of bank/active channel and into bars
    - Optimal system needs: 4000 cfs for spawning success; Platania states 85% correlation with successful spawning recruitment at 3000cfs for 7-10 days at alb gage
- **Substrate requirements**
- **Food resource requirements**
  - Energy inputs, carbon, connectivity needed, RGSM fish are adapted to avoid displacement and move to margins for spawning and emerge as a sack of bones and need to eat fast or die – best place is floodplain, newly flooded terrestrial vegetation; fish were found healthier here even though there is the risk of drying and death
- **Type(s) of habitat preferred and avoided (through the year, at what life stage, how)**
  - vote for habitat heterogeneity as very important, depends on time of year

- River drying: greater effect on older species, need to maintain parental stock; need minimal habitat to maintain an adequate parental stock to drive growth rate equation; need more source habitats than sink habitats; type 3 survivorship curve - mike
- Proportion of suitable habitats vs. # patches; random neutral habitat model; 0.2-0.4% fish species movement across habitats is favorable, less than 0.58% bad for species - mike

- **Types of disturbances to which the species is sensitive**
- **Possible predators or exotics utilizing the same habitat**

OTHER

- **Species Diversity**
  - species diversity vs. reproductive guilds; more steep curve = volume supports diversity; less steep = heterogeneity supports diversity – mike
- **How has management of the river affected these plants/species?**
  - River management has reduced birth (recruitment to adult stage), with overbanking comes better recruitment
- **What maintenance requirements**

Part II – Site Preparation & Maintenance

What site preparation would have occurred historically or be required in an altered system for establishment? Consider projected trajectories, succession, and sustainability of established aquatic species (including natural regeneration).

Maintenance via spring snowmelt pulses (April-June and outside that range with lesser frequency); species evolved NOT to extreme highs or lows but something in between; snowmelt driver is more managed now with dams; irrigation and spawning timing relationship. Importance of tributary input of sand/course substrate supplies and flows for species; epilithyc spawners need larger particle substrates. Historic deep pools were probably refugial habitats. Trajectory: we're going to lose imported water: agricultural to urban consumption; is the native supply sufficient to drive these things? What is our compatibility with other uses? Ie. Ag. Large bodied fish need more water.

What maintenance in an altered system might be required? Consider goal of different age classes, mosaic of habitat features, and other factors like occasional flooding, other.

Storage of spring runoff possibilities. Snowmelt pulse vs. perennial flows for spawning. Over-irrigation (ie. In the Isleta reach) results in bank storage that bleeds back to the river. Ensure that floodplains are connected to recessional flows and not isolated. Every 3 years a flow of 3000 cfs greater than 15 days in the spring = hypothesis, depends on species, incubation requirements. Temporary storage at Cochiti. Mimic a temp recessional limb with more pronounced peak. Refugial habitats will need maintenance; brown arroyo, other opportunities? Easier to keep river wet from San Acacia dam to north edge of Soccoro than Socorro down to south boundary of Bosque del Apache – losing reach and progressively aggrading, population dynamics sink, LFCC pumping. Idea: pump at Lemitar out of LFCC, could keep san acacia to Socorro (population source) and south boundary of Bosque del Apache south (pop source) wet; compromise, need July 1st date instead of June 15?. Not a lot of levee confinement on west side; area overbanks but if adjacent area is going to dry, fish will not survive without link back, rescue near impossible here. East side abandoned irrigation canal riffles water into eastern riparian area. Need to reconnect, gating canals? For managed floodplain, other species benefits, birds. Restorative connections also should be considered, need more information.

Part III – Prioritization of Questions/Hypotheses

- Use the results of Parts I and II to distinguish between current scientific information, accepted assumptions, and questions that haven't been addressed. Where is there no clear agreement on what is assumed? Are these questions or unknowns important enough to managing the ecosystem, the restoration community, water managers, or other stakeholders that a research project should be developed to attempt to get more information about a particular aspect of the system?
- Develop working hypotheses based on the above discussion.
- Begin to organize these questions in terms of priorities.

Our purpose, assumptions: viability = probability of extinction, acceptable loss of genetic variation per generation. Viability is influence by B, D, E, I – unknown = critical rates. Intervention Channel: we can manage flows, we can modify habitat, etc.

Vital Questions: How much habitat is needed to sustain a viable population? How many viable populations do you want? Where within San Acacia do you want viable populations?

Channel and habitat characteristics: patches: backwater pools, wide vs. narrow sections, woody debris

Assumption: channel characteristics and flow regimes needed for diverse aquatic community; what are the trends?

- Channel characteristics for species diversity: multi-threaded, sediment size diversity and richness, higher width/depth ratio: wider than deeper better, dynamic/avulsive, SW/GW connectivity, backwaters, woody debris, habitat patches
- Flows: what level of flooding is needed to create desired channel attributes? What is the return period needed to keep the river working? Uprooting has not been occurring with modern high flows. We know the flow velocities for moving substrates, riparian vegetation modifies this relationship.

Working Hypotheses Regarding Aquatic Species			
	Clear Agreement on What is Assumed? (Y/N)	Important enough to conduct research?	Priority (H,M, L)
Current Scientific Information			
1. Historic species communities, hydrographs			
2. Geomorphilogical characteristics			
3. flow vs. substrate relationships			
Accepted Assumptions			
1. Heterogeneity of habitats needed for diverse community: a. vote for habitat heterogeneity as very important, depends on time of year b. River drying: greater effect on older species, need to maintain parental stock; need minimal habitat to maintain an adequate parental stock to drive growth rate equation; need more source habitats than sink habitats; type 3 survivorship curve - mike c. Proportion of suitable habitats vs. # patches; random neutral habitat model; 0.2-0.4% fish species movement across habitats is favorable, less than 0.58% bad for species – mike d. species diversity vs. reproductive guilds; more steep curve = volume supports diversity; less steep = heterogeneity supports diversity – mike	Y		
2. Hydrograph variability through years provided heterogeneity a. spring snowmelt pulses (april-june and outside that range with lesser frequency); species evolved NOT to extreme highs or lows but something in between; snowmelt driver is more managed now with dams; irrigation and spawning timing relationship.	Y		
3. Variable system, species have resilience, benefits and costs involved with adaptations	Y		
4. We've lost species	Y		
5. We have enough organic supplies.	Y		
Questions that Have Not Yet Been Addressed			
2. What would a hydrograph range look like that provides desired heterogeneity requirements? a. channel characteristics for species diversity: multi-threaded, sediment size diversity and richness, higher width/depth ratio: wider than deeper		Y	1

better, dynamic/avulsive, SW/GW connectivity, backwaters, woody debris, habitat patches b. what level of flooding is needed to create desired channel attributes? What is the return period needed to keep the river working? Uprooting has not been occurring with modern high flows. We know the flow velocities for moving substrates, riparian vegetation modifies this relationship. 3. Modeling tools with multiple runs and assumptions.			
2. Is the diversion dam/altered flows affecting other fish species and other parts of food web?		Y	4
3. Is there an important water quality shift in the LFCC pumping and SW exchange?		Y	3
4. What is the optimal habitat size and spatial and temporal configuration of habitat that will maximize the incremental increase in growth rates of multiple species?		Y	2

Part IV - Opportunities for Monitoring and Testing Hypotheses

- **What is currently on the landscape in the San Acacia reach that supports the conditions your group determined as favorable for these communities and/or species?**
  Reach is unfragmented, most natural reach in NM, great opportunities for less constrained interventions (flooding), lower part of reach contains our desired characteristics for heterogeneity.

- **Is there monitoring or the opportunity to monitor existing examples where these communities and/or species occur to improve our information on them?**
  Look at historic information (BOR). Monitor channel characteristics in year to year variability (tied to flows) and key indicator species

- **At what locations are there opportunities to test hypotheses?**
  Historic information, modeling, synthesis of multidisciplinary information

  OTHER considerations?

  Check for undesired consequences
  Monitoring costs

WOODLAND & DENSE SHRUB Worksheet

Parts I and II - Table

Describe what is known and what is not known about the needs of the plant community/species on which your small group is focusing. What site preparation would have occurred historically or be required in an altered system for establishment? What maintenance in an altered system might be required?

Attribute	Cottonwood forest (includes tree willow)	Cottonwood forest (includes tree willow)	Willow shrub Include coyote willow and *Baccharis sp.*	Willow shrub Include coyote willow and *Baccharis*
	Establish	**Maintain**	**Establish**	**Maintain**
Surface h20	*Populus sp.* late May-early June; 5-30 days duration? Needs scouring floods or moist soils and Limb recession < 2-3 cm/day	Limb recession not important except for some wildlife like Southwestern willow flycatcher	Same as cottonwood forest except longer duration and slower limb recession; more frequent flooding; limb recession < 2 cm./day	Same except adapted to annual flooding
Seed dispersal	Late April – early May flowering and late May-early June seed dispersal; tree willow same but compressed seed phenology		Baccharis, mid-summer early Fall	
Disturbance	Scouring flows; open soils	Beaver good? High intensity and frequency of fire is negative	Beaver; scouring flows; mowing	Fire adapted; can tolerate flood disturbance and higher sediment inputs
Ground water	2-3 cm decline per day; *Populus sp.* 3-6 feet; *Salix sp.* 1-3 feet (assumed)	*Populus sp.* < 3m <2 m	Tied to limb recession 2-3 feet?	< 2 meters; baccharis may tolerate more xeric conditions
Soil texture/ salinity	*Populus sp.* – course to medium but can tolerate fines; salinities <4dsm; salix coarse to medium - saline intolerant	same	*Salix sp.* - coarse to medium, low salinity tolerance; baccharis tolerant of finer soils and high salinities; both shade intolerance	same

Wildlife assoc.	*Populus sp.* – canopy and subcanopy important to avifauna; herpitiles, beavers, porcupines, Rio Grande turkey, elk/deer; raptors; javelina; bear; bobcats, arthropods	Salix - WIFL	*Salix sp.* and *Baccharis sp.* – all groups of wildlife; *Salix sp.*: Southwestern willow flycatcher; Bell's vireo; riparian obligate shrub nesters *Baccharis sp.:* chats, blackbirds	
Proximity to channel	*Populus sp.:* establish away from bars and islands Salix: closer to channel	See groundwater requirements	*Salix sp.*: generally closer to rivers edge/bars *Baccharis sp.*?	Depends on groundwater availability
Mgmt. Effects	Have mature forest with little regeneration; non-native dominated understory; flooding limited due to reduced peak flows and armored banks	Altered flow regime; less dynamic; reduced recruitment; reduced spatial availability and extent; lowered groundwater table		Increased fire frequency (flood to fire) community conversions.

NOTES

Cottonwood – all stages of life cycle
Surface water – timing (late May to early June) and duration of peak flow, recessional limb (no more than 2-4 cm. per day)
Flowering in late April – coincides with Spring migration
Need seed viability and dispersal info. Data gaps

Disturbance – scouring floods; intolerant of high frequency and high intensity fires
Groundwater – mature up to 3 meters; saplings 3-5 feet depends on size and soil texture and chemistry (data gap? or site specific)

Soil texture/salinity – less than 4 deciSeimens/meter (dsm), sandy loam may be able to handle more of a range of soils, well-drained

Need open canopy, wetted soils

Wildlife category, young cottonwood – sub canopy nesters (i.e. yellow-billed cuckoo)

Mature cottonwood: summer tanagers, beavers are both young and mature cottonwood, porcupines, Rio Grande turkey, elk/deer; raptors; javelina; bear; bobcats

Arthropods: young and mature communities

Leaf fall important for nutrient cycling

Tree willow – intolerant of salinity

Avifauna rely more heavily on subcanopy and canopy elements of C-W forest

DATA Gaps

Timing of willow generation; seed dispersal and flowering

Conditions required for establishment and maintenance of *Baccharis salicina*

Timing and duration of flooding to maintain cottonwood communities

Frequency of flooding to reduce salinities for maintenance of communities

Effects of fire intensity on C-W communities; fire as a successional/regenerative force

Herptile use of cottonwood and willow communities?

Minimum patch size for wildlife species

Pollinators for plant communities

Assumptions

Cottonwood willow– seed viability is 5-30 days

Salix is same time frame shorter duration seed dispersal/viability

Need to have male and female species

Salix 1-3 feet groundwater needed for establishment, tied to groundwater recession in first year

Tree willow need coarse to medium soils; CW can tolerate finer soils

Timing of flooding for WIFL is important

Coyote willow needs more flooding disturbance or herbivory, more tolerant of sediment deposition

Part III – Prioritization of Questions/Hypotheses

- Use the results of Parts I and II to distinguish between current scientific information, accepted assumptions, and questions that haven't been addressed. Where is there no clear agreement on what is assumed? Are these questions or unknowns important enough to managing the ecosystem, the restoration community, water managers, or other stakeholders that a research project should be developed to attempt to get more information about a particular aspect of the system?
- Develop working hypotheses based on the above discussion.
- Begin to organize these questions in terms of priorities.

Assumptions:

1. Non-natives species will not be removed by natural flows alone
2. Higher groundwater tables will favor native vegetation over non-native (test)
3. Non-natives will remain a non-dominant part of the ecosystem
4. Spring flooding and hydraulic connection (groundwater-surface water connection) is necessary for regeneration: test for timing and frequency, duration, rate of descending limb
5. Soil disturbance in the absence of inundation at the appropriate time, leads to exotic species colonization and domination.
6. Intact native communities are more resistant to fire and non-native species colonization (test)

Working Hypotheses Regarding Plant Community/Species			
	Clear Agreement on What is Assumed? (Y/N)	Important enough to conduct research?	Priority (H,M, L)
Current Scientific Information			
Flood return intervals and groundwater tables at a macro-scale are known.			
Flood duration and frequency are known (see maps)			
Accepted Assumptions			
Maintaining the hydrologic connectivity of the river to the floodplain is important to maintain the dominance and health of native communities			
Existing non-natives species will not be removed by natural processes alone.			
Non-natives will remain a non-dominant part of the ecosystem.			
Spring flooding and hydraulic connection (groundwater-surface water connection) is necessary			

for regeneration: test for timing and frequency, duration, rate of descending limb.			
Soil disturbance in the absence of inundation, at the appropriate time, leads to exotic species colonization (in a community dominated by exotics).			
Questions that Have Not Yet Been Addressed			
Higher groundwater tables will favor native vegetation over non-native			
Intact native communities are more resistant to fire and non-native species colonization (test)			
How do we maintain the hydrologic connectivity required to support recruitment, regeneration and sustainability for cottonwood and coyote willow?			H
Site specific groundwater and flood information			
What frequency and duration of river flows are required to maintain groundwater levels that support native plant communities in the woodland and dense shrub?			

Hypotheses:

1. There has to be hydrograph peak in late May to mid-June, and a descending limb of the hydrograph that results in a decline in the groundwater depths of 2-4 cm per day through the growing season to result in successful recruitment of cottonwood and willow seedlings.

2. If an area overbank floods at a reasonable discharge and has a relatively high groundwater elevation, the site may be modified to maintain a site locally to establish and sustain cottonwood and willow communities.

3. The existing hydrology may be modified to maintain a site locally to establish and sustain cottonwood and willow communities.

Part IV - Opportunities for Monitoring and Testing Hypotheses

- What is currently on the landscape in the San Acacia reach that supports the conditions your group determined as favorable for these communities and/or species?

Groundwater

- Is there monitoring or the opportunity to monitor existing examples where these communities and/or species occur to improve our information on them?

- At what locations are there opportunities to test hypotheses?

MARSH Worksheet

Marsh: cattails, bulrush, sedges, spikerush, potamegetten/pond weed, submergents, milafoil, beaver, Mexican jumping mouse (edge), leopard frog, woodhouse toads, spadefoot toad, redwing & yellow wing blackbirds, water fowl, wading birds, dragon/damsel flies, rails, macroinvertebrate, chironomids, midges, emergent flying insects, mosquitos, raptors, migrating birds, bald eagles, predatory birds, snails, isopods, fish(periodically), tiger salamander, muskrats, turtles

Part I – Plant Community/Species Needs. Please answer all applicable questions.

Describe what is known and what is not known about the following needs of the plant community/species on which your small group is focusing:

For plants:

- **Minimum and maximum groundwater depths required for these species**

See

Cattails/Bulrush = 3 ft of Surface water to -1.5 ft GW

Sedges=2 ft to – 2 ft

Spikerushes = +1 to -1 (indicator of transition)

Submergents = +1 to +3

Depth/Height to Water (vertical axis >-2 to +3 ft, 0 = ground surface) vs. Plant Species (horiz axis) Drawing

- **Location where the species usually occurs on the floodplain, describe landforms**

Marshes may be perennial, may be ephemeral

In-channel – inundated by run-off

Overbank area – inundated by river flows & ground water (tied to surface water level)

Sustained by groundwater or Low Flow Conveyance Channel (LFCC)

Perched – Oxbows/abandoned channels, silt & clay lens,

Topographic low areas

- **Expected salinity tolerance (for plants) (low/moderate/high)**

Not a Limiting factor

Not salt tolerant (based on plant type)

- **Typical soil texture, soil chemistry and other descriptors typical of plant locations**

Defined in terms of electrical conductivity, mineral or organic, oxic/anoxic, fine texture

How long can plant communities/insects/macroinvertebrates tolerate high pHs (such as 9 to 10)? May affect metals, speciation and toxicity.

- **Disturbance required or sensitivities**

Water extremes, overbanking, drought, floods that deposit sediment/nutrients, drops in water table from any cause, breaking of lens seal for perched marshes (tree roots/dredging), head cuts, temp channel dredging, ground water draw down,

- **Regeneration requirements**

Flooding for germination, satisfactory water regime, inundation (cattails may survive with 1 week per year for several years), permanent or seasonal or temporary flooding (NWI terminology), anecdotal - spikerush is spread by water fowl, cattails spread by wind, grazing/fire/scouring/other disturbance events needed for regeneration, submergents may not need a disturbance – or may need a period of drying,

Question: how often do marshes need to burn or be disturbed so vegetation doesn't get too thick/reset succession?

- **OTHER**

Highest abundance & richness of plants and birds of any other woody/riparian community

For terrestrial species:

- **Food source requirements**

Birds depend on the insects/macroinvertebrates.

Part IA – What are the functions provided by this plant community?

Nursery habitat for critters/aquatic/amphibians, nutrient cycling, transient flood storage, fire buffer, ground water discharge, bank storage, VERY IMPORTANT migratory habitat, pollutant filter/sink (heavy metals), seed bank, sediment filter/trap, exports detritus to terrestrial food chain, primary productivity, carbon sequestration & export (global warming), major recreational income (hunting, birding, tourists), food chain support (amphibians, birds, mammals eat the insects),

Part II – Site Preparation & Maintenance

What site preparation would have occurred historically or be required in an altered system for establishment? Consider projected trajectories, succession, and sustainability of established plants (including natural regeneration).

Amount of water/inundation may be more important than substrate type

Changes in substrate affect succession, may be important to have enough clay to hold water,

Look at topographic low areas for development (in channel or groundwater connectedness for long-term support)

What maintenance in an altered system might be required? Consider goal of different age classes, mosaic of habitat features, and other factors like occasional flooding, other.

Recreate scouring to remove fines blocking growth of vegetation – see regeneration discussion

Cattail Marsh may exist for 25 years and then need to be regenerated

Part III – Prioritization of Questions/Hypotheses

Working Hypotheses Regarding Plant Community/Species			
	Clear Agreement on What is Assumed? (Y/N)	Important enough to conduct research?	Priority (H,M, L)
Current Scientific Information			
Inventory of wetland areas – 2002 NWI, 2002 URGWOPS, 2005 plant maps on Refuges,			
Fairly good species (birds & plants) inventories			
Good groundwater models			
Accepted Assumptions			
Selenium not an issue.			
Ground water fed marshes will decrease in species richness faster than an in-channel marsh	N		
Groundwater fed marshes age differently than in-channel marshes			
Flows need to be more than 10,000 cfs to tear out vegetation			
Need to have flows high enough for channel avulsion to create new marshes			
To sustain these types of habitats on the landscape we need dynamic geomorphology, scouring flows or channel avulsion	N		
We need to maintain a minimum amount of each of the 3 types of marsh to support wildlife in the San Acacia reach.			
Marshes will not remain in a permanent location but will move in response to channel dynamics and flows	Y		
Marshes are the rarest and most valuable type of habitat in the San Acacia reach.			
We need to increase the amount of marsh habitat in the San Acacia reach.			
Man-made disturbances are needed to create and maintain marsh habitat (excavators, irrigation, seeding, plowing, burning, mowing) because episodic flood events are not likely to occur.			
Questions that Have Not Yet Been Addressed			
At what point does water/soil chemistry become a limiting factor to marsh species (plant & animal & macroinvertebrates) and habitat?	N		L
Is pH a limiting factor for abundance & species richness? (macroinvertebrates) May affect metals, speciation and toxicity.		?	L
Are mercury & arsenic levels an issue?			L
What are the key chemical elements that create issues?			L
How does sediment deposition affect marsh longevity?		Y	M/H

Not sure if small mammal inventories exist.		Exists	
Soil characteristics not mapped – how do they affect?		Y	M
How often do marshes need to be disturbed to reset succession? (temporal disturbance regimes required to reset the 3 different marsh types?)		Y	H
What are the factors affecting the longevity of 3 different types marshes?		Y	H
What are the successional communities of macroinvertebrates over the lifetime of a marsh? What are the disturbance regimes needed to maintain a suitable plant community to support species richness/primary production/benthic productivity/macroinvertebrates? What's the food base? How does it change over time?		Y	M
Off channel marshes: What are the differences in plant succession/longevity in relation to distance from river?			
What do spring runoff flows need to be in order to create the marshes? (see rewording below re: flow regimes)			H
What is the life expectancy for a groundwater fed marsh? What are the key factors that determine the longevity of a groundwater marsh?			M/H
What are the factors that lead to senescence (decrease in species richness)?		Y	
What are the river flows needed to maintain the water regime for the 2 types of marshes influenced by surface water?		Y	H
What episodic flows are required (in terms of volume, frequency & duration), to initiate the different dynamic natural processes such as overbanking, scouring, channel avulsions, to create new marshes?			H
What are the flow requirements to maintain current marsh attributes in terms of the different dynamic natural processes such as overbanking, dynamic in-channel geomorphology, bank-full flows, groundwater levels? What frequency and duration is needed?		Y	H
What is the relative value of each marsh type?	N		
Where should habitat restoration efforts be focused?			

Hypotheses:

1. Marsh Creation: A 10-year flow event (10,000 cfs that scours) is needed to naturally create all three types of marshes.
2. Marsh Maintenance: To maintain plant productivity water levels must fluctuate a minimum of 3 feet annually within a 3 year period.
3. Marsh Longevity: Over time marsh species richness and productivity will decrease.
4. Marsh Longevity: Groundwater-fed marshes have a lifespan of 20 years.

FLOODPLAIN EDGE Worksheet

Part I – Plant Community/Species Needs. Please answer all applicable questions.

Describe what is known and what is not known about the following needs of the plant community/species on which your small group is focusing:

For plants:

Floodplain edge: anything above the high water line (100yr level, upland interface, xeric)

- *Sacaton*
- *4 wing saltbush*
- *honey mesquite***
- *sages***
- *mallows*
- *salt cedar*
- *wolfberry*
- *creosote***
- *cacti*
- *yuccas*
- *cholla*
- *gramas*
- *dropseeds/gramas***
- *juniper*
- *desert willow*

- **Minimum and maximum groundwater depths required for this species**
  - All xeric, linked to rain rather than g/w
  - Mesquite, desert willow: some g/w connection [exact levels unknown, maybe 10-15ft]
- **Location where the species usually occurs on the floodplain, describe landforms**
  - 2nd and 3rd terrace, alluvial fans, dropseeds can occur further up
  - sand tolerant species (sages and dropseeds)
- **Expected salinity tolerance (for plants) (low/moderate/high)**
  - Moderate for most [exact tolerance unknown]
  - Soils different on each side of floodplain

- W side gravelly and coarse, E side is wind driven
- Salinity of g/w??

- **Typical soil texture, soil chemistry and other descriptors typical of plant locations**
  - Sandy, porous, coarse grained
  - Finer as transitions to floodplain, extreme local variability (old channels)
  - Saline (sodium, calcium)
  - Mycorhizal fungi
- **Disturbance required or sensitivities**
  - Draught and wind (seed dispersal) benefit these species
  - Fire (good for grasses, infrequent, short duration)
  - Grazing (natural good, short duration properly timed good, heavy livestock grazing bad)
  - Flash flooding (periodic disturbance that may be good for establishing grasses, willows)
- **Regeneration requirements**
  - Wind and rain
  - Rodents & burrows
  - Micorhyzal innoculum
  - Adjust density of mesquite so it does not dominate (create mosaic)
  - Disturbance can negatively impact restoration (look @ 10 yr project)
- **OTHER**
  - Difficult community to regenerate
  - Least disturbed of riparian area
  - Can't ignore regeneration because serves as seed source for lower areas

For terrestrial species:

- *Collard lizards***
- *Horned toads*
- *Rattlesnakes***
- *Burrowing Owl***
- *Prairie dogs*
- *Kangaroo rats*
- *Spineys*

- *Warblers*
- *Crisal Thrasher***
- *Orioles*
- *Road runners***
- *Quail***
- *Deer*
- *Jumping mouse*
- *Bats*

- **Nesting structure requirements**
    - Holes in ground
    - Mesquite (salt cedar)
    - Dense grasses, sage (quail)
- **Food source requirements**
    - Seeds, insects, lizards, baby quail
- **Types of habitat avoided**
    - roads
    - heavily forested areas
- **Time of year the species is utilizing habitat and how**
    - Burrowing owl, thrasher here April to October for breeding/nesting
    - Lizards are local migrants, use for forage
- **Types of disturbances to which the species is sensitive (other questions related to birds?)**
    - Human disturbances
    - Grazing
- **Possible predators or exotics utilizing the same habitat**
    - Changed density of higher predators like wolves
    - Coyote density increased
    - Bobcats
    - Aerial predators
    - Oryx
    - Russian thistle, Canada thistle, camelthorn

- Collard doves

- **OTHER**

For all:

- **How has management of the river affected these plants/species?**
  - Promoted tamarisk
  - Incision dropping water table
  - Terraces getting higher and drier
  - Mesquite and willows moving down as g/w drops
  - Changed predator/prey relationships
- **What maintenance requirements**
  - Mechanical/chemical removal of exotics
  - Compact/water rights issues for maintaining connectivity and g/w
  - $$
  - socioeconomic values
  - land ownership
  - monitoring
  -

Part II – Site Preparation & Maintenance

What site preparation would have occurred historically or be required in an altered system for establishment? Consider projected trajectories, succession, sustainability of established plants (including natural regeneration).
Draught followed by winds followed by arroyo flows
Trajectories, succession more tied to catastrophic change (washouts)
Edge communities more sustainable temporally that other riparian areas
Less large scale restoration than lower areas
Pepperweed, knapweed management in arroyos, alluvial fan

What maintenance in an altered system might be required? Consider goal of different age classes, mosaic of habitat features, and other factors like occasional flooding, other.
Control invasive species
Monitor results
Mosaic of mesquite and grasses, no thatchy grasses or mesquite dominated
Different canopy layers (although much lower than in other areas)

NOTE: Conceptual ecological model should add floodplain edge specific drivers stressors and effects
QUESTION: How far into the uplands do we want to look?

Part III – Prioritization of Questions/Hypotheses

- Use the results of Parts I and II to distinguish between current scientific information, accepted assumptions, and questions that haven't been addressed. Where is there no clear agreement on what is assumed? Are these questions or unknowns important enough to managing the ecosystem, the restoration community, water managers, or other stakeholders that a research project should be developed to attempt to get more information about a particular aspect of the system?
- Develop working hypotheses based on the above discussion.
- Begin to organize these questions in terms of priorities.

Arch Sites??? Need to id where they are to see if they would impact any management

Define and characterize the area: what is considered floodplain, what is considered 'floodplain edge' What is the boundary?

Need baseline data for physical characteristics of the area (g/w, salinity, soil classification)

Need biological data for plant and animal species that populate the area

Responses to stressors, disturbances.

WHAT WE DO HAVE:

-BOR has geomorphology mapped

WHAT DO WE NEED:

- Locations of Arch sites
- Map and definition of our area
- Biological data on plant species
  - Germination
  - Relationship to g/w
  - Response to stressors like fire, grazing
- Biological data on animal species
  - Preferred habitats, food sources
  -
- Physical characteristics data
  - Soil salinity
  - Soil types
  - Depth to groundwater & fluctuation

Vision for the Floodplain Edge: mosaic of mesquite/grassland-sage

Questions:

- How do we define the floodplain edge? By referencing human-made or natural boundaries? Some options:

    - By depth to groundwater
    - By age - $2^{nd}/3^{rd}$ terrace
    - By the 100 year flood line
    - By the levee road
- How, if at all, does the floodplain edge interact with the floodplain/action channel?
    - Is there hydrologic connectivity?
    - Via arroyos if they make it to the river?
    - Is there a groundwater connection? If so, how does it affect vegetation?
- How do age classes of terraces affect present vegetation?
- What is the relationship between variation in height of age classes of terraces and vegetation?

Working Hypotheses:

- Removal of exotic plants will result in the natural re-establishment of native plant communities (e.g. local ecotypes grown in local soil and water conditions). Test removal methods and conditions, and identify where different methods would work.
- Optimal re-establishment of natives requires:
    - X Depth to water and X recession rate
    - Precipitation
    - Flooding
    - (Wind) seed dispersal and presence of pollinators
    - Defer/manage grazing
    - Infrequent fire
    - Removal of exotic plants