Revised Navajo Dam operating procedures for the 1999 San Juan River Flow Recommendations

Draft

22 March 2018

The San Juan River Basin Recovery Implementation Program
2105 Osuna Rd NE
Albuquerque, NM, 87113

Table of Contents

Acronyms and Abbreviations List 4

Executive Summary 5

Introduction 8

Summary of meetings 11

Flow Workshop I 11

Objectives and Desired Outcomes of Workshop I 12

Planning Meeting 16

Objectives and Desired Outcomes of Planning Meeting 16

Flow Workshop II 20

Objectives and desired outcomes of Flow Workshop II 21

Modification of available water calculation and End of Water Year Storage Targets 24

Modification of Navajo Dam Operation Decision Tree 26

Analysis of 2017 Navajo Dam Operation Decision Tree 27

Conclusion 29

Box 1. *Primary and secondary flow targets from the 1999 Flow Recommendations* 31

Box 2. *Annual procedures for implementing releases from Navajo Dam* 34

Box 3. *Description of 2017 operation decision tree for Navajo Dam* 35

Tables 36

Table 1. Summary of San Juan River flows between 1998 and 2015 36

Table 2. Modeled results (Navajo Dam Operations Model) of variable End of Water Year Storage Targets 37

Table 3. Annual mean (Mean), minimum (Min), and maximum (Max) modeled depletions .. 38

Figures 39

Figure 1. Navajo Dam operation decision tree from the 1999 Flow Recommendations (Holden et al. 1999). Letters in each node were added to the original figure for reference. 39

Figure 2. Total annual San Juan River runoff (gray bars) and five year moving average (red line) of total annual runoff (million af) of the San Juan River at Bluff, UT (USGS gage 09379500) between 1929 and 2015. 40

Figure 3. First proposed revision to the Navajo Dam operation rule decision tree by Brian Westfall (BIA) and Susan Behery (BOR; BOR Tree). Major changes included removal of "look-backs"..... 41

Figure 4. The four types of hydrographs developed for spring releases for Navajo Dam from the 1999 Flow Recommendations (Holden et al. 1999)...... 42

Figure 5. Second proposed revision to the Navajo Dam operation rule decision tree by Susan Behery (BOR) and the PO (referred to as Flex Tree)...... 43

Figure 6. 2017 Navajo Dam operation decision tree for the San Juan River. See Box 3 for further details...... 44

Figure 7. Modeled results of primary flow targets comparing the frequency and duration of San Juan River flows using the original 1999 decision tree and the 2017 decision tree between 1929 and 2013. The open symbols denote flow variability at each target level using the original 1999 decision tree. Filled symbols are the respective flow targets from the 1999 Flow Recommendations. The vertical bars denote the change in flow variability using the 2017 tree (black bars denote increases in frequency and gray bars denote decreases in frequency)...... 45

Figure 8. Modeling predictions of secondary flow targets for the four high flow metrics using the 1999 and 2017 decision trees compared to the 1999 flow recommendation targets. 46

Literature Cited 47

Comments and responses to first draft..... 48

Acronyms and Abbreviations List

af	Acre-Feet
AW	Available Water
AWC	Available Water Calculation
BC	Biology Committee
BIA	US Bureau of Indian Affairs
BOR	US Bureau of Reclamation
CC	Coordination Committee
cfs	Cubic Feet per Second
ESA	Endangered Species Act
EWYST	End of Water Year Storage Target
ft	Feet
NIIP	Navajo Indian Irrigation Project
PO	Program Office
ROD	Record of Decision
Service	US Fish and Wildlife Service
SJRIP	San Juan River Basin Recovery Implementation Program
USFWS	US Fish and Wildlife Service

Executive Summary

In 2014, the Bureau of Reclamation (BOR) proposed a modification of the available water calculation for determining flow releases on the San Juan River to the San Juan River Basin Recovery Implementation Program (SJRIP). Following, the SJRIP participants and Program Staff reviewed the 1999 Flow Recommendations and revised Navajo Dam operations for the San Juan River. The higher flow targets from the flow recommendations have been difficult to attain and the risk of shortage sharing has increased due to recent lower than average hydrology in the San Juan River Basin. Three meetings of SJRIP participants were held to review the 1999 Flow Recommendations, review new data on effects of flows on habitats and fishes, assess the observed flows since implementation of the flow recommendations and evaluate a new approach to Navajo Dam operations. The SJRIP participants concluded that 1) it is currently difficult to evaluate the effects of the high-flow targets because those targets were infrequently attained, but the flow targets from the 1999 Flow Recommendations should not be altered, and 2) short-duration high flow releases as prescribed by the 1999 Navajo Dam operation decision tree do not demonstrate benefits to habitat for native fishes in the absence of higher discharges.

The SJRIP participants decided to alter how available water for instream flow augmentation will be calculated and to modify the Navajo Dam operation 1999 decision tree to increase the probability of reaching the higher flow targets while keeping the probability of potential shortage sharing low. Available water will be recalculated with two End of Water Year Storage Targets (EWYST) for the reservoir (one if a spring release occurs, another one if not). The Navajo Dam operation 1999 decision tree has also been modified to omit spring releases of 5,000 cfs with durations less than 21 days to provide for longer duration releases in the future.

Additionally, the recommended ramp-up duration to the maximum release discharge (i.e., 5,000 cfs) decreased to three days and the ramp-down duration increased to 14 days.

The effects of these changes to the operational releases from Navajo Dam on the San Juan River's hydrology were evaluated with the Gen4 Hydrology Model (*documentation in preparation; Susan Behery Per. Comm.*) using current levels of water depletions. Modeling results comparing the final modified decision tree (hereafter referred to as the 2017 decision tree), including the new way to calculate "available water" and 1999 decision tree indicated that utilizing the 2017 decision tree would increase the annual probability of reaching the two highest primary flow targets (i.e., 10,000 and 8,000 cfs) by 3 and 7%, respectively. The ability to meet each of the associated secondary targets (i.e, the secondary targets of a maximum of 10 years between meeting 10,000 cfs target and 6 years between meeting 8,000 cfs target) would also be increased. It was also apparent that releases from Navajo dam would need to match peak runoff from the Animas River in order reach these higher flow targets. Finally, the modeled modifications to the Navajo Dam operating procedures negligibly affected the likelihood of shortage sharing over the modeled period of record (i.e., from 0 to 1 year out of 84 years in the model, or 1.2%).

Because only current depletions were considered in modeled scenarios here, any current or future projects that increase depletions from current levels will likely impact the ability of these modified Navajo Dam Operations to both meet the 1999 Flow Recommendations as well as provide continued low probabilities of shortage sharing. Therefore, the 1999 Flow Recommendations, and the 2017 decision tree developed here, should both be revisited through adaptive management strategies if new information emerges that substantially alters our

understanding of the effects of the San Juan River's flow regime on endangered fishes or if new substantial depletions occur in the future.

Introduction

This document summarizes the process the San Juan River Basin Recovery Implementation Program (SJRIP) used to modify Navajo Dam operating procedures to better attain targets from the 1999 Flow Recommendations (Holden et al. 1999) to aid the recovery of endangered Colorado Pikeminnow (*Ptychocheilus lucius*) and Razorback Sucker (*Xyrauchen texanus*). The 1999 Flow Recommendations were developed from research assessing the responses of fish populations and habitat on variable hydrographs from Navajo Dam in the San Juan River between 1991 and 1997 (Holden et al. 1999). This research quantified relationships among river discharge, geomorphology, fish habitat, and habitat availability and was used as the foundation for recommending base flows, primary and secondary flow targets, and perturbation releases. Recognizing a need for a hydrologic modeling tool to help analyze flow conditions, a general hydrologic Riverware model was then built that simulated water flow in the San Juan River Basin over space and time by incorporating known past, present, and future water development projects (Gen1 Hydrology Model; Holden et al. 1999). This model was used to simulate flows between 1929 and 1993 and the flow targets were developed to aid endangered fish recovery by mimicking a natural hydrograph based on statistical variability of the pre-dam hydrograph from this 65-year period of record.

The flow targets were designed to provide what the researchers thought would be advantageous conditions for native fishes by developing and maintaining habitats via environmental flows (see Box 1 with updated hypotheses for effects of flows on fishes and habitat). The specific flow target metrics were listed in terms of flow magnitude, duration, and frequency mostly during the spring runoff period (March 1 to July 31). Both primary and secondary targets were included as recommendations where primary targets were a specified

flow rate (e.g., 8,000 cfs) of a minimum duration (e.g., 10 days) with a specific annual frequency (e.g., 33% of years) and the secondary targets were a maximum duration between occurrences (e.g., not to exceed 6 years without reaching 97% of the target flow). To reach these targets while continuing with water development, an operating rule decision tree was developed and followed for Navajo Dam (Figure 1) with the understanding that the flow targets would likely be met if the San Juan River Basin experienced the same statistical hydrology as it did for the modeled period of record. Whereas the 1999 Flow Recommendations served to guide releases from Navajo Dam, these recommendations were designed to be adaptive as new information about maximizing the benefits of environmental flows for native fishes emerges.

Between 1998 and 2015 Navajo Dam was operated following the decision tree as outlined in the 1999 Flow Recommendations (i.e., the 1999 decision tree). However, due to lower than average hydrology in the San Juan River Basin the amount of annual available water for environmental flows since 1999 was lower compared to earlier time periods (Figure 2). These successive years with drier than average annual hydrology reduced the ability of releases from Navajo Dam to meet the higher discharge primary and secondary flow targets (Table 1). Concurrently, desirable habitat characteristics (e.g., area of backwaters and secondary channels) have decreased over time, likely due to the lack of large spring runoffs in recent years (Lamarra and Lamarra 2016). This general deterioration of desirable habitats is likely attributable to the apparent change in hydrologic conditions and associated Navajo Dam operation experienced during the last 15 years in the San Juan River Basin and the increasing impact of nonnative vegetation that tends to stabilize river banks and reduces habitat complexity. Moreover, because the operation of Navajo Dam based on the 1999 decision tree assumed hydrologic conditions would be similar to the period of record examined, the 1999 decision tree prescribed short

duration spring peak releases in years with below average snow pack. These short duration releases resulting in moderately high flows (i.e., 5,000 cfs) were subsequently determined to not elicit the predicted positive responses in habitats without accompanying higher flows (i.e., ≥ 8,000 cfs; Miller 2006). Without concurrent benefits to habitats, these short duration releases also impeded the ability to recover storage in the reservoir, which further decreased availability of water for longer duration spring releases in the future, other releases to benefit endangered fish (e.g., elevated base flows), and increased the risk of water shortage.

The 1999 decision tree precluded back-to-back large spring releases, even when water was available to do so, further limiting the SJRIP's ability to reach the higher flow targets. In 2014, the Bureau of Reclamation (BOR) proposed a modification of the available water calculation for determining flow releases on the San Juan River to the SJRIP (Appendix I). The SJRIP determined that the flow recommendations, decision tree, and Navajo Dam operations should be revisited and revised as necessary to increase the effectiveness of Navajo Dam releases in aiding the recovery of the endangered fishes while continuing to provide for water development in the San Juan River Basin.

This document provides a description of the decisions made by the SJRIP to manage environmental flows in the San Juan River considering the observed flows in the river over the last 15 years. Overall, the SJRIP determined there was not enough information to evaluate and revise the 1999 Flow Recommendation's flow targets, but Navajo Dam operations should be altered to better meet these targets during periods of drought. Two key components of Navajo Dam operations have been modified to increase the probability of reaching desired flow targets as outlined in the 1999 Flow Recommendations and keeping the probability of water shortage sharing low. These two changes detailed in the 2017 decision tree and summarized here, are: 1) a

new method for calculating available water with increased reservoir storage targets, which interacts with 2) modification of the operating rules (2017 decision tree) for releases from Navajo Dam. Additionally, the hypothesized effects of the 1999 Flow Recommendations flow targets were updated to reflect newly acquired information and unresolved questions.

This document includes: 1) brief summaries of the three meetings held by SJRIP participants to discuss potential changes to the 1999 Flow Recommendations, 2) a detailed description of the new process for determining available water, 3) presentation of the process for altering and arriving at the Navajo Dam operation 2017 decision tree, and 4) assessment of the proposed changes to the calculation of available water and the 2017 decision tree.

Summary of meetings

Three separate meetings of some SJRIP participants were conducted to evaluate the 1999 Flow Recommendations, the observed flows in the San Juan River following those recommendations, Navajo Dam operating procedures, and to make recommendations as necessary. These meetings took the forms of a preliminary workshop (Flow Workshop I), followed by a smaller planning meeting (Planning Meeting), and concluded with a final workshop (Flow Workshop II). These summaries below describe the major objectives, desired outcomes, and final decisions of each meeting. Further details, including attendees, of each meeting are available as executive summaries and meeting notes in Appendices II-IV.

Flow Workshop I

The first environmental flow workshop (Flow Workshop I) was held February 12-13th, 2015 in Albuquerque, NM, with the goal of making a decision as to the incorporation of BOR's proposal to modify the available water calculation (Appendix I) and initiate a process to review and increase the effectiveness of implementing the Program's 1999 Flow Recommendations

while continuing to reduce the risk of water shortages in the San Juan River Basin (full meeting notes are available in Appendix II). Additionally, until any new processes were developed, an interim recommendation for environmental releases in 2015 was developed. Forty-eight people representing the 12 SJRIP partners and other interested parties were in attendance.

Objectives and Desired Outcomes of Workshop I

<u>Objectives:</u>

1) Review and evaluate current Navajo Reservoir and Dam operation procedures, including methodology for calculating available water, operation decision tree, and how different target reservoir elevations could affect operations
2) Recommend the most appropriate available water calculation (for determining end-of-year target reservoir elevation) to best meet SJRIP goals and reduce risk of shortage in the San Juan River Basin
3) Recommend a process for determining environmental releases from Navajo Dam in 2015
4) Develop a conceptual framework to be applied in Flow Workshop II for evaluating and modifying the 1999 San Juan River Flow Recommendations, as needed, to best meet the SJRIP goals including development of an effective monitoring strategy to measure key uncertainties that are outlined in SJRIP's Long Range Plan

<u>Desired Outcomes:</u>

1) Decision on available water calculation for 2015 for incorporation into flow recommendations
2) Recommendations for changes to current procedures and methodology for planning and managing 2015 reservoir environmental releases including the process to be followed by

the Biology Committee (BC), Coordination Committee (CC), BOR, and the US Fish and Wildlife Service (USFWS) in 2015

3) Recommendation on a conceptual framework/outline for conducting Flow Workshop II to evaluate and modify the 1999 San Juan River Flow Recommendations to best meet SJRIP recovery goals

During the workshop several presentations were given that provided participants with relevant background information including: 1) Review of 1999 Flow Recommendations and reservoir operating procedures (Ron Bliesner; Keller-Bliesner Engineering); 2) Bureau of Reclamation's operational limitations for implementing the 1999 decision tree; 3) Hydrology modeling analysis of Navajo Dam operations; 4) Overview and update of San Juan River Hydrology Model Gen3 (presentations 2-4 by Susan Behery; BOR); and 5) Environmental releases experiment being conducted by the Upper Colorado Endangered Fish Recovery Program at Flaming Gorge Dam (Beverly Heffernan; BOR).

The focus of the workshop was discussing how to attain the higher flow targets (i.e., 8,000 and 10,000 cfs) with desired durations from the 1999 Flow Recommendations and maintaining target base flows while keeping the potential risk of shortage sharing low. The 1999 operations decision tree used to implement the 1999 Flow Recommendations resulted in frequent low-magnitude and low-duration (i.e., 2,500 and 5,000 cfs, ~1-week) spring releases and few years when releases matched the Animas River's spring peak (i.e., releases from Navajo coinciding with peak Animas River flows to elevate flows downstream). Additionally, Miller (2006) found that when the low-magnitude targets occurred, they did not appear to maintain habitat as expected in the absence of the higher targets. These operations combined with the recent hydrologic regime have prevented the recovery of Navajo Reservoir water storage which

threatens the ability of the reservoir to make subsequent long-duration spring peak releases and maintain late summer base flows. While to date water users in the San Juan River Basin have never had to implement shortage sharing agreements that would have limited their water supplies, lower reservoir elevations could increase the risk of shortage sharing. With improved science, data collection, and changing hydrology, it was widely recognized that the 1999 Flow Recommendations needed to be revisited and perhaps revised to better achieve the desired flow targets while continuing to consistently provide water to users.

Agreement was reached during the workshop to pursue a different method for calculating available water for environmental releases using an End of Water Year Storage Target (EWYST; see ***Modification of available water calculation and End of Water Year Storage Target*** below). The SJRIP participants agreed on two factors related to the available water calculation: 1) an EWYST elevation of 6,063 ft above sea level should be implemented with the option to drop to 6,050 ft for environmental flows; and 2) the shape, timing, and duration of the spring peak release hydrograph should be reviewed and possibly revised to meet SJRIP's goals. In addition, environmental release decisions need to include monitoring to measure responses of fishes and habitats to flows. In support of the recommended process for 2015, the USFWS specified that as long as the environmental flow release recommendations come from the SJRIP through the BC, they will be considered the best science available for progress toward recovery of the listed species and deemed to be in compliance with the 2006 Record of Decision (ROD; U.S. Bureau of Reclamation 2006). The SJRIP participants also agreed that unless significant changes occurred in the predicted hydrology and the volume of available water for 2015, the BC recommendation would be to forego a one-week spring peak release in 2015 (given most probable forecast at the time and following the 1999 decision tree). There was general support

for pursuing this strategy recognizing the proposed process only changed how the environmental water would be released from the dam on an annual basis to achieve the 1999 Flow Recommendations and did not change current flow targets.

The agreement to implement the new EWYST method was based on it being an interim process for determining Navajo Dam environmental releases until a full evaluation of the 1999 San Juan River Flow Recommendations could be conducted during a second workshop. A conceptual framework/outline for Flow Workshop II was discussed with attendees recommending that the Program Office (PO) take the lead on a Planning Meeting before conducting the second workshop. It was decided that for the purposes of the Planning Meeting for Workshop II, the PO would manage workshop details and logistics such as compiling relevant documents and reports, identifying information needed prior to the workshop, and developing priority hypotheses.

<u>Decisions:</u>

1) With a majority in support, attendees agreed to an EWYST of 6,063 ft with the flexibility to reduce to 6,050 ft for environmental flows
2) An interim process for determining releases from Navajo Dam in 2015 and beyond was developed and agreed on by the majority (See Box 2)

<u>Outstanding tasks:</u>

1) Determine how available water should be used
2) Evaluate 1999 Flow Recommendations
3) Revise 1999 Flow Recommendations, as necessary

Planning Meeting

At the first workshop (Flow Workshop I), attendees recommended that the PO take the lead on planning for and organizing the second workshop by convening a subgroup to handle workshop details and logistics such as pulling together relevant documents and reports, identifying information needed prior to the workshop, and developing priority hypotheses. This meeting was held December 3-4th, 2015 in Durango, CO, and attended by 26 people to continue with the process of planning for evaluation of the 1999 Flow Recommendations (the attendance list and a full meeting summary can be found in Appendix III).

Objectives and Desired Outcomes of Planning Meeting

There was general agreement the higher flow targets (i.e. 8,000 and 10,000 cfs) have been infrequently achieved since the 1999 Flow Recommendations were in place; therefore, the SJRIP was limited in its ability to evaluate the effects of the higher flow targets on fish or habitats.

Objectives:

1) Summarize existing information on flow-habitat-fish relationships
2) Identify potential outstanding analyses
3) Review history of Navajo releases (why flow recommendations have not been met?)
4) Devise means to better meet flow recommendations and determine what to do with available water
5) Develop new decision tree for flow releases
6) Logistically determine how flow recommendations can be met
7) Develop research/monitoring to assess effects of flows

Desired Outcomes:

There were no desired outcomes listed for the meeting.

Review of current state of knowledge

The meeting started with summaries, reviews, and a general discussion of the current state of knowledge of environmental flows on the San Juan River. The summary of existent knowledge of flows-habitat-fish relationships was provided in the form of several presentations: effects of flows and habitat variation (Vince Lamarra; Ecosystems Research Institute), larval fishes and their responses to flow (Michael Farrington; American Southwest Ichthyological Researchers), small-bodied fishes and their responses to flow (Keith Gido; Kansas State University), effects of flows on river temperature (Bill Miller; Miller Ecological Consultants), and the history of Navajo Dam releases and the flows observed on the San Juan River (Susan Behery; BOR).

Discussion then turned to potential outstanding analyses that should be conducted before any alterations to the 1999 Flow Recommendations would be made. While there were some suggestions for analyses that may provide some insight into the effects of flows on habitat, fishes, and temperature, there was generally agreement to proceed with revising Navajo Dam operations without conducting these analyses because of the infrequency in which the higher flow-targets were observed and the limited number of wild-spawned endangered fishes that experienced those flows. The SJRIP participants in attendance did call for reassessment of current habitat and native and nonnative fish monitoring to quantify the effects of flows in the future.

The SJRIP participants then discussed potential options for revisions to the Navajo Dam operation decision tree to increase the annual frequency of high spring flows. Between Flow Workshop I and the Planning Meeting, Brian Westfall (representing Bureau of Indian Affairs

[BIA]) and Susan Behery (BOR) developed a revised decision tree (referred to as the BOR Tree) that modified the operating rules of the 1999 decision tree by simplifying the number of nodes and potential releases by removing “look backs” into the determination to release spring peaks (Figure 3). This was the first proposed alteration that generally moved away from trying to match the statistical hydrology as described in the 1999 Flow Recommendations to a strategy that releases as much water for environmental flows each year as is available without considering past releases (i.e., no “look-backs”). Notably, this proposed modification continued to contain shorter-duration releases (i.e., 1-2 week) as well as the original prescriptively-shaped hydrographs (i.e., Type I, II, III, IV; Figure 4). Susan Behery and the PO followed these changes with the BOR Tree and further eliminated spring releases unless they would be at least a Type III hydrograph (3-weeks at 5,000 cfs, referred to as the Flex Tree; Figure 5). This change was made to functionally conserve water during drier than average years for use in wetter years when the likelihood of the Animas River having a large spring runoff is greater. To conserve this water during years without releases, the tree would prescribe two potential EWYSTs based on reservoir elevation levels during the forecast season. Available water would be first calculated using a 6,050 ft EWYST. If there is sufficient available water for at least a Type III or Type IV release, a spring release of these magnitudes would be made. If not, then an EWYST of 6,063 ft would be used and any water available above that target during the year would be released via an operational spill. Susan Behery assessed the potential results of the San Juan River’s hydrology using this Flex Tree in her operations model and noted this modification, on average, allowed for two more Type IV releases per decade compared to the 1999 decision tree and the BOR tree for the period of record.

Review of Flow Recommendations

The SJRIP participants continued discussion of the merits of the original 1999 Flow Recommendations and determined they still provide a reasonable basis for the previously described flow target categories. The SJRIP participants came to a general consensus that the flow targets were still valid goals but the methodology to reach those targets needed to change in light of more recent and drier hydrology in the San Juan River Basin. Moreover, any new method for implementing the flow targets would need to allow for more flexible decision-making based on current needs of the SJRIP. Thus, any changes to the 1999 Flow Recommendations would focus more on operations that help mimic a natural hydrograph under current conditions and place emphasis on the flow targets that are harder to achieve (i.e., high flows) rather than change the flow targets as outlined in the 1999 Flow Recommendations.

Whereas the SJRIP participants in attendance decided the flow targets from the 1999 Flow Recommendations should still remain as goals for Navajo Dam operations, they also agreed that the purposes and hypotheses behind these targets should be reevaluated and any new questions included or addressed if and when they are realized. The SJRIP participants decided the accompanying hypotheses (original and new hypotheses) need to answer priority questions of what magnitude, timing, and duration is needed to benefit native/endangered fishes and their habitats (e.g., what flows are needed to best disadvantage Russian olive establishment, when do high flows cause temperature depression that could negatively affect spawning?). Moreover, implementation of specific monitoring protocols to measure effects of the targeted releases and flows on fish and habitat should be an integral part of the flow recommendations. It was also noted that a scientifically-sound research program is needed that can assess the effects of releases and flows on fish and habitat. For example, monitoring activities need to occur before and after high flows to quantify variability in and changes to specific stream habitats. The list of

hypotheses associated with each flow target was discussed and the PO was assigned to bring an updated list of hypotheses to the last workshop (Flow Workshop II).

Decisions:

1) The SJRIP participants agreed to eliminate Type I and II hydrographs as environmental releases because they are not having their intended effects and the lower flow targets have been easier to achieve
2) Attaining the desired frequency of high flows as described in the 1999 Flow Recommendations is still dependent on Animas River flows; therefore, trying to time Navajo Dam releases with the Animas River spring peak is a high priority
3) The SJRIP participants decided to further refine the Flex Tree decision tree and focus on the shape and duration of the hydrograph with the understanding that the hydrograph does not have to be restricted to the four types (i.e., Types I-IV) as outlined in the 1999 Flow Recommendations

Outstanding tasks:

1) Develop draft revised decision tree that prioritizes longer duration releases at the expense of lower duration releases
2) Design metrics for determining when the Animas River is “spent”
3) Incorporate flexibility in the decision tree for other potential environmental releases (e.g., elevated base flows)
4) Update hypotheses behind flow targets

Flow Workshop II

The final flow workshop (Flow Workshop II) was held on April 5-6th, 2016 in Albuquerque, NM and was attended by 37 individuals. This workshop continued discussion of

altering the Navajo Dam operations decision tree, started discussion of the timing and shape of the hydrograph, and what to do with available water during years when there is not enough water available to conduct a spring release. There was also continued discussion of how the effects of all environmental releases will be evaluated. Detailed notes of the meeting are available in Appendix IV.

Objectives and desired outcomes of Flow Workshop II

Objectives:

1) Reach agreement on modifications to Navajo Dam operation decision tree
2) Review Navajo Dam operation model results comparing various decision trees
3) Determine the duration of spring peak releases and the shape, magnitude, and volume of the ascending and descending limbs of a spring peak hydrograph
4) Agree when to implement elevated target base flows in any revised decision tree
5) Determine the timing, duration, and magnitude of base flow targets > 500 cfs
6) Develop a monitoring program to evaluate the hypotheses and assumptions of the flow recommendation targets
7) Decide on a structure for the document summarizing changes to the 1999 Flow Recommendations or operating procedures
8) Discuss Navajo Dam operations for 2016

Desired Outcomes:

1) Decide when and how long to implement a spring peak release from Navajo Dam
2) Decide the shape of the spring peak release (ascending and descending limbs), decide how and when to implement elevated base flows (>500 – 1,000 cfs target)
3) Finalize operation decisions for 2016 and beyond

4) Determine a monitoring program to move forward with evaluating the flow recommendations
5) Determine a process and assignments needed to finalize the outcomes of the flow workshops (I and II) and any revisions to the 1999 San Juan River Flow Recommendations or Navajo Dam operations

Meeting Summary:

The meeting began with discussion of documenting the rationale behind changing Navajo Dam operations (i.e., decision tree) without supporting data for those changes. The general consensus was the justification for abandoning focus on the lower flow targets was based on Miller's (2006) conclusions. The SJRIP participants reiterated and agreed that the 1999 Flow Recommendations targets were not being altered; Navajo Dam operations were being altered to better meet the 1999 flow targets. The SJRIP participants agreed that the hypotheses of the 1999 Flow Recommendations should be updated and Navajo Dam should be operated to shift focus to the higher flow targets at the expense of targeting the lower flow targets. The SJRIP participants agreed there was no good rational to alter the original 1999 flow targets at this time but would be open to changes should new data emerge indicating otherwise.

The SJRIP participants in attendance then discussed the potential benefits of elevating base flows above the targeted 500-1,000 cfs currently identified in the 1999 Flow Recommendations. There was general agreement that elevating base flows would likely increase the number of flowing secondary channels and potentially increase availability of other low-velocity habitats but at the expense of spring releases and colder temperatures. The SJRIP participants decided that the SJRIP's primary focus should be on reaching higher spring flow targets to create and maintain habitats but then investigate effects of elevated base flows when

there is not enough water for a spring release. The SJRIP participants also noted that a good way to evaluate the effects of elevated base flows is not currently in place and some projects may need to be tweaked or developed in the future to do so.

The SJRIP participants in attendance discussed effects of potential changes to the Navajo Dam operation decision tree in addition to elevated base flows on the San Juan River's hydrology. Susan Behery reported on modeling results using the Navajo Dam Operations model with three different decision trees and three different levels of base-flows for a total of nine scenarios. The three decision trees included the original 1999 decision tree with an increased EWYST of 6,063 ft, a modified BOR Tree with only Type III and IV releases and an increased EWYST of 6,050 ft, and a revised Flex Tree with the maximum number of days at 5,000 cfs (up to 60 days) with an EWYST of 6,050 ft. Generally, results indicated elevating base flows reduced the availability of water for higher spring releases. The revised Flex Tree decision tree with the maximum number of days at 5,000 cfs (highest operational release from Navajo Dam) did the best job of achieving the higher flow targets compared to the other trees.

The SJRIP participants then began discussion of the shape of the hydrograph during spring releases using the Flex Tree. The general consensus was the spring release should decrease the amount of ramp up time because there was no biological reason for a longer ramp up duration and a shorter ramp up duration would increase the number of days Navajo Dam could release 5,000 cfs. However, the ramp down should be extended to two weeks in order to increase the amount and duration of low velocity habitats and flooded vegetation for larval endangered fishes. The SJRIP participants agreed the Flex Tree should include a rapid ramp-up duration of 3 days, keeping flows at 5,000 cfs until the Animas River is "spent" (definition to be determined at a later date) up to a total of 60 days, and a two-week ramp down (See Box 3). The

SJRIP participants agreed the final assessment between the original 1999 operation decision tree and the final revised decision tree (2017 tree) would be evaluated through analysis of a comparison of the river's modeled hydrology using the Gen4 Hydrology Model (see ***Analysis of proposed changes to Navajo Dam operations*** below).

<u>Modification of available water calculation and End of Water Year Storage Targets</u>

The method for calculating available water was modified from the 1999 Flow Recommendations. Previously, the annual availability of water was calculated as:

(1) AW = Storage + Inflow –TBF Releases – Evaporation – NIIP Diversions – Carryover Storage

Where:

AW is the available water for a spring release,
Storage is the amount of water in the reservoir at a given time step,
Inflow is the predicted water inflow into the reservoir through October 1,
TBF Releases is the amount of water needed to meet target base flows,
Evaporation is predicted water loss due to evaporation out of the reservoir,
NIIP Diversions is the water predicted for use through the Navajo Indian Irrigation Project,
Carryover Storage was a constant at 900,000 af.

The available water was calculated at each time step until October 1. Similarly, the amount of operational spill was calculated as:

(2) Spill = Inflow – Available Space – TBF Releases – Evaporation – NIIP Diversions

Where:

Spill is the volume of water to be spilled and

Available Space was the difference between 900,000 af and the current water volume in the reservoir at each time step.

Due to the recent drier hydrology in the San Juan River Basin, BOR suggested the Carryover volume of 900,000 af (or an elevation of 6,018.8 ft above sea level) should be increased to reduce the probability of shortage in the San Juan River Basin while acknowledging

a higher Carryover volume will increase the probability of operational spill. To estimate what the Carryover volume that would balance the tradeoff between reducing the probability of shortage against the increased probability of spill the BOR conducted a modeling exercise to arrive at a range of values that could be used as a new EWYST. Using the Navajo Dam Operations model, BOR modeled the period from 1971 to 2013, which included the 2012 NIIP diversions, ROD base release of 250 cfs with a target base flow of 500-1,000 cfs, but then added different EWYSTs as variable reservoir elevations between 5,990 to 6,080 ft over 10 ft increments. The resulting hydrology was then summarized over this time period and the frequency and volume of shortages and operational spill were investigated. Additionally, the predicted duration the San Juan River Basin could undergo varying levels of drought (i.e., 90% exceedance) before entering shortage sharing was modeled and quantified among the variable EWYST levels.

Modeling results indicated a relatively narrow range of reservoir elevations that would simultaneously reduce the probability of shortage in the San Juan River Basin while not increasing the probability of operational spill (Table 2). Of the 42 modeled water years, the percent of years with shortage ranged from 49% at an EWYST of 6,000 ft to zero years when above 6,050 ft. Operational spill did not occur at EWYST values below 6,060 ft. Given these results, BOR recommended the EWYST be a minimum of 6,050 ft to reduce the probability of shortage and a maximum of 6,063 ft to avoid spill.

The second analysis investigated the influence of variable EWYSTs and the number of years before the San Juan River Basin would enter shortage under different drought scenarios. Results similarly suggested an EWYST between 6,050 and 6,063 ft would provide up to three years of shortage protection at exceedance levels of 90% for the period of record. Therefore,

BOR suggested the EWYST should be set between 6,052 and 6,063 ft with preference for the higher level due to change in recent hydrology and the perceived higher risk of shortage.

The SJRIP participants agreed to increase the EWYST but still had concerns with setting a strict reservoir elevation level due to the inflexibility of the 1999 decision tree to manage flows. Continued discussions with the BC, BOR, and the PO resulted in the use of a somewhat flexible EWYST in that BOR could set the "side-boards" at 6,050 and 6,063 ft but the SJRIP could have the flexibility to operate between those targets in some years. This flexibility in EWYST was integrated into the 2017 decision tree to improve the ability of using Navajo Dam operations to help meet the 1999 flow recommendations.

Modification of Navajo Dam Operation Decision Tree

The Navajo Dam operation 1999 decision tree was modified to address concerns that not all of the 1999 flow targets were being achieved and the threat of shortage sharing had increased during the latest drought period in the San Juan River Basin (Figure 6). Several changes were made to address these concerns as well as other modifications aimed at aiding endangered fish recovery (see Box 3). Generally, changes included 1) increasing the Navajo Reservoir target elevation from ~6,020 to between 6,050–6,063 ft above sea level to reduce the probability of shortage sharing, 2) cessation of short duration spring releases to conserve water for longer releases, 3) shifts in the shapes and durations of the release hydrographs to maximize the days at the highest discharge and increase the availability of nursery habitats, and 4) built-in flexibility for the use of other environmental flows as determined through adaptive management. Additionally, because of the shift in focus to reaching the higher flow targets, the 2017 decision tree omits "look-backs" from release determinations and indicates spring releases should occur if there is available water and the San Juan River Basin hydrology suggests high spring flows could

be reached with the aid of the Animas River. The 2017 decision tree for Navajo Dam was constructed with all of these processes in mind with the ultimate goal of maximizing the benefit of environmental flows for endangered fish recovery while continuing to provide for water use and development in the San Juan River Basin. The potential effects of these changes to the 1999 decision tree will be evaluated through hydrologic modeling (see below), as well as through observed flows and monitoring programs in the future.

Analysis of 2017 Navajo Dam Operation Decision Tree

Hydrology Model

Proposed changes to the Navajo Dam operation decision tree were evaluated using Gen4 San Juan River Hydrologic Model using RiverWare software (Zagona et al. 2001). The model was developed to support the SJRIP's goals to recover populations of the Razorback Sucker and Colorado Pikeminnow in the San Juan River Basin while proceeding with water development. The model currently has the flexibility to provide alternative hydrologic conditions, in addition to historic hydrologic conditions, that can be used to evaluate future water availability and risks under different assumptions of future climatic and hydrologic conditions.

Hydrology Model Configuration

The model was configured to assess how the proposed changes to the Navajo Dam decision tree may affect annual flow variability of the San Juan River as well as the probability of shortages. The hydrology of the San Juan River Basin was modeled between 1929 and 2013 with depletions limited to "current depletions" (Table 3). The 1999 decision tree and 2017 decision tree were evaluated by running the two different decision trees using the same hydrology in the San Juan River Basin. Annual flow variability between the two decision trees was then evaluated for their relative ability to meet the primary and secondary flow targets above

5,000 cfs in the 1999 Flow Recommendations (see Box 1). Specifically, the analysis quantified the ability of the 2017 decision tree to increase the frequency of the higher flow targets (i.e., >5,000 cfs) at the expense of the lower flow targets as well as decrease the number of years between meeting the higher flow targets all while still keeping the probability of shortage sharing low.

Model Results

Primary Targets

Model results indicated the 2017 decision tree could increase the SJRIP's ability to meet the higher primary flow targets in the San Juan River compared to the original 1999 decision tree while keeping the risk of shortage low. Generally, the 2017 tree increased the frequency of higher flows at the expense of the lower flows. Both decisions trees resulted in meeting the primary flow targets for the three highest metrics but the 2,500 cfs target was not achieved with the 2017 decision tree (Figure 7). At the two higher flow target (10,000 and 8,000 cfs), the 2017 tree increased the annual frequency of the targets by 3% and 7%, respectively, compared to the 1999 decision tree, but both trees resulted in the targets being met for the period of record. At the 5,000 cfs target, there was no difference in the frequencies at the target duration and both decision trees were above the target of 21 days in 50% of years. Additionally, the frequency of longer durations of flows above 5,000 cfs also would increase substantially using the 2017 decision tree. At the lowest primary target (2,500 cfs), only the original 1999 decision tree achieved the frequency at the desired duration. Overall these results indicate using the 2017 decision tree rather than the original 1999 decision tree increases the probability of reaching the higher flow targets. However, flows from the Animas River largely dictate the ability of both

models to reach flow targets >5,000 cfs in critical habitat because of discharge limitations from Navajo Dam.

Secondary Targets

Modeled results similarly predicted the 2017 decision tree would increase the SJRIP's ability to achieve the secondary flow targets (duration between meeting each discharge target) of the 1999 Flow Recommendations (Figure 8). The 1999 Flow Recommendations set a maximum duration of 10 years between attainment of 10,000 cfs flows. The 2017 decision tree predicted the duration between the target being reached was reduced from 9 to 7 years. For the 8,000 cfs target, current modeling of the original 1999 decision tree shows the duration between reaching this target would be 7 years, missing the minimum target by one year. The 2017 tree would perform better by decreasing the duration between target attainment to a maximum number of 4 years during the entire period of record. Both trees were predicted to achieve the two lower-flow targets (i.e., 5,000 and 2,500 cfs) as suggested by the 1999 Flow Recommendations.

Model results also suggested the 2017 decision tree will affect elevations of Navajo Reservoir but have minimal impacts to the probability of shortage with current levels of depletions. Navajo Reservoir elevation was predicted to decrease on average from 6,063 to 6,056 ft during the period of record with the 2017 decision tree compared to the 1999 decision tree. While modeled shortages never occurred using the 1999 decision tree, use of the 2017 tree increased the percentage of years undergoing shortage from 0 to 1 out of 84 years or 1.2%.

Conclusion

Through the process described above, the Navajo Dam Operations were modified to increase the probability of achieving the two highest 1999 Flow Recommendation flow targets while still providing low probabilities of shortage sharing in the San Juan River Basin. The

actual 1999 Flow Recommendation flow targets were not modified because there was no evidence to indicate they are not important for endangered fish recovery. Moreover, the modeled results using current depletions indicate these changes will likely increase the probability of reaching these higher-flow targets. Because only current depletions were considered in modeled scenarios here, any current or future projects that increase depletions from current levels will likely impact the ability of these modified Navajo Dam Operations to both meet the 1999 Flow Recommendations as well as provide continued low probabilities of shortage sharing. Therefore, the 1999 Flow Recommendations, and the 2017 decision tree developed here, should both be revisited through adaptive management strategies if new information emerges that substantially alters our understanding of the effects of the San Juan River's flow regime on endangered fishes or if new substantial depletions occur in the future.

Box 1. ***Primary and secondary flow targets from the 1999 Flow Recommendations for the San Juan River. The hypothesized biotic and abiotic effects of each target with their evidence and assumptions are provided. New or modified hypotheses from the 1999 Flow Recommendations are noted with (*).***

Flow target: 10,000 cfs

Duration: A minimum of 5 days between March 1 and July 31.

Frequency: Flows > 10,000 for 5 days or more need to occur in 20% of the years on average for the period of record 1929-1993. Maximum number of consecutive years without meeting at least a flow of 9,700 cfs (97% of 10,000 cfs) within the 65-year period of record is 10 years.

Hypothesized effects:

Abiotic	**Evidence/ assumptions**
1. Changes channel morphology and maintains channel complexity	Increased number of islands after high flows
2. Suppresses nonnative vegetation out of the bank full channel*	
Biotic	
1. Increases Colorado Pikeminnow reproductive success	
2. Important to Colorado Pikeminnow and Razorback Sucker	
3. Promote native fish abundance*	(Gido and Propst 2012)

Flow target: 8,000 cfs

Duration: A minimum of 10 days between March 1 and July 31.

Frequency: Flows of > 8,000 cfs for 10 days or more need to occur in 33% of the years on average for the period of record 1929-1993. Maximum number of consecutive years without meeting at least a flow of 7,760 cfs (97% of 8,000 cfs) within the 65-year period of record is 6 years.

Hypothesized effects:

Abiotic	**Evidence/assumptions**
1. Maintenance of channel cross section at secondary channel control points	Bankfull discharge is between 7,000 and 10,500 cfs below Farmington, with 8,000 cfs being representative of the bulk of the river
2. Create larval Razorback Sucker habitat during peak and receding flows (i.e., low velocity habitats and/or flooded vegetation)	

Box 1. *Continued.*

4. Promotes native vegetation in the bank full channel*	
Biotic	
1. Increase abundance of native fish	Bluehead Sucker and Speckled Dace showed a positive response to flows above 8,000 cfs for 1-19 days (Gido and Propst 2012)
2. Colorado Pikeminnow reproductive success	

Flow target: 5,000 cfs

Duration: A minimum of 21 days between March 1 and July 31.

Frequency: Flows of > 5,000 cfs for 21 days or more need to occur in 50% of the years on average for the period of record 1929-1993. Maximum number of consecutive years without meeting at least a flow of 4,850 cfs (97% of 5,000 cfs) within the 65-year period of record is 4 years.

Hypothesized effects:

Abiotic	**Evidence/assumptions**
1. Clean backwaters and maintain low velocity habitat in Reach 3 at flows above 5,000 cfs	Increases nursery habitat
2. Suppressed nonnative vegetation in secondary channels*	
Biotic	
None	

Flow target: 2,500 cfs

Duration: A minimum of 10 days between March 1 and July 31.

Frequency: Flows of > 2,500 cfs for 10 days or more need to occur in 80% of the years on average for the period of record 1929-1993. Maximum number of consecutive years without meeting at least a flow of 2,425 cfs (97% of 2,500 cfs) within the 65-year period of record is 2 years.

Hypothesized effects:

Abiotic	**Evidence/ assumptions**
1. Provides secondary channel habitats for native fish*	
2. Nonnative vegetation is suppressed between 500-2,500 cfs. Need to investigate at what flows*	

Box 1. *Continued.*	
Biotic	
1. Triggers spawning by Colorado Pikeminnow	

Flow target: Timing of the peak flows noted above must be similar to historical conditions, and the variability in timing of the peak flows that occur historically must also be mimicked.

Timing: Spring peak releases from Navajo Dam will be timed to match the Animas River's spring peak.

Hypothesized effects:

Abiotic	**Evidence/ assumptions**
None	
Biotic	
1. Important for endangered fish spawning	

Flow target: Base flow (mean weekly non-spring runoff flow)

Level: 500-1,000 cfs from Farmington, NM to Lake Powell, with 250 cfs minimum from Navajo Dam.

Hypothesized effects:

Abiotic	**Evidence/ assumptions**
1. Target base flows between 500 – 1000 likely increase low velocity habitats. Threshold effects need to be investigated.*	Long-term decline in total channel area (Lamarra per. comm.)
Biotic	
1. Important for endangered fish growth, survival, and spawning	
2. Suppress nonnative fish abundance (Red Shiner, Fathead Minnow and Mosquitofish)*	(Gido and Propst 2012)

Flow target: Flood control releases (incorporated into operating rule)

Control: Handle flood control release as increases to base flows.

Hypothesized effects:

Abiotic	**Evidence/ assumptions**
1. Improve low velocity habitat quality by flushing sediment	
Biotic	
1. Suppress Red Shiner and Fathead abundance*	(Gido and Propst 2012)

Box 2. ***Annual procedures for implementing releases from Navajo Dam***

- Step1 – Bureau of Reclamation (BOR) should provide the Available Water Calculation (AWC) based on the EYWST of 6,050 ft to the Biology Committee (BC) by **April 1**.

- Step 2 - The BC formulates and provides a draft recommendation for Navajo Dam environmental flow releases to the Program Office (PO) by **mid-April** based on: a) the AWC, b) Desired or appropriate San Juan River hydrograph, c) Review of fish and habitat responses to flow, d) 1999 Flow Recommendations; and, e) Final 2017 Decision Tree.

- Step 3 - The recommendation for Navajo Dam releases is provided to the Coordination Committee (CC) through the PO by **mid-April**. The CC reviews the recommended releases and provides any comments to BOR and the U.S. Fish and Wildlife Service (USFWS).

- Step 4 - BOR and the USFWS work toward accomplishing the recommendation for the Navajo Dam releases based on the May forecast (including an ESA compliance check). If significant changes in the May forecast have occurred, the BC will re-evaluate the draft recommendation and submit modifications, if necessary (process resets to Step 2 - BC formulates and provides a draft recommendation to the PO).

- Step 5 - BOR implements the final recommendation.

Box 3. ***Description of 2017 operation decision tree for Navajo Dam***

A. Determine available water based on the End of Water Year Storage Target (EWYST) of 6,050 ft Navajo Reservoir elevation.

If available water is ≥ 292,000 af (not including water needed to maintain baseflow targets of 500-1,000 cfs), conduct a spring release (B), if not, forgo a spring release and recalculate the EWYST at 6,063 ft (C).

B. Implement prescribed spring release

The spring release should be timed to match the peak snow melt runoff from the Animas River and should consist of a three-day ramp up to 5,000 cfs, held at 5,000 cfs for a minimum of 21 days to a maximum of 60 days, followed by a 14 day ramp down. After a minimum of 21 days release at 5,000 cfs, ramp down will begin after the Animas River is done contributing 'substantially' to discharge in critical habitat of the San Juan River. Assuming Navajo Dam is releasing 5,000 cfs, the ramp down will be initiated when the mean daily discharge between the Shiprock and Four Corners USGS gauges is ≤ 6,500 cfs and not anticipated to increase in the near future.

C. Forgo spring release; reassess available water based on the EWYST of 6,063 ft.

If water is available, conduct other environmental flow management (D; e.g., elevate base flow), if water is not available, target base flow 500-1,000 cfs (E).

D. Other environmental flow management

Use available water to conduct other flow management (e.g., elevate target base flows above 500-1,000 cfs using EWYST 6,063 ft (amount of increase will be dictated by the quantity of available water). Conversely, use available water to implement some other recovery action for endangered fishes (e.g., flow spikes).

E. Do not elevate target base flow

Keep target base flows at 500-1,000 cfs and use EWYST 6,063 ft.

Tables

Table 1. Summary of San Juan River flows between 1998 and 2015 and primary and secondary spring flow targets. For the primary targets, each value is the accumulating percentage of years reaching each target. Years in which the target percentages were not attained is shaded in gray. Asterisks (*) denote years in which the flow targets were attained. For secondary targets, each cell is the number of years passing without reaching the target, years in which minimum targets were exceeded are highlighted in gray. Working flow targets are 97% of actual targets to allow for gage error (e.g., 9,700 instead of 10,000 cfs).

	Primary Targets				Secondary Targets			
Year	5 days @ >9,700cfs in 20% of years	10 days @ >7,760cfs in 33% of years	21 days @ >4,850cfs in 50% of years	10 days at >2,425cfs in 80% of years	<10 yrs between >9,700 cfs target	<6 yrs between >7,760 cfs target	<4 yrs betwen >4,850 cfs target	<2 yrs between >2,425 target
1998	0	0	100*	100*	1	1	0	0
1999	0	0	100*	100*	2	2	0	0
2000	0	0	67	100*	3	3	1	0
2001	0	0	75*	100*	4	4	0	0
2002	0	0	60	80	5	5	1	1
2003	0	0	50	83*	6	6	2	0
2004	0	0	43	86*	7	**7**	3	0
2005	13*	13*	50*	88*	0	0	0	0
2006	11	11	44	89*	1	1	1	0
2007	10	10	50*	90*	2	2	0	0
2008	18*	18*	55*	91*	0	0	0	0
2009	17	17	50	92*	1	1	1	0
2010	15	15	46	92*	2	2	2	0
2011	14	14	43	93*	3	3	3	0
2012	13	13	40	93*	4	4	4	0
2013	13	13	38	88	5	5	5	1
2014	12	12	35	88*	6	6	6	0
2015	11	11	33	89*	7	7	7	0

Table 2. Modeled results (Navajo Dam Operations Model) of variable End of Water Year Storage Targets (EWYST) and percentage of years between 1971-2013 that were predicted to undergo a shortage or operational spill with the different targets in place.

EWYST (ft)	Shortage	Spill
6,000	49%	0%
6,010	26%	0%
6,020	16%	0%
6,030	7%	0%
6,040	5%	0%
6,050	2%	0%
6,060	0%	0%
6,070	0%	21%
6,080	0%	72%

Table 3. Annual mean (Mean), minimum (Min), and maximum (Max) modeled depletions (af) for the current 30 water users between 1929 and 2013 in the San Juan River Basin.

				Annual depletion (af)		
State	Type/Local	Tribal	Title	Mean	Min	Max
New Mexico	Irrigation	Tribal	NIIP	206,500	120,700	243,000
			Hogback	7,900	5,900	9,400
			Fruitland and Cambridge	5,600	3,900	6,800
			Cudei	900	700	1,100
			NIIP Ground Water	200	(17,000)	7,400
			Jicarilla	100	0	100
		Non-Tribal	Animas River	14,900	10,300	17,800
			Hammond Project	10,800	8,100	12,800
			Upper San Juan	8,300	6,100	9,800
			Farmers Mutual Ditch	6,200	4,500	7,500
			La Plata River	3,400	600	6,400
			Jewett Valley	2,800	2,000	3,200
			Above Navajo - Private	900	700	1,200
	Non-Irrigation		4C Power Plant	28,800	25,500	28,800
			Navajo Evaporation	26,900	16,900	30,200
			SJ Generation Station	23,900	21,200	23,900
			Miscellaneous	11,600	11,600	11,600
			Bloomfield M&I	2,500	2,500	2,500
			Jicarilla M&I	340	340	340
Colorado	Above Navajo		Pine	105,600	82,000	117,600
			Upper San Juan	32,800	26,200	38,600
			Piedra	17,500	13,100	19,500
	Below Navajo		Florida	38,400	12,000	52,300
			Mancos	25,400	9,000	31,300
			Animas	18,500	14,200	21,900
			La Plata	16,200	5,700	23,800
Utah			Utah	12,300	12,300	12,300
Other			San Juan Chama	105,200	7,400	233,500
			Navajo Gallup	35,800	31,800	35,900
			Animas-La Plata	2,400	2,400	2,400

Figures

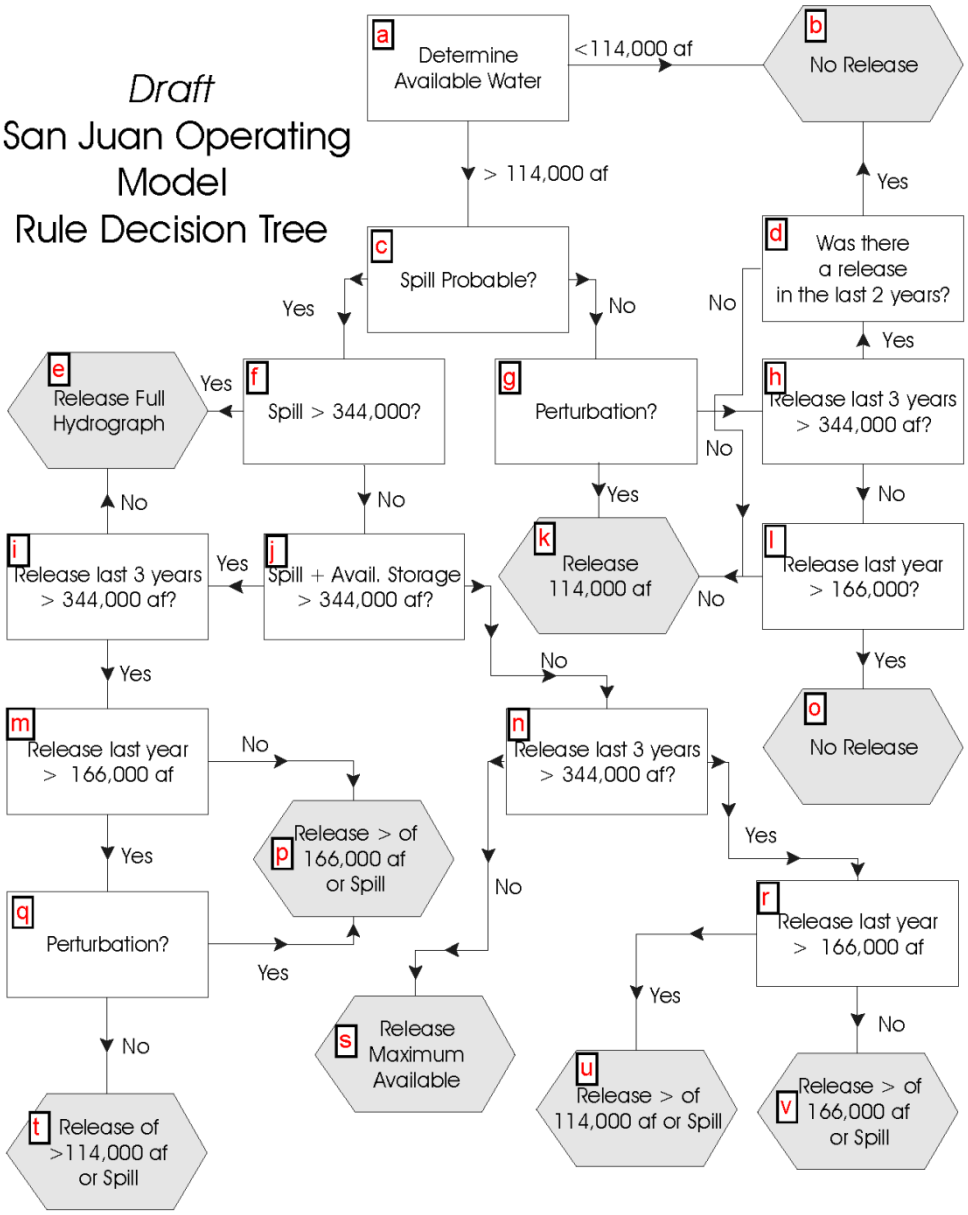


Figure 1. Navajo Dam operation decision tree from the 1999 Flow Recommendations (Holden et al. 1999). Letters in each node were added to the original figure for reference.

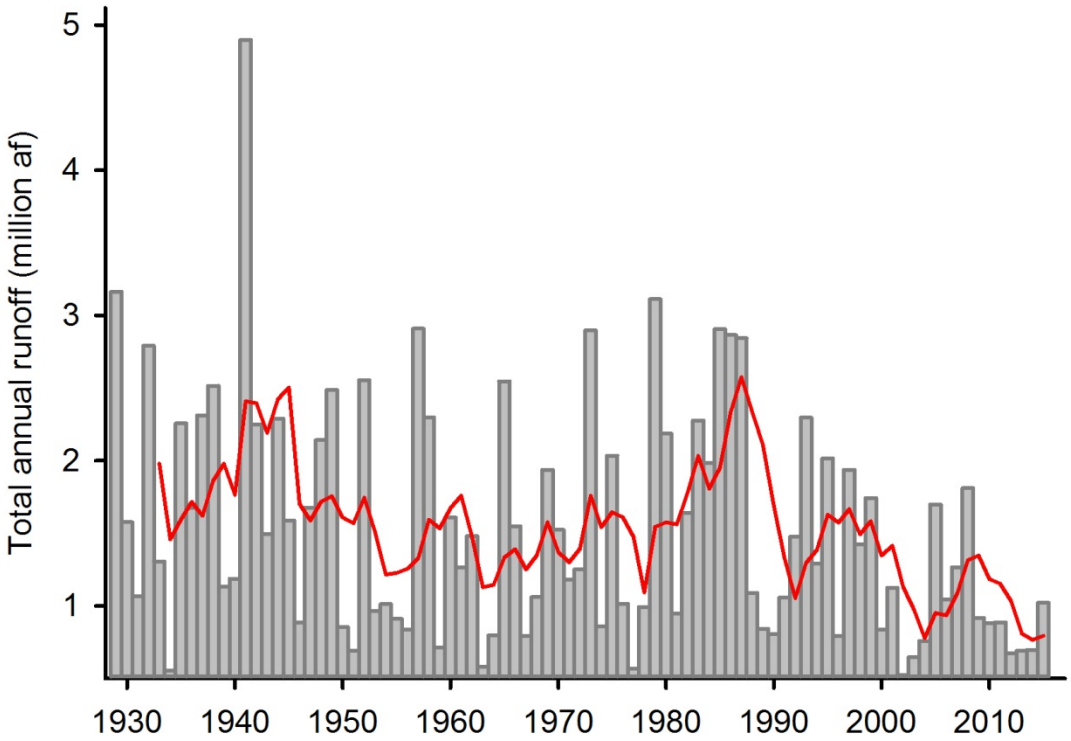


Figure 2. Total annual San Juan River runoff (gray bars) and five year moving average (red line) of total annual runoff (million af) of the San Juan River at Bluff, UT (USGS gage 09379500) between 1929 and 2015.

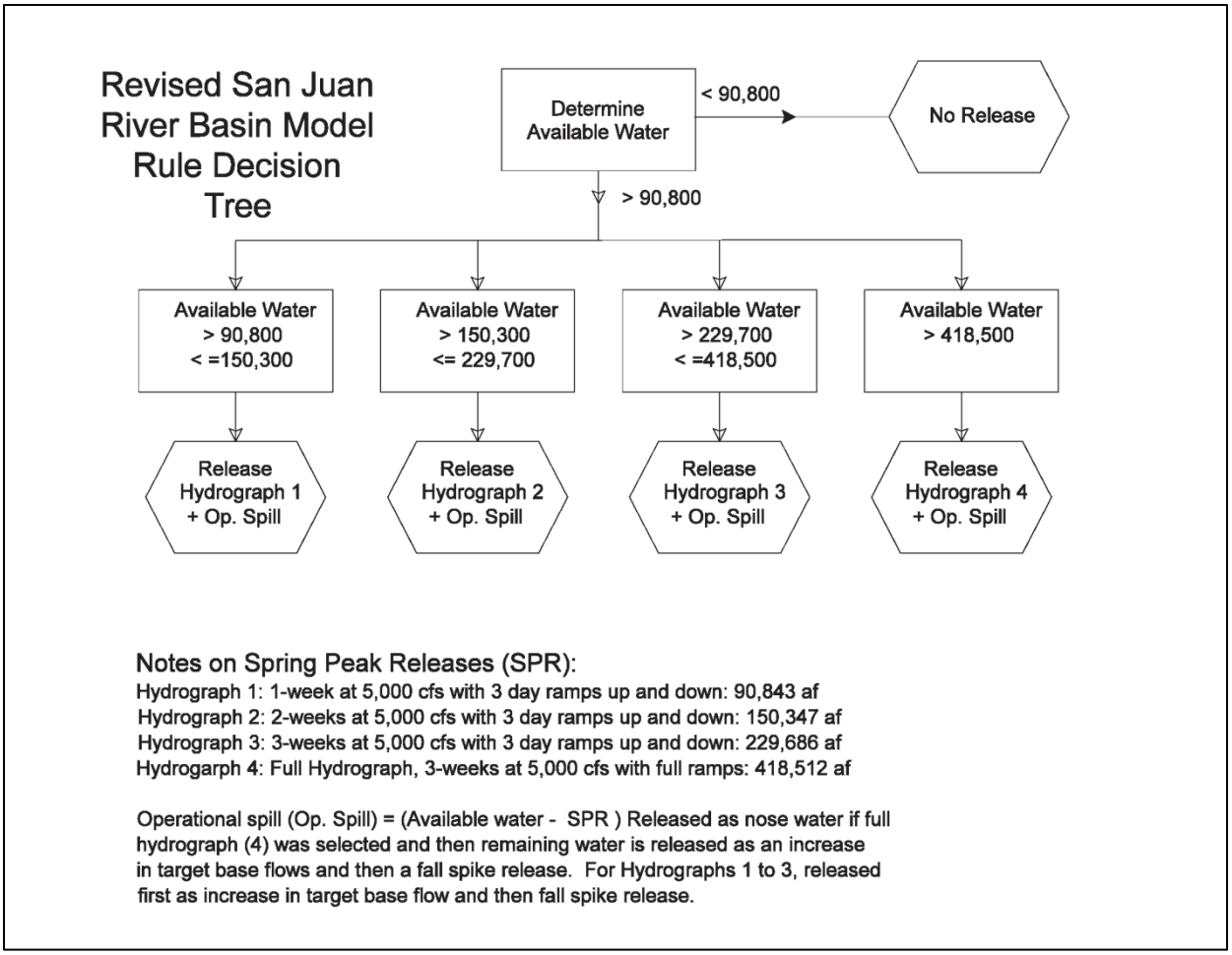


Figure 3. First proposed revision to the Navajo Dam operation rule decision tree by Brian Westfall (BIA) and Susan Behery (BOR; BOR Tree). Major changes included removal of "look-backs".

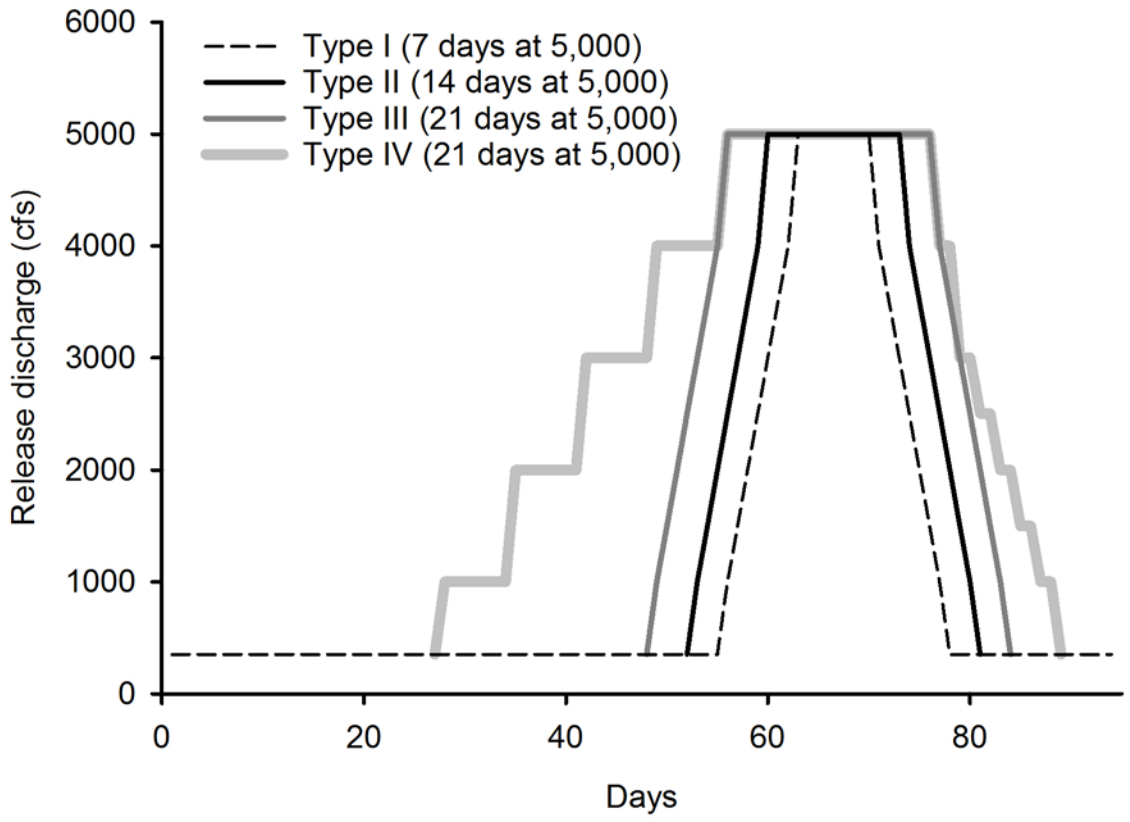


Figure 4. The four types of hydrographs developed for spring releases for Navajo Dam from the 1999 Flow Recommendations (Holden et al. 1999).

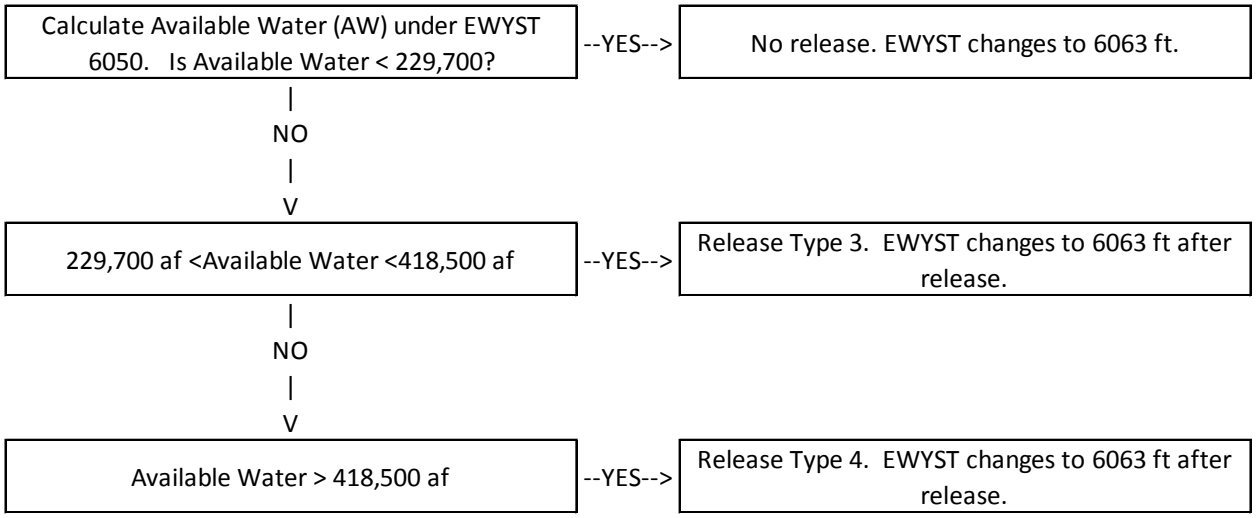


Figure 5. Second proposed revision to the Navajo Dam operation rule decision tree by Susan Behery (BOR) and the PO (referred to as Flex Tree).

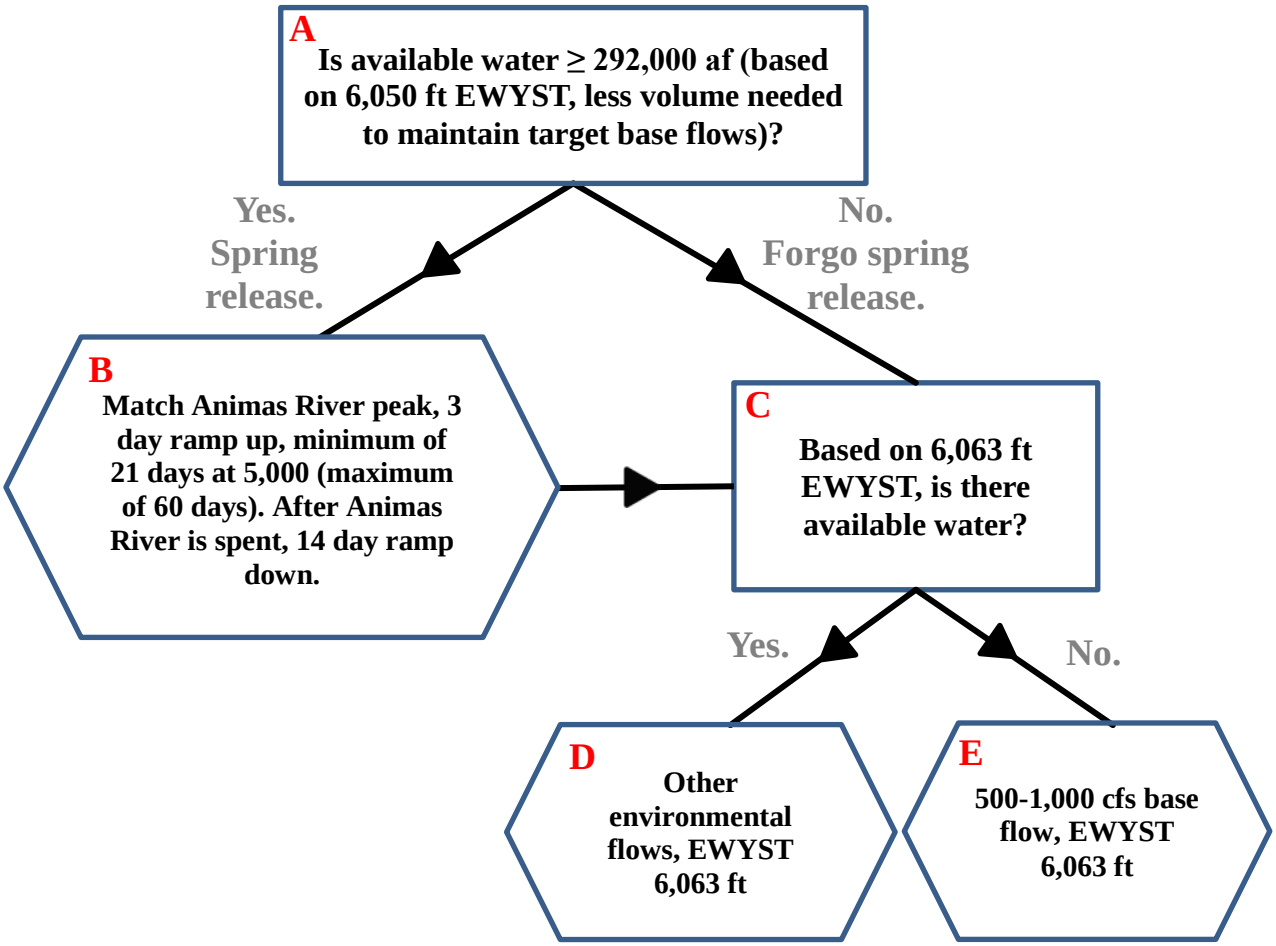


Figure 6. 2017 Navajo Dam operation decision tree for the San Juan River. See Box 3 for further details.

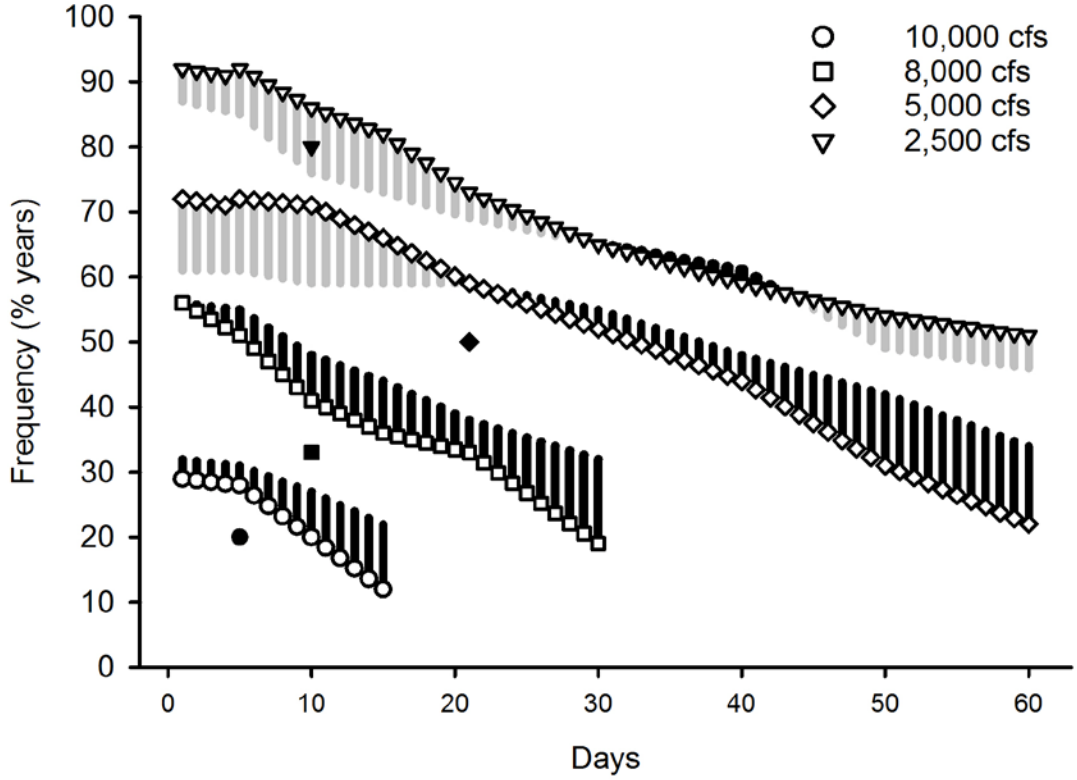


Figure 7. Modeled results of primary flow targets comparing the frequency and duration of San Juan River flows using the original 1999 decision tree and the 2017 decision tree between 1929 and 2013. The open symbols denote flow variability at each target level using the original 1999 decision tree. Filled symbols are the respective flow targets from the 1999 Flow Recommendations. The vertical bars denote the change in flow variability using the 2017 tree (black bars denote increases in frequency and gray bars denote decreases in frequency).

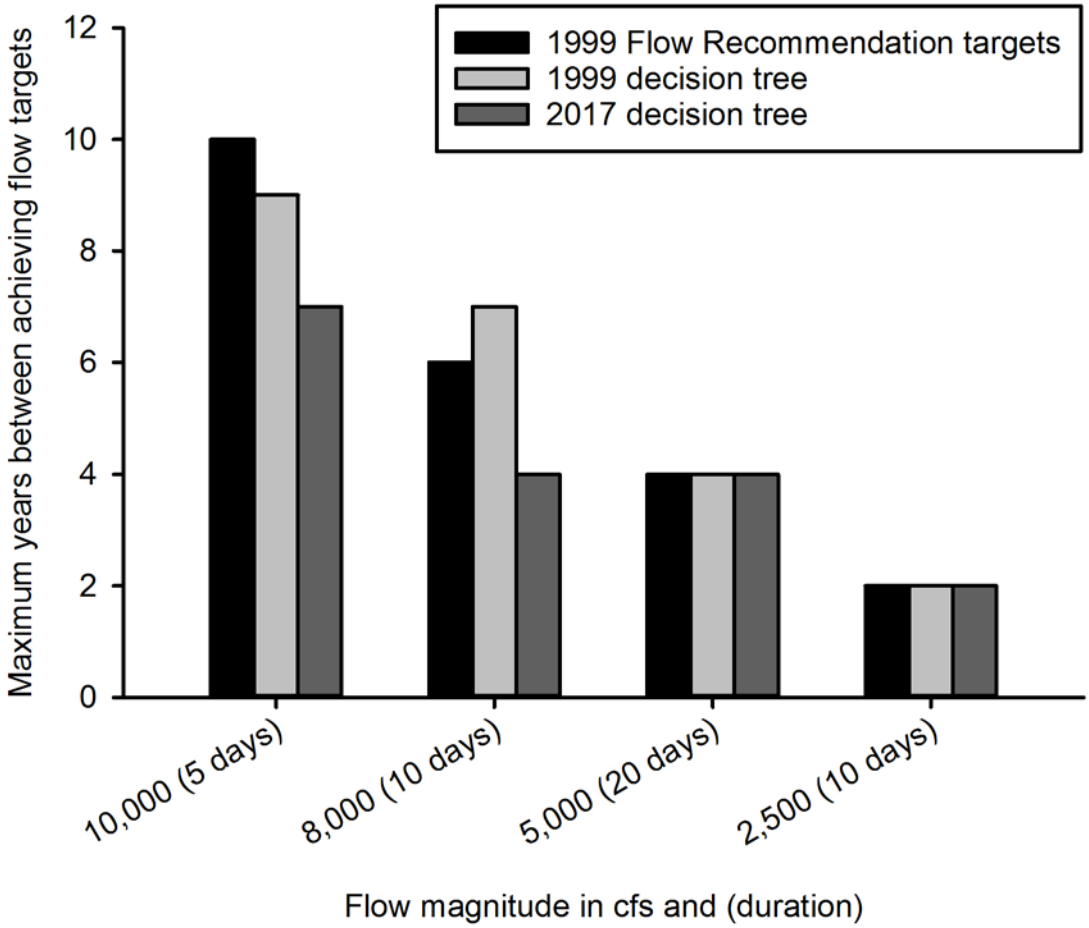


Figure 8. Modeling predictions of secondary flow targets for the four high flow metrics using the 1999 and 2017 decision trees compared to the 1999 flow recommendation targets.

Literature Cited

Gido, K.B. and D.L. Propst. 2012. Long-term dynamics of native and nonnative fishes in the San Juan River, New Mexico and Utah under a partially managed flow regime. Transactions of the American Fisheries Society. 141:645-659.

Holden, P.B. (Ed.). 1999. Flow recommendations for the San Juan River. San Juan River Basin Recovery Implementation Program, USFWS, Albuquerque, NM.

Lamarra, D. and V. Lamarra. 2016. Spatial and temporal trends in San Juan River habitat. Final report 2011-2015. San Juan River Basin Recovery Implementation Program. Albuquerque, NM.

Miller, W.J. 2006. San Juan River Standardized Monitoring Program Five Year Integration Report. San Juan River Basin Recovery Implementation Program, Albuquerque, NM. 83 pgs.

U.S. Bureau of Reclamation. 2006. Record of decision for the Navajo Reservoir Operations, Navajo Unit – San Juan River New Mexico, Colorado, Utah Final Environmental Impact Statement. Upper Colorado Region, Salt Lake City, Utah. 12 pgs.

Zagona, E.A., et al. "RiverWare: A generalized tool for complex reservoir system modeling." JAWRA Journal of the American Water Resources Association 37.4 (2001): 913-929.

Comments and responses to first draft

Below are comments (italics) and responses to those comments (bold) that were considered during the first revision of the Draft Revised Navajo Dam operating procedures for the 1999 San Juan River Flow Recommendations.

Commenter: Tom Pitts, CC member representing Water Development Interests

The document seems to say two different things. It says it is NOT changing the 1999 Flow Recommendation (See title of document and lines 97, 154, 346) and it says it IS changing the 1999 Flow Recommendations (see lines 122, 162, 364). It is difficult to tell if changes are to the Recommendation and the Navajo Dam Operating Procedures or just the Procedures with the intent to achieve the higher flows.

We have now tried to clarify that the SJRIP has not suggested changes to the 1999 Flow Recommendations but only have suggested changes to the Navajo Dam operating procedures.

There is no discussion about improvement in the status of the endangered species under the current operating procedures, yet the report indicates confidence low flows are not helping. (See lines 139 and 412). There needs to be an explanation of why low flow not playing a role in the improved status of the species and why the current frequency of high flows is not playing a role. it is?

The purpose of this report was to accurately document the process by which the 1999 Flow Recommendations were reviewed and the Navajo Dam Operating procedures were revised. During this process, there was no discussion about the probability that the lack of high-flow discharges in the river is aiding endangered fish recovery. Therefore, discussion of this proposition is not included in the report.

The high flow release frequency has increased: two more Type IV releases per decade (line 336); the duration between 10,000 cfs releases goes from 9 years to 7 years (line 564), and target attainment from 10 years to 4 years (line 567). However, the new operating procedures rely more on the Animas River to meet these targets (line 555). If the increased system demand is truly concentrated in high runoff years, then this may not be a problem. In normal years, where is the source of this increased volume? It appears to come from the elimination of low flow targets that results in increased storage that is available for release. If this is true, then why the increased reliance on the Animas River to meet targets?

This is a good point, and the statement on line 555 likely led to this confusion. This sentence was simply trying to convey the fact that we can't hit the high 8000 and 10000 cfs targets without relatively high flows out of the Animas. There is NOT an increased reliance on the Animas to reach targets with this new decision tree. This sentence has been reworded to: "However, flows from the Animas River largely dictate the ability of both models to reach flow targets >5,000 cfs in critical habitat because of discharge limitations from Navajo Dam."

The document says the modification lowers the probability of shortage sharing (line 158) but also says that it increases the probability of shortage sharing by less than 1% (line 93). Which is it? It may be that both correct. Is the report stating that the recent drought is causing shortage sharing (see line 502) but the previous model did not include the recent drought? By implementing the modification, the probability of shortage sharing during droughts is lowered. This needs to be clarified.

These portions of the document have been reworded to reduce this confusion. Generally, if we are going to use the Gen4 hydrology model to quantify different probabilities of flows and shortages we needed to reword the goals of this process. Initially it was stated that we were trying to reach higher flow targets while REDUCING the probability of shortage. However, because the model runs using the 1999 Decision tree gave a zero percent probability of shortage (i.e., no year out of 84 experienced shortage in the model) it was impossible to reduce this probability, based on defining it by the model runs. Therefore, this verbiage has been reworded to state we were trying to increase the probability of reaching the high flow targets while keeping the chances of shortage sharing low.

After further review of the model outputs, there is a slight increase in the modeled probability of shortage (from 0 to 1.2% or 1 year out of 84), and this shortage occurred following the back to back extremely dry years in 2002 and 2003. This level of probability of shortage was also corroborated by BOR initial model runs used to identify what levels to set the EWYST targets (see Table 2 above, e.g. EWYST 6,050 ft has 2% chance of shortage from results from the Navajo Dam Operations model).

<u>Commenter: Tom Wesche, BC member representing Water Development Interests</u>

On behalf of the Water Development Interests, I appreciate the opportunity to comment on this important Program document for updating Navajo Dam operation procedures in our attempt to better meet the 1999 flow recommendations while minimizing spill and the probability of future shortage sharing. I continue to be supportive of the revised procedures we have developed through our workshop process and offer the following comments to hopefully clarify and strengthen this draft document. Once comments are received from all parties and a revised draft is developed, I would like to have an opportunity to review before it is finalized. Thank you.
General Comment: Overall, I found the document to be quite thorough, well-written, and understandable, although there are several exceptions to this that I will attempt to point out below with my more detailed comments. Also, the document would benefit from a short Summary/Conclusions section at the end. I remain supportive of the revised procedures described and feel not only will they benefit our endangered fish recovery efforts, but also current water use and future development in the basin.
A short Conclusion section has been added.

More Detailed Comments and Edits (by line):
Line 1 – Date and location information needs to be provided on the title page.
Date and location have now been added.

Line 68 – Delete the first "and".
Done.

Line 78 – Reword to say "higher discharges".
Done.

Lines 88 to 94 – Some clarification is needed here at the end of the Executive Summary to be certain the reader has a clear understanding of the model results being reported. First, I assume the comparisons between the 1999 and the 2017 trees were made with both trees based upon the revised available water calculation utilizing EWYST's of 6050 and 6063 ft.
Your assumption is not entirely correct; the models did not use the same EWYSTs we have now tried to make this clearer in the report. Several changes were made from the 1999 tree and these included, in addition to other factors, how "available water" was calculated each year. The 1999 decision tree did not 'target' an end of year pool elevation like the 2017 tree does, but rather it used a "minimum carry-over" storage level (~6,018 ft) when calculating the amount of "available water". For example, if the predicted pool elevation at the end of the year was below 6,018 ft the 1999 decision tree would prescribe 'no release'. If it was above 6,018 ft, there might be a release considering other factors (e.g., if a full hydrograph was recently released or not), but the model doesn't target a specific pool elevation at the end of the year. Therefore, because there were several changes simultaneously made to the decision tree it is difficult to contribute one specific change to the observed model results.

If this is not the case, there would appear to be little compelling evidence to move to the new 2017 tree. Clarification is needed in regard to the comparisons being made.
The compelling evidence to move to the new 2017 tree is the increased probability of reaching the higher flow targets while keeping the probability of shortage sharing low. The model results did indicate that using the 2017 decision tree with the new EWYSTs did result in shortage for a short period in January of 2004 after the extremely dry years of 2002 and 2003. These model results show very similar probabilities of shortage compared to initial model runs conducted by BOR when evaluating new EWYSTS levels (i.e., 2% at EWYST 6,050 ft; see Table 2 above). Moreover, BOR also indicated that an EWYST of 6,050 ft would provide protection against shortage for ~2 yrs, which it did in this case.

Second, the frequency increases of 3 and 7% need additional explanation. Using the 7% value as an example, does this mean that a 3-year recurrence interval flood event would now have a recurrence frequency of 3.21 years (3 + (3x0.07)) or does it simply mean that in any given year, a flow of a given magnitude (e.g. 8000cfs) has an enhanced occurrence probability of 7%. Depending on a reader's background, these percentages could be interpreted either way.
This is a good point. We now have tried to clarify that the model suggests that the annual probability of a given flow (for example 8,000 cfs target) has been increased by 7%.

Thirdly, the final sentence here about shortage sharing is rather strangely worded and perhaps quite misleading. At first glance, I interpreted this to mean we did nothing to improve the shortage sharing situation by switching to the 2017 tree. However, based on my first point above, I don't think this is the case. The original 1999 tree was based on an available water

calculation using a reservoir elevation of about 6018 ft, which according to Table 2, relates to a shortage sharing probability of about 18%. Using the revised procedure, this percentage drops to about 0%. This important difference needs to be clearly explained both here in the Executive Summary as well as later in the document on pages 23 to 26.

This is partly true, but you are mixing "apples and oranges" here a little bit. The 6,018 ft used to calculate "available water" in the 1999 tree is not an EWYST, the 1999 tree doesn't target a specific pool elevation at the end of the year. This 6,018 ft is rather a minimum carry-over storage level which is used to calculate 'available water' in the 1999 tree. We could have modeled the new EWYSTs in the 1999 decision tree and assessed those changes on the probability of shortage, however, the major goal of the changes to these operating procedures were to increase the probability of reaching the higher flow targets while keeping the probability of shortage low. We really don't need model runs to tell us that adding an EWYST of 6,063 ft to the 1999 decision tree would reduce the probability of shortage, it would. However, that change would not be reflected in the model as a change in the number of years the basin went into shortage because it never did (i.e., no years out of 84 experienced shortages with the 1999 tree). Moreover, just a change to a new EWYST doesn't help the Program reach the higher flow targets that have not been met. Therefore we modeled the several changes simultaneously.

Fourth, model error is mentioned on Line 94, but I don't believe it is discussed elsewhere in the document. Do we have an actual estimate of what that might be or is an assumption being made here about model error? Either way, a brief discussion of model error in the body of the document would be helpful.

This is a good point. However, there are a lot of different sources of potential error in the model which some may or may not be quantifiable. We really don't have a good idea about how much error exists in the model and we should really keep that this model is an imperfect mathematical representation of hydrology in the basin rather than reality when discussing these results. We have removed this statement.

Line 101 – Reword to read "responses of fish populations and habitat to variable…".

Done

Line 108 – Is there a citation for Gen 1 Model?

We have now included the Holden et al. 1999 citation for this statement.

Line 140 – Reword to read "accompanying higher flows".

Done.

Line 143 – Replace "larger" with "longer".

Done.

Line 144 – Should be "elevated" base flows.

Done.

Lines 156 to 163 – Very long and convoluted sentence. Should be broken into two, with first ending at end of Line 158, and Line 159 beginning with, "These two changes, detailed in the 2017 decision tree, are 1)…… and 2)……..".
Done.

Line 163 – Begin new paragraph with "The structure….".
Done.

Lines 210 to 217 – Add agency affiliation of each speaker.
Done.

Line 258 – Something is missing in sentence.
Fixed.

Lines 278 to 282 – Delete last sentence as it doesn't seem to fit with preceding text.
This sentence was omitted.

Line 293 – Delete "or long range plan" as this is confusing with the Program's LRP.
Done.

Line 295 – Suggest "research/monitoring".
Done.

Line 372 – What is a "prescriptive hydrograph"? Brief explanation would be helpful.
This was reworded to describe the four types of original hydrographs as well as added a figure at the request of another reviewer.

Lines 427 & 428 – We may need to "tweak" a few monitoring projects to better evaluate flows, but I think this sentence is a bit over-stated regarding need for new future projects.
We added 'tweaked or developed'.

Line 452 – Is this start of a new, major section or still a part of Workshop II?
This is a section in Workshop II.

Line 458 – Add "to" between "needed" and "meet".
Done.

Lines 543 to 558 – See comments above for lines 88 to 94. Same apply here. This is where more explanation could be provided. Also, the mention in Lines 557 and 558 regarding importance of Animas River flows in meeting higher flow recommendations needs to be included up front in the Executive Summary. In Line 552, should it be "21" not 20 days?
We have now included verbiage about the importance of the Animas runoff in meeting the higher flow targets. Line 552 should have read "21" not "20". Good catch.

Line 563 – Insert "of" between "duration" and "10".
Done.

Lines 573 to 575 – Misleading. See comments above for lines 88 to 94.
We don't think this sentence is misleading. See response to similar comment above.

After Line 575 – Add a Summary/Conclusions section here.
Done.

Box 1 and elsewhere – As we have little solid evidence to support the 10,000 cfs recommendation and no way to control flow to attain it without the Animas contribution, I suggest we consider merging it with the 8000 cfs recommendation and simply calling it, "8000 cfs and greater".
During this process the Program participants agreed that these targets should not be changed until we have more information to actually evaluate them. Moreover, merging the 8,000 cfs and 10,000 cfs target would effectively eliminate the 10,000 cfs as an actual target.

Line 642 – Under Biotic 1., we should add "growth and survival" to spawning.
Done.

Line 685 – The mention of 350 cfs would appear to conflict with the 250 cfs mentioned in Box 1, Line 638.
We have changed the "350 cfs" value in Box 3 to "not including water needed to maintain baseflow targets of 500-1,000 cfs" to avoid this confliction. This disparity occurred because 250 cfs is the absolute minimum from the ROD while the 350 cfs is closer to reality to what is needed to maintain actual base flows, but this volume can be variable.

Commenter: Bill Miller, BC member representing Southern Ute Indian Tribe

Thank you for the opportunity to review and comment on the subject document. I support the new modification to the operating procedures and feel it is an important modification needed to assist with recovery of the two listed species. Overall it does a good job of documenting the process used to arrive at the proposed modification to the Navajo Dam operating procedures to meet the 1999 Flow recommendations. I recommend that the executive summary clearly states that the Flow recommendations were not changed, however, the operating procedures in the 1999 Flow recommendations were changed.
This was made clearer in the executive summary.

I recommend that the use of the rather vague terms "SJRIP" and "the group" be clarified to identify who was responsible for the discussion, decisions made and actions taken. In most instances this can be clarified using the terms "SJRIP participants", "BC members" or "Program Office staff" as appropriate. The discussions and interim decisions are an important part of the process and should be clarified to inform the Coordination Committee members for the formal adoption of the report and modification to the procedures.
We changed most of these vague terms to "SJRIP participants".

I recommend the addition of a list of acronyms, which would be beneficial to readers not familiar with the SJRIP. I also recommend consistent use of either the full name or use of acronym throughout the various sections of the document.
Done.

I have made additional comments in the MS Word version of the draft document. Please contact me if you have questions.
Comments were reviewed and addressed where appropriate.

<u>Commenter: Brian Westfall, BC member representing Bureau of Indian Affairs</u>

Thank you for drafting the "Update to Navajo Name operating procedures for the 1999 Flow Recommendations for the San Juan River" and providing the draft for comment. We have been hoping for something like this since 2007 when we first recognized that the 1999 decision tree was calling for releases that were not effective in improving and maintaining habitat. We do have a few points that we think should be understood by the Biology Committee and should be clarified in the document.

The executive summary states "The San Juan River Basin Recovery and Implementation Program (SJRIP) reviewed and revised the 1999 Flow Recommendations and Navajo Dam operations for the San Juan River." This leaves the impression that the flow recommendations are being modified, when, in fact, only the Navajo Dam operating procedures are being changed. We suggest modifying the language to reflect what is actually being changed.
This suggested change was made.

We fully support the changes in the end-of-year storage target computations and the 2017 decision tree as presented in Figure 5 of the draft document for current depletion conditions. However, we are concerned that some may believe that this is the best operating procedure under all future conditions when it likely is not. The 1999 decision tree was based on baseline depletions, not current depletions and some of the statistics are still better with those operating criteria than the 2017 decision tree under baseline conditions (see the graphs below). For example, based on Gen 4 model runs completed by Reclamation, the 2017 decision tree results in longer maximum time between meeting the 8,000 cfs criteria under baseline depletions (Figure 2) when the goal is to meet those more frequently. We are not suggesting that the 1999 decision tree be retained, but that the 2017 decision tree be qualified as best meeting the desired flow results in the river under current conditions. It should be further acknowledged in the document, that as more information is obtained, the decision tree can be modified in the future.
This is a good point. We have added a "Conclusion" section that addresses this concern.

We have added a few edits to the document with track changes, but have not

inserted language to address the concerns listed above. If the document acknowledges that the 2017 decision tree is designed for current depletion conditions and will be evaluated in the future as depletions increase and as more information is gained about the needed flows in the river to support recovery, then we can support this update to the 1999 Flow Recommendations.

Please see the "Conclusion" section of the revised document.

Appendix I. BOR proposal for modification of available water calculation

September 9, 2014

PROPOSED

MODIFICATION OF AVAILABLE WATER CALCULATION FOR DETERMINING SPRING PEAK RELEASES ON THE SAN JUAN RIVER

BACKGROUND:

Navajo Reservoir has been operated since 2006 to follow the San Juan River Basin Recovery Implementation Program's Flow Recommendations (Flow Recommendations) for the San Juan River while meeting its originally authorized purposes in accordance with the April 2006 Record of Decision. The Flow Recommendations are intended to mimic a more natural hydrograph with the objective of increasing river channel complexity to support the habitat needs of endangered native fish. The Flow Recommendations were based on the best scientific information available at the time. To achieve the desired flow regimes, operations at Navajo Reservoir have been guided by a decision tree which uses the March 31st reservoir storage volume and projected spring runoff volumes as well as consideration of recent peak flow magnitudes and frequencies. The decision tree uses these inputs to determine the availability of water to be used for spring peak flow augmentation (Available Water). The Available Water volume is then used to determine a target magnitude and duration of current year spring reservoir releases timed to coincide with the Animas River peak, based on four prescribed hydrographs described in the Flow Recommendations. The logic behind the decision tree is based upon a statistical analysis of the historic gage record, existing water depletions, and projected future water depletions that have undergone ESA consultation.

It has been observed that the spring peak release operations since operating under the Flow Recommendations pursuant to the Record of Decision may not have achieved the expected outcome in terms of channel complexity and fish habitat development and maintenance. This habitat response may be attributed to an apparent change in hydrologic conditions in the 1999 to 2013 period as compared to the longer term period since 1971. See Figure 1 of the Hydrologic Modeling Analysis. Additionally, because of the inherent lack of flexibility in this process, the decision tree forces low magnitude, short duration spring peak flow releases in below average snow pack years. These releases do not appear to have achieved the desired habitat response and may be contributing to an acceleration of the loss of channel complexity. What we can say with surety is that operations under the current Flow Recommendations have resulted in a situation where we are making spring peak augmentation releases in the face of below average snow pack which has prevented the recovery of reservoir storage. This threatens the ability of the reservoir to make subsequent large, long duration spring peak releases,

maintain late summer base flows in the critical habitat reach, jeopardizes water supplies to water users, and increases the risk of needing to implement shortage sharing, while failing to achieve the desired habitat response.

PROPOSED APPROACH:

Reclamation and the Service are proposing two modifications to the Flow Recommendations. The first modification involves minimal changes but would only partially address the apparent weaknesses to the existing process. The second builds upon the foundation of the first modification by providing a mechanism to more fully address the apparent shortcomings of the Flow Recommendations. The proposed modifications could be implemented in phases as Modification # 1 could likely be implemented in a relatively short time frame. Modification # 2 will likely require more time and consideration to fully develop and implement.

Modification # 1 – Modified Available Water Calculation:

> An end-of-water year storage target would be employed to calculate the volume of Available Water. See Hydrologic Modeling Analysis for details of the proposed formula for computing Available Water. Based on Reclamation's operational experience and recent analysis, a minimum storage target of 1,225,550 acre-feet on October 1st (reservoir water surface elevation of 6050 feet), is adequate to meet the desired base flow range (500 to 1,000 cfs) in the critical habitat reach of the San Juan River and meet all legally entitled water demands, even with the prospect of a multiyear drought. However, Reclamation recommends a storage target of 1,412,737 acre-feet (reservoir water surface elevation of 6065 feet) to further reduce the risk of shortage while still providing a safe volume of available capacity to store excess inflow. See attached Hydrologic Modeling Analysis. A lower target will introduce a higher risk of shortages and would impact the ability to make larger magnitude long duration spring peak releases. A higher target increases the risk of a reservoir spill or flood control release which could occur at less than optimal times and conditions to support fish recovery efforts. However, any target used will result in the essentially the same Available Water for spring peak releases for a given year, as the only variable in the Available Water calculation is based on that year's natural hydrology.
>
> The Available Water volume would then be input into the existing decision tree to determine the prescribed magnitude and duration of spring peak release. Under Modification # 1 no other changes would be made to the existing (1999 Flow Recommendations for the San Juan River) process.

Adaptive Management:

The above modified approach to calculating Available Water will provide additional certainty for maintaining the desired base flow regime and protect against shortages in the San Juan River Basin;

however, by itself, it will not address the need to reconsider how to best manage Available Water to achieve the fish recovery objective recognizing the apparent change in basin hydrology and less than optimal habitat response to current operations under the Flow Recommendations.

An additional modification to the current process could provide a more flexible decision making process to guide future Navajo Reservoir operations. This proposed modification is similar to a successful adaptive management process employed at Flaming Gorge Reservoir to implement flow recommendations for the Green River. Further information regarding the Flaming Gorge process can be found at: http://www.usbr.gov/uc/water/crsp/wg/fg/twg/twgSummaries.html

While we recognize that this is a generalized approach to implementing an adaptive management process which will require more specific details, we believe it is a start towards a more flexible process which will provide for a dynamic adaptive management approach to species recovery. The general concept is that the Biology Committee would rely upon the current state of knowledge to formulate hypotheses for recovery of the species. Selected hypotheses would be tested with experimental releases developed as outlined below. An example hypothesis could take the form of, "San Juan River flow regimes should disadvantage reproductive success of non-native fish species as a primary objective to recover endangered fish species", or "Navajo Reservoir operations should be directed at achieving less frequent, larger magnitude and longer duration spring peak flows to achieve more habitat complexity as a primary objective to recover endangered native fish". These hypotheses are only provided as examples and are not being recommended as part of this proposal. They are simply provided as the types of hypotheses the Biology Committee would be asked to formulate and test as part of the Adaptive Management Framework Alternative. The Program's existing or modified field monitoring efforts would be utilized to determine the validity of the hypotheses and serve as a feedback loop for further refinement to operations. This approach, with adaptations to specific physical and institutional considerations unique to the San Juan Basin, is summarized below:

Modification # 2 - Adaptive Management Framework:

> As the snow pack develops in the January through May time period and more reliable runoff projections are obtained from the Colorado River Basin Forecast Center, Reclamation would use the end-of-season storage target to calculate the volume of Available Water. The Available Water estimates, beginning with the final March forecast, would be made available to the San Juan Recovery Program (Program), Program Directors Office (SJRP_PDO) as they are developed. The SJRP_PDO would distribute the estimates to the Biology and Coordination Committees.
>
> The SJRP_PDO, utilizing the Available Water volume estimates provided by Reclamation and the scientific expertise of the Program Biology Committee, would formulate a recommended spring peak augmentation reservoir release. This process would necessarily be iterative in nature as the initial Available Water estimates will be based on early snowpack information that is likely to change. Reclamation would make a final declaration of the volume of Available Water for spring peak flow augmentation using the final May runoff forecast or earlier forecast if an early Animas River forecast is projected.

The recommendation would include the timing, magnitude and duration of the reservoir release as well as modifications to the field monitoring program if needed. The recommendation may also include other attributes as determined necessary to achieve the intended objective. The San Juan Recovery Program may also utilize other technical expertise as determined appropriate in formulating a recommended spring peak release. The recommended spring peak release would be based on the best available scientific information regarding the habitat/recovery needs of the listed fish species and comply with the operational side boards established by the April 2006 Navajo Reservoir Final Environmental Impact Statement (FEIS). The recommendation would be presented to the Program Coordination Committee for review and approval. The approved recommendation would then be transmitted by the SJRP_PDO to Reclamation within one week after receiving the final Available Water declaration for spring peak flow augmentation as a final flow request letter.

The request letter will be made available to stakeholders and the general public as part of the established Navajo Reservoir operations meeting process to identify stakeholder concerns. Reclamation would consider the final flow request letter, along with expressed stakeholder concerns, in the Navajo Reservoir operations plan. Just as currently is the case, Reclamation would retain the right to modify recommended operations if they would result in public safety hazards, compromise the integrity of Navajo Dam or violate the FEIS operational sideboards.

Other Considerations:

Some comments on the previous version of this proposal inferred that the volume of water released from Navajo Dam would be altered if operations were modified as described under this proposal. Neither of the proposed modifications will change the volume of water that must be released from the reservoir as compared to current operations over the long term. Rather the timing and shape of the hydrograph could be modified such that water would only be released for spring peak augmentation purposes if there was a sufficient amount of Available Water. The proposed methodology would force large volume spring flow augmentation releases to be made only when large snow pack conditions exist and small volume releases in low snow pack years, rather than speculate on future hydrologic conditions. The net effect over time will be a nearly identical augmentation release volume, but with different temporal distribution and reduced risks of shortages. Under either method the amount of augmentation volume available is still dependent on the natural hydrology.

Currently the Program relies on spring peak flow augmentation metrics as a component of Endangered Species Act compliance for current and future water resource development. Modifying the Flow Recommendations, as outlined in Modification # 2, will require a different approach to Endangered Species Act compliance which understandably causes concern. Alternative ESA compliance metrics that could be considered are fish population status, habitat response, Navajo Dam operations that comply with the Services annual final flow request letter and/or meeting Long Range Plan schedules.

National Environmental Policy Act (NEPA) compliance for both Modification # 1 and # 2 should be straight forward as long as the sideboards of the FEIS are not violated. If the adaptive management

approach indicates a need to deviate from these sideboards, additional NEPA compliance would be required, but would be driven by a more thorough understanding of species recovery needs, based on the results of the adaptive management experimentation.

Other issues and concerns will undoubtedly be identified and will need to be resolved through the collective efforts of Program participants. However, no action on the part of the Program with our current knowledge of the weaknesses associated with the Flow Recommendations presents its own risks.

RECOMMENDATION:

As a first step towards implementation, Reclamation and the Service recommends that the Program convene a technical workshop to provide a forum for further discussion and analyses of the proposed modifications. The expected results of the technical workshop would be the further refinement of the proposed modifications and/or development of new or hybrid modifications; and, identification of issues and further analyses that would be needed to provide the basis for selection and implementation of an alternative.

San Juan River Environmental Flows Workshop 1
Executive Summary and Notes

February 12th and 13th, 2015

Executive Summary Prepared By:
San Juan River Recovery Implementation Program

2105 Osuna Road NE
Albuquerque, NM 87113

Notes Prepared By:
Alliant Environmental, LLC

7804 Pan American Fwy, NE, Suite 5
Albuquerque, NM 87109

San Juan River Basin Recovery Implementation Program
Environmental Flows Workgroup Meeting Workshop #1
February 12-13, 2015, Albuquerque, NM

Executive Summary

The San Juan River Basin Recovery Implementation Program (Program) Biology Committee (BC) held an environmental flows workshop Feb. 12-13, 2015, to initiate a process to increase the effectiveness of implementing the Program's 1999 San Juan Flow Recommendations (Holden 1999) and reduce the risk of future water shortages in the San Juan River Basin. The operations decision tree, used annually since about 2006, to implement the 1999 Flow Recommendations resulted in frequent low-magnitude spring releases and limited releases that met the higher flow targets. Miller (2006 Integration Report) found that the low-magnitude, 2,500 cfs and 5,000 cfs flows, did not appear to maintain habitat as expected in the absence of the higher 8,000 and 10,000 cfs flow targets. Under the combination of these operations and the hydrologic regime of the last 20 years, frequent water shortages have also occurred in the San Juan Basin. With improved science, data collections, and changing hydrology, it was widely recognized for some time that the 1999 Flow Recommendations needed to be revisited and revised. The question in front of the BC during the workshop was how to attain higher spring peaks on a more frequent basis and reduce the risk of shortages. The priority needs for the workshop were to develop a new process for implementing the 1999 Flow Recommendations and develop a plan to initiate a process to review and revise, as needed, the 1999 Flow Recommendations. Until the new process was completed, an interim recommendation for environmental releases in 2015 was also needed.

The Program was established in 1992 as a result of an Endangered Species Act section 7 consultation on the Animas-La Plata Water Development Project (ALP) in Colorado. The two goals of the Program are to: (1) recover the endangered Colorado Pikeminnow and Razorback Sucker in the San Juan River Basin; and, (2) allow for continued water development in the basin. The Program implements numerous recovery actions to benefit the endangered fish including environmental releases from Navajo Dam to improve habitat conditions for the native fishery in the San Juan River Basin. In 1999, the Program developed flow recommendations for Navajo Dam releases to provide the framework for flow targets needed to mimic a natural hydrograph. A Navajo Dam operational decision tree provides annual release criteria needed to meet the various flow targets. Reclamation has operated Navajo Dam under this decision tree since 2006 (under the 2006 Record of Decision for ALP).

Prior to Flow Workshop #1, Reclamation proposed an alternate way to implement San Juan River flow recommendations utilizing an End of Water Year Storage Target (EWYST) to calculate the volume of Available Water for environmental releases from Navajo Dam. The volume of water in excess of EWYST is deemed "available water" that can be released from Navajo Dam for environmental purposes (given the release constraints of the dam). Based on Reclamation's operational experience and modeling results, an EWYST of 6,050 feet on October 1st (minimum storage target of 1,225,550 acre-feet) is adequate to meet the desired base flow range (500 to 1,000 cfs) in the critical habitat reach of the San Juan River and meet all legally entitled water demands, even with the prospect of a multiyear drought. However, Reclamation recommended an EWYST of 6,065 feet (storage target of 1,412,737 acre-feet) to further reduce the risk of shortage while still providing a safe volume of available capacity to store excess inflow. The second part of Reclamation's recommendation was to develop an adaptive management framework for more flexible decision-making to best manage Available Water to achieve the fish recovery objectives recognizing the apparent change in basin hydrology and less than optimal habitat response to current operations under the 1999 Flow Recommendations. Reclamation's proposal was reviewed and revised by both the Program's Coordination Committee (CC) and the BC. Both committees

voiced general support for pursuing the strategy recognizing the proposed process did not change the current flow recommendations; it just changed how the environmental water would be released from the dam on an annual basis to achieve the flow targets.

During the workshop, several presentations were given that provided participants with relevant background information including: 1) 1999 Flow Recommendations and reservoir operating procedures; 2) Reclamation's operational limitations for implementing the 1999 decision tree; and 3) Hydrology modeling analysis of Navajo Reservoir operations. Other presentations included: 1) Environmental releases experiment being conducted by the Upper Colorado Endangered Fish Recovery Program at Flaming Gorge Dam in northern Utah; and, 2) Overview and Update of San Juan River Hydrology Model Gen2 and Gen3.

There was general agreement among workshop participants that the original 1999 decision tree does not function as originally intended under current San Juan River hydrology resulting in frequent low-magnitude, one week peak releases that do not achieve the higher flow targets. The benefits to fish and habitat from these short duration peaks have not been observed. In addition, the reservoir is maintained at a lower elevation resulting in a higher risk for annual shortages in the San Juan River Basin. Modeling shows the EWYST method will maintain the reservoir at a higher elevation providing more frequent longer duration peak flows while minimizing the risk of shortages. Model results show 6,052 ft. is the minimum EWYST to avoid shortage and 6,063 ft. is the maximum EWYST to avoid spill and minimize the risk of shortage.

Consensus was reached during the workshop to pursue the EWYST method and replace the "decision tree" of the 1999 Flow Recommendations with a more flexible way to utilize available water. For 2015, two major factors to be considered in making Navajo Dam releases for environmental purposes include: 1) EWYST elevation is 6,063 ft. with flexibility to drop to 6,050 ft. for biological flexibility (e.g., extend flow duration from 3 weeks to 5 weeks); and, 2) The shape, timing, and duration of the spring peak release hydrograph can be modified through adaptive management to meet the Program goals. In addition, environmental release decisions need to include monitoring to measure fish and habitat responses to flows. In support of the recommended process for 2015, the Service specified that as long as the environmental flow (e-flow) release recommendations come from the Program through the BC, they will be considered the best science available for progress toward recovery of the listed species and deemed to be in compliance with the 2006 ROD. The group also agreed that unless significant changes occurred in the predicted hydrology and Available Water for 2015, the BC recommendation would be to forego a one-week spring peak release in 2015 (given most probable forecast).

An interim process for determining 2015 Navajo Dam environmental flow releases was also developed (see flow chart in workshop notes). The process includes:

- Step1 - Reclamation provides the Available Water Calculation (AWC) based on the EYWST to the Biology Committee by **April 1**.
- Step 2 - The BC formulates and provides a draft recommendation for 2015 Navajo Dam e-flow releases to Program Office by **mid-April** based on: a) EOYWST/available water calculation (Reclamation's model); b) Desired or appropriate San Juan River hydrograph; c) Review of fish and habitat response to flow; and, d) 1999 Flow Recommendations.
- Step 3 - The recommendation for 2015 Navajo Dam e-flow releases is provided to the CC through the Program Office by **mid-April**. The CC reviews the recommended releases and provides any comments to Reclamation and the Service.
- Step 4 - Reclamation and the Service works out the final details toward accomplishing the recommendation for 2015 Navajo Dam e-flow releases based on the May forecast (including an ESA compliance check). If significant change in the May forecast has occurred, the BC will re-evaluate

the draft recommendation and submit modifications, if necessary (process resets to Step 2-BC formulates and provides a draft recommendation to the Program Office).

- Step 5 - Reclamation implements the final recommendation.

The agreement to implement the EWYST method was based on it being an interim process for determining Navajo Dam environmental releases until a full evaluation and modification of the 1999 San Juan River Flow Recommendations could be conducted during a second workshop. A conceptual framework/outline for Workshop #2 was discussed. Attendees recommended that the Program Office take the lead on planning for and organizing a second workshop. To do this, a workgroup will be formed to deal with workshop details and logistics such as pulling together relevant documents and reports, identifying information needed prior to the workshop, and developing priority hypotheses. It was agreed that it would be beneficial to get as much background work accomplished as possible prior to the second workshop. Outstanding tasks identified from the workshop included: 1) determining how to "use" available water; 2) evaluating the effects of flows from the 1999 Flow Recommendations; and, 3) revising the 1999 Flow Recommendations, as necessary.

Notes were taken during Workshop #1 by an independent, third party recorder. The draft workshop notes were reviewed by the BC and all comments received were incorporated. The workshop notes provide a detailed accounting of discussions that occurred and decisions that were made during the workshop but they are not necessarily a BC consensus product. This document and all Workshop #1 background materials are available on the SJRIP website at:
http://www.fws.gov/southwest/sjrip/SJREFW.cfm

San Juan River Environmental Flows Workshop 1 Meeting Notes

February 12th and 13th, 2015

Prepared For:
San Juan River Recovery Implementation Program

2105 Osuna Road NE
Albuquerque, NM 87113

On Behalf Of:
U.S. Bureau of Reclamation

125 South State Street
Salt Lake City, UT 84138

Prepared By:
Alliant Environmental, LLC

7804 Pan American Fwy, NE, Suite 5
Albuquerque, NM 87109

Table of Contents

Read Aheads and Preparatory Documents i

Acronyms and Abbreviations List ii

DAY ONE: February 12th, 2015 1

1.0 Opening and Introductions: 1

2.0 PRESENTATION: Background on 1999 Flow Recommendations and Reservoir Operating Procedures 1

2.1 Discussion and Questions 3

3.0 PRESENTATION: Reclamation's Operational Limitations for Implementing Decision Tree and Hydrology Modeling Analyses of Navajo Reservoir Operations 4

3.1 Discussion and Questions 7

4.0 GROUP DISCUSSION: Develop draft recommended available water calculation/end-of season volume 13

- *Decision Item: Forego 1-week release in 2015* 14
- *Decision Item: Accept Proposed Methods and Revised Decision Tree* 14

5.0 PRESENTATION: Flaming Gorge Environmental Releases Experiment 14

5.1 Discussion and Questions 15

6.0 GROUP DISCUSSION: Discuss development of process for determining 2015 Navajo Dam environmental release, including but not limited to identifying information that will be needed (what), the sequence for decision-making (who), and timelines (when) 16

- *Decision Item: 2015 Process Flow Chart* 18

7.0 PRESENTATION: Overview and Update of SJR Hydrology Model Gen2 and Gen3 18

7.1 Discussion and Questions 19

8.0 Group Discussion: Finalize Recommended Available Water Calculation 19

- *Decision Item: Setting of the EOWYST* 20

9.0 NEPA/ESA compliance check: 20

10.0 Conclusions and Wrap-up: 20

DAY TWO: February 13th, 2015 21

1.0 Opening and Re-Cap of Day One 21

2.0 Group Discussion: Discuss options and objectives for evaluating and modifying the 1999 San Juan River Flow Recommendations during Workshop #2 including but not limited to goals, requirements, outstanding questions, needed analyses/information, stakeholders, and timelines..... 22

4.0 Group Discussion: Develop draft conceptual framework/outline (or possibly draft agenda) for Workshop #2 25

5.0 Group Discussion: Finalize recommendations for conducting Workshop #2 to evaluate and modify the 1999 San Juan River Flow Recommendations 28

6.0 Workshop Conclusions and Wrap-Up 29

San Juan River Environmental Flows Workshop 1: Attendees 29

Read Aheads and Preparatory Documents

In advance of the San Juan River Environmental Flows Workshop #1, read aheads and preparatory documents were posted on the San Juan River Recovery Implementation Program webpage. Additional information may be found there as well: **http://www.fws.gov/southwest/sjrip/**

- **Specific Workshop #1 documents included:**
  - *Modeling Analysis of Navajo Reservoir Operations (Behery, January 2015)*
    - http://www.fws.gov/southwest/sjrip/pdf/workshop/1-Modeling_Analysis_Navajo_Reservoir_Operations_Jan-2015.pdf
  - *Proposed Modification of Available Water Calculation for Determining Spring Peak Releases on the San Juan River (Reclamation/Service Sept. 9, 2014)*
    - http://www.fws.gov/southwest/sjrip/pdf/workshop/2-Proposed_Modification_SJR_flow_Recommendations_Sept-9-2014.pdf
  - *Draft memo recommending Operating Rules change BC to CC (May 16 2007)*
    - http://www.fws.gov/southwest/sjrip/pdf/workshop/3-Draft_flow_recommendation_memo_BC_to_CC_May-17-2007.pdf
  - *Memo regarding New Op Rules Model Runs Keller-Bliesner to Hydrology Committee (Oct 9 2006)*
    - http://www.fws.gov/southwest/sjrip/pdf/workshop/4-Model_Runs_New_Operating_Rules_K-B_HC_Oct-9-2006.pdf
  - *SJR Draft Final Integration Report (Miller 2005)*
    - http://www.fws.gov/southwest/sjrip/pdf/workshop/5-SJR_Draft_Final_Integration_Report_Miller_2005.pdf
  - *SJR Flow Recommendations (Holden 1999)*
    - http://www.fws.gov/southwest/sjrip/pdf/workshop/6-Flow_Recommendations_San_Juan_River_Holden_1999.pdf
  - *Gen2 and Gen3 model run flow statistics spreadsheet (Run_Comparisons_G3.xls)*
    - www.fws.gov/southwest/sjrip/pdf/workshop/7-Gen2_Gen3_Run_Comparisons.xls
  - *Information relevant to the Flaming Gorge process*
    - http://www.fws.gov/southwest/sjrip/pdf/workshop/8-Links_Flaming_Gorge_Process_Information.pdf
  - *Summary Report For The San Juan River Basin Recovery Implementation Program Habitat Monitoring Workshop, January 11 – 12, 2012*
    - http://www.fws.gov/southwest/sjrip/pdf/workshop/9-Summary_Report_SJRRIP_Habitat_Workshop_SWCA_Feb-8-2012.pdf
  - *KB Response to Revision of Available Water Calculation*
    - http://www.fws.gov/southwest/sjrip/pdf/workshop/KB_Response_Revision_Available_Water_Calcuation_January-2015.pdf

Acronyms and Abbreviations List

ac-ft	Acre-feet
BO	Biological Opinion
CBRFC	Colorado Basin River Forecast Center
CC	Coordination Committee
cfs	Cubic feet per second
EIS	Environmental Impact Statement
EOWYST	End of Water Year Storage Target
ET	Evapotranspiration
FY	Fiscal Year
HR	Habitat Restoration
LTP	Long-term Plan
LTSP	Larval Trigger Study Plan
NEPA	National Environmental Policy Act
NIIP	National Infrastructure Protection Plan
Pike Minnow or PM	Colorado Pike Minnow
Program	San Juan River Recovery Implementation Program
Reclamation	U.S. Bureau of Reclamation
RERI	River Ecosystem Restoration Initiative
RIP	Recovery Implementation Program
ROD	Record of Decision
RM	River Mile
SJR	San Juan River
Sucker or RZB	Razorback Sucker
USFWS or Service	U.S. Fish and Wildlife Service

DAY ONE: February 12th, 2015

1.0 Opening and Introductions:

- Jim Brooks opened the workshop and welcomed everyone. He explained meeting logistics and introductions were made. The purpose of this two-day workshop is to "initiate processes to reduce risk of water shortage in the San Juan River Basin and increase effectiveness of implementing the 1999 San Juan River Flow Recommendations."
- The agenda was reviewed and the Flaming Gorge Environmental Releases Experiment Presentation was moved to earlier on Day 1.
- Sharon Whitmore briefly shared the background on the San Juan River (SJR) Recovery Implementation Program (RIP) and Flow Recommendations:
    - The San Juan River Recovery Implementation Program (Program) was established in 1992 with the goals to: (1) recover listed endangered species and (2) allow for continued water development in the basin. In 1999, the Program developed flow recommendations for Navajo Dam releases – these flows were intended to mimic natural flow releases. In the 2006 Record of Decisions (ROD), an alternative 250,000 acre-feet (ac-ft) was selected as a way to implement the flow recommendations.
    - With improved science, data collections, and changing hydrology, it has since been recognized that the 1999 Flow Recommendations need to be revisited and revised. The changing hydrology and system constraints have made meeting the flow recommendation challenging.
    - The Bureau of Reclamation (Reclamation) has put forward a proposal to modify the current Decision Tree process (under the 2006 ROD) as a way to reduce the risk of shortages as well as improve the ability to meet the flow recommendations.
    - This workshop was convened to work on the release process and flow recommendations for 2015. The 2015 process is an interim process while the flow recommendation revision process continues. Additional objectives include discussing possible future workshops.

2.0 PRESENTATION: Background on 1999 Flow Recommendations and Reservoir Operating Procedures

- Brian Westfall and Ron Bliesner, with Keller-Bliesner Engineering, LLC, were introduced. They began a background presentation on the 1999 Flow Recommendations and reservoir operating procedures. This presentation covered review of the background and history of the flow recommendations and discussion of some of the current challenges.
- Attendees were reminded that the goals of the Program and the flow recommendations are to: (1) conserve populations of the Colorado Pike Minnow (pike minnow or PM) and Razorback Sucker (sucker or RZB) and (2) proceed with water development.
- During a 7-year research period, the fish populations and habitat response to reregulation of Navajo Dam has been analyzed and data has been collected.
- *Foundations:* The foundation of the 1999 Flow Recommendations included the "mimicry of statistical parameters of flow based on flow/geomorphic/habitat linkages and the statistical variability of the pre-dam hydrology rather than mimicry of each annual hydrograph."

Therefore, the resulting flows will not mimic a natural hydrology in all years, but will mimic the variation and dynamic nature of the 65-year record of the San Juan River.

- *Basin Model:* Using the operations of Navajo Dam under various scenarios, the San Juan Basin Model was developed as a modeling tool to explore the relationship(s) of flow along the river. Hydrographs from 1929 through 1993 were used to simulate flow in the river at various gaging points. Post-processing was utilized to derive daily flow from monthly data for evaluation of the flow statistics.
    - The results identified specific flows of particular benefit to the biology and habitat (see handout Table S.1.). These translated into the hydrologic recommendations and ultimately the Decision Tree that influences the operations of Navajo Dam.

- *Assumptions:* The underlying assumption is that over a long period of time, history will repeat itself; if the conditions were met during the past 65-years, they will be met in the future. To the extent that the water supply is different in the future, then the natural conditions would also be altered and the conditions of mimicry would be maintained, although the exact flow recommendations statistics may not be met.
    - What has been observed is that historic conditions will eventually be met, but the "patterns" have shifted. The revised recommendations would still mimic nature, but "nature" may be different. The flow recommendations are doing what they are supposed to do – but they are mimicking a different system compared to what it was in the past.

- *Elements of the Flow Recommendations:* The flow recommendations specify flow magnitude, duration, and frequency targets. The runoff period extends from March 1st through July 31st. The 5,000 cfs maximum release out of Navajo Dam cannot meet the high flow statistics alone.
    - *High Flow:* The High Flow criteria are 10,000 cfs for 5-days. A high flow must occur once in a 10-year period. The intended purposes of the high flows are to (1) overbank the river; (2) generate new cobble sources and spawning habitat; (3) increase habitat complexity; (4) nutrient loading to improve habitat productivity; and (5) provide flow and habitat deemed important to the pike minnow and sucker. We may determine some of this criterion is no longer accurate or attainable for today.

    - *Medium Flow:* One of the middle-range flow criteria is 8,000 cfs for 10 days. This type of flow must occur once every 6 years. The target is to get the river "bank full" once every 3 years.

    - *Medium Flow:* A second middle-range flow criteria are 5,000 cfs for 21 days. The maximum duration of not meeting this flow is 4 years. Frequency is dependent on perturbation storms requiring flushing in about 50% of years and is critical to the maintenance of pike minnow spawning at River Mile (RM) 132 and the moving of cobbles. This flow recommendation was based partially on observed, physical river processes and not just statistics. This particular flow targets the cleaning of fine sediment out of backwaters.

    - *Low Flow:* The low flow criteria are 2,500 cfs for 10 days. The maximum duration of not meeting this flow is 2 years. This level of flow is enough to trigger a pike minnow spawn but it is recognized that higher flows are better. The frequency specified represents a need for frequent spawning conditions.

    - *Base Flow:* Base flow criterion is 250 cfs from Navajo Dam to Farmington and 500 cfs from Farmington to Lake Powell. This flow enhances nursery habitat conditions and backwater habitats.

- *San Juan Operating Model Rule Decision Tree*: The San Juan Operating Model Rule Decision Tree provides operating criteria for Navajo Dam operations to meet the flow recommendations and fulfill commitments made as part of the Biological Opinion (BO). Hydrographs were developed for various time frames of 1 to 4 weeks. The hydrograph is overlaid on top of base flow to get to the volume numbers (which range from 114,000 ac-ft to 344,000 ac-ft).
    - *Definitions:*
        - Carryover storage – is water in the reservoir that remains at the end of the year. It is similar to End of Water Year Storage Targets (EOWYST). The water year ends on September 30th.
        - Perturbations – a year in which the nursery habitat has been deteriorated by storm events to a level requiring flushing. In other words, a year in which there have been more than 13 sediment event days between August 1 and December 31. To determine perturbation, if a 6th day is greater than 150 cfs *more* than the previous 5-day running average, this is defined as a perturbation event.
- *Flow Challenges:*
    - Examination of the 10-year running mean-average flow indicates that the system is no longer having high flows. There has not been a "bumper" flow for a long time. In other words, there has not been a very wet years above the average. The reality of this is that it is now very challenging to get to the 8,000 cfs and 10,000 cfs flows.
    - 2005 was one of the wettest periods in record and has strongly influenced the statistics.
    - Encroachment of non-native vegetation has resulted in an "armoring" of the channel and banks in many of the reaches. The combination of riparian vegetation changes and loss of high flows has resulted in significant challenges.
    - It has also been determined that, by itself, 5,000 cfs flows do not do what they were supposed to do. It doesn't improve habitat unless the flow reaches 5,000 cfs, but then continues to increase to a larger flow (of 8,000 cfs or greater).
        - Similarly, there is no correlation (or observable changes) between 2,500 cf flow days and cleaning cobbles even in decent runoff years. This doesn't necessarily mean that no areas get cleaned, it is just that forcing a 2,500 cfs release in poor water years is not cleaning the cobbles as anticipated.
- *Conclusion:* The Decision Tree and flow recommendations were developed with the information available at the time. But we now have better information and more data. Some revisions have already been initiated, but there is general acknowledgment that more changes are needed in order to meet the changing system.
    - One suggestion is to consider not attempting to "force" a hydrological peak that nature isn't going to provide or support. An 8,000 cfs or 10,000 cfs river cannot be accomplished without the Animas River contributions and even then there is a timing issue. The concept that Reclamation is proposing [see Section 3.0 of these notes] is correct – to store up water to have the resources available to release higher flows and less "smaller" flows.

2.1 Discussion and Questions

- ***Comment***: The fitted line in the negative habitat response graph is basically meaningless. A linear relationship could have been "drawn."
    - ***Response:*** This is a correct observation. Big flows are needed to do the "big work." Dumping a 5,000 cfs flow for 21 days is not enough to get the work done. This is partially due to the armoring of the banks.

- ***Question***: Where did the hypothesis originate that a flow of 5,000 cfs for 21 days would have a significant physical effect?
    - ***Response:*** The flow recommendation came from years in which similar flows were observed to clean the channels. However, there was an auto-correlation occurring as those flows continued from 5,000 cfs to 8,000 cfs or greater.
    - Even though there are only 5 data points, the data and the observation on the river indicate the same things – the 5,000 cfs flows do not clean out the backwater areas and there is no increased functionality.
- ***Discussion:***
    - The 2005 Revised Flow Recommendations included investigation of the ability to obtain high peak flows (of 8,000 cfs and greater) during runoff periods. The shape of the ascending and descending limbs of the hydrograph was changed. It also resulted in the recommendation to focus on achieving higher flows at the expense of not meeting the 2,500 cfs and 5,000 cfs flow recommendations. This resulted in a simplified Decision Tree.
    - Reclamation's recently recommended changes [see Section 3.0 of these notes] simplify the Decision Tree even further. The underlying question is "why force a release that doesn't do any good?"
    - Similarly, it has been determined that the perturbation releases don't work at all either (don't provide enough water to accomplish any cleaning) so those have been eliminated as well.
- ***Comment:*** It almost appears that the river seems to "bounce along" and then suddenly there are big changes. Even with high flows, the river "meanders along" for a while but then there is a big change year (example: 1995 and 2008).
    - ***Response***: Previous to 1999, the river system was actually very different due to more water (and higher flows). The "reset" in 2008 is harder to explain. Cobble mobilization is a local effect - even at bankfull cobbles won't necessarily be transported at all locations. The system is neither aggrading nor degrading; but it is becoming narrower and this changes the total wetted area. The armoring of the channel also impacts how the system functions.

3.0 PRESENTATION: Reclamation's Operational Limitations for Implementing Decision Tree and Hydrology Modeling Analyses of Navajo Reservoir Operations

- Ryan Christianson, with Reclamation, provided background information on the operation of Navajo Dam.
    - Navajo Dam has been operating on the revised recommendations and Decision Tree from 2006. As operators, Reclamation has to meet contractual obligations and all commitments on the project. Over the last several years, the reservoir levels have become critically low and there are real concerns with shortages in the river basin. These concerns include having enough resources to meet baseflows in drought conditions. Reclamation has developed a concept – an idea to provide some protection in a multi-year drought by "saving" supply toward larger release flows for the species.
- Susan Behery, with Reclamation, then presented on Reclamations Operation Limits for Implementing the Decision Tree and Hydrology Modeling Analyses of Navajo Reservoir Operations.
    - *Concerns and Challenges:* The hydrology reduction (water available) in the San Juan Basin is one of the main concerns. There has been an 18% decrease in the

average inflow into Navajo Reservoir over the last 15 years. The drier conditions are forecasted for the future as well. Stakeholders and operators have to plan for this.

- *The Implementation of the Flow Recommendations and Decision Tree:* Using the Colorado Basin River Forecast Center's (CBRFC) inflow forecast (2x monthly from January to the end of July), the hydrology predictions for spring are calculated. Remember that the forecasts can change until just before a spring release and this can result in a modified decision.
    - There is usually a "spread" in what can happen – between the minimum and maximum of the forecast. In recent years the system tends to be typically drier than the forecasts. In only 3 of the last 15 years did the actual hydrology turn out to be higher than the predicted hydrology.
    - 2014 has been the only year to date that the Decision Tree wasn't followed. A "one week" release was recommended, but the decision was made by Reclamation and the SJRIP to forego that release due to the drought. There is the prospect of getting "stuck" in a small-release "cycle" in the Decision Tree due to below-average water years.
        - The 2,500 cfs flow recommendations have been met due to the Animas River flows having enough to cover the recommendation without a release.
- *Reclamation's Proposed Changes:*
    - One suggested change is to **operate Navajo Reservoir on an annual basis** – in part because the reservoir hasn't been able to "recover" in subsequent years. This would be done by adjusting the **Available Water Calculation – focusing on an End of Water Year Storage Target (EOWYST);** the proposal is to start and end the water year at the same lake elevation every year instead of having a small carryover storage that protects the reservoir for 1 year only.
- *Modeling:*
    - The differences in spring peak release frequency, size, and timing between the original and proposed methods are being modeled to help determine the change in probability of shortage or spill (see explanation of 'spill' below).
    - Modeling was also used to help determine which EOWYST will provide the most insurance against shortage while minimizing the probability of spill.
- *Recovery Period:* Within the bounds of a single water year, neither method does much better than the other due to the same limiting hydrology. The difference is in the recovery period. Reservoir levels recover quicker with the proposed changes thereby reducing the risk of shortage.
    - In response to a question regarding the risk of using data from 1970 through 2013 compared to just using the 1990s and on, it was responded that the modeling was completed as 2 separate analyses for just this purpose.
    - In response to a question regarding how the lake elevations are changing the available water, it was shared that if lake elevation is low (ex. 6020 ft.) and the following year is very dry, there will be a shortage. But if the lake elevation is between 6050ft. and 6060 ft. and the same dry year (same hydrology) follows, the reservoir will go down, but is not critically low.
        - If lake elevation is too high, then there is risk of having to "spill" the water. "Operational Spill" water is excess water that has to be released quickly for storage or flood control reasons to prevent uncontrolled spill. Spilled water can almost be considered "wasted"

as it is not available for habitat or other environmental uses. EOWYST above 6064 ft. is too high.
    - If lake elevation is too low, then a single dry year sees very little inflow, but high diversions resulting in shortage situations.
    - If the lake elevation is at a "sweet spot" (~6063 ft.), then the reservoir can afford to drop 20-30 ft, still meet demands, and be able to recover more quickly - and thus be in a better starting situation for whatever the following year brings.

- *Changes Under the Proposed Method:*

Original Method	Proposed Method
Less periods of "no releases"	More periods of "no releases"
More 1-week releases	Less periods of 1-week releases
Less periods of higher flow releases	Increased frequency of higher flow releases

  - The water that would have otherwise been "used" or available for the 1-week releases could be "held" toward higher magnitude flows (which are the most beneficial and provide more "bang for the buck.")
  - In other words, there would be more frequent Type 2, Type 3, and Type 4 flows at the expense of reducing the Type 1 flows – using the same decision tree hydrographs and same baseflow volumes that are in the current flow recommendations. And baseflows are the same for each type of release.
    - In response to a question regarding the potential to have to "chase the base flow," it would depend on the year. If available water remained after one of the prescribed hydrographs, then the release could be held slightly higher than the minimum required, and the number of summer changes would be reduced.

- *Flow Statistic Comparison Graph:* Under the proposed method, the lower flow recommendations will be met less often; but the higher flow recommendations are more likely to be met more often.
  - In response to a question regarding how the releases were centered (timing of release), it was responded that the Navajo release is centered on June 4th in the model which produced better flow statistics than trying to chase the Animas peak. There is potential to improve the flow statistics if we could reliably forecast the Animas peak in time to adjust the release from Navajo.
- *End Of Water Year Storage Target (EOWYST):* Several model runs of 5-year drought cycles were done to inform the selection of an EOWYST in order to maximize safety while reducing the risk of shortage in the reservoir.
  - The drought scenarios showed the increasing below-average conditions that have been seen over the last fifteen years as opposed to the longer-term record
  - Under all statistical drought scenarios, an EOWYST of 6063 ft. was successful in avoiding a shortage for at least 3 years.
  - *EOWYST Recommendations*:
    - The minimum elevation to avoid shortage is: 6052 ft.
    - The maximum elevation while avoiding spill is: 6063 ft.
    - Reclamation's preference is to "aim" for a higher elevation based on the extended period of dry hydrology and the resulting higher risk of shortage.

- In response to a question on the statistics of the diversions (how often/how much), it was responded that those weren't analyzed for this process. This model was "gage to gage" as a statistical model. However, the worst year (2002) was run 5 consecutive times to model a worst case scenario.

- *Comparison of Current and Proposed Methods for Implementation Now:*
  - Hydrology/inflow was presented, based on the February 3rd CBRFC forecast.
  - The date for the EOWYST is September 30th (end of the water year).
  - Reclamation continues producing twice-monthly calculations.
  - Potential spring peak releases:

Original Method	
2015	1-week spring peak release
2016	1-week spring peak release

    - Under the original method, a 1-week spring peak release would be called for in both 2015 and 2016.

  - In the proposed method:

Proposed Method		
EOWYST (ft.)	Year/Release	Year/Release
6030	2015: 2-wk spring peak release	2016: full hydrograph (Type 4)
6040	2015: 86,000 af available water	2016: full hydrograph (Type 4)
6050	2015: 0 releases	2016: full hydrograph (Type 4)
6060	2015: 0 releases	2016: 3-week peak release
6070	2015: 0 releases	2016: 3-week peak release

    - The reservoir elevation has to be built up, but once met there will then be opportunity to produce necessary high pulse flows.

3.1 Discussion and Questions

- At the conclusion of the Proposed Methods presentation, attendees asked questions and held a "round robin" table discussion.

- ***Question***: How "good" are the Animas predictions?
  - ***Response***: Animas predictions have only been done for the last 2 years but it is better than just centering over the June 4th date. However, it is not perfect.
  - Looking at release patterns in history, the first peak of the Animas tends not to be the biggest. There is the risk of releasing to match the Animas only to determine it was a "false" peak.
  - The peak is one of the most difficult to forecast and operators have to provide a week's notice in anticipation of a spring peak release. The Animas peaks are driven by temperature.

- ***Comment***: If there is agreement to the EOWYST, a high water year could raise lake elevation beyond the EOWYST which would require a "dumping" of water at the end of the year to maintain the agreed-to elevation.
  - ***Response:*** Correct; the goal would to be start and end every water year around the agreed elevation (e.g., 6050 ft. or 6065 ft.). There needs to be sufficient space in the reservoir to capture big snow years but covers the dry years as well. The elevation goal is not a "rule" but a target that considers flood control, drought, species needs, etc.

    - If needed/necessary, a fall spike release for flood control purposes would be made. However, in reality and practice, it is better to increase the target baseflow throughout the season(s) instead of waiting until the end of September. Remember, September is in the middle of monsoon season and the reservoir can come up ~10ft or more.

- ***Question***: In the new approach, elevation target "feeds back" into the management of the reservoir to achieve that goal?
    - ***Response***: Yes; the Available Water Calculation determines what type of spring peak can be made.
    - Reclamation is proposing to operate with a higher EOWYST volume in order to be prepared for multiple drought years.
    - The available water will not necessarily match the releases made. But the intent is to go into the following year with a certain "bank of water." Under the original method, the reservoir can get much lower.
    - Essentially, there is an increase in the carryover storage.

- ***Question:*** How much impact/influence, if any, does the recreational use of Navajo Reservoir have on the management of the water?
    - ***Response***: They have input if there is an excess of water, but they have no real driving input.

- ***Question***: What is the difference between carry over and EOWYST? Carry over looks at how the flow recommendation(s) had been met in the previous year?
    - ***Response:*** Carry over doesn't look back directly, but does consider the previous releases.
    - The proposal is to do an annual "accounting" – so once the target elevation has been reached, inflow will basically equal outflow. Animas annual scale of hydrology (i.e. if Animas is having a big year, Navajo will release like a big year, if Animas is having a small year, Navajo hydrograph will be smaller, etc)

- ***Comment****:* Concern was raised that the fish would "bear the brunt" of the "shortage" until the reservoir elevations have been met. What do these "interim" years mean in biology terms for the needs of the fish? We know they need the full hydrograph which will be delayed until the lake reaches elevation.

- ***Question:*** To give us a sense of comparison, if lake elevation were at 6060 ft. in 1999 and given the actual hydrology (actual inflows, 2012 NIIP, etc.) what are the predicted model results? How would the recent years look compared to how they actually turned out?
    - ***Response:*** The models that Reclamation ran used the actual inflow and actual hydrology (gage data) for the period. The releases from Navajo are modeled. Reclamation modeled the predicted releases based on which method was selected.

- ***Question:*** There is general understanding that the proposed changes will increase reservoir elevation to provide "insurance" toward avoiding shortage situations, but how long is it going to take to get to that reservoir elevation? It can be assumed that there will be little or no spring peak releases during that time. And the situation may remain the same in terms of providing base- and other flows. Isn't it likely that once the water user demands have been met the recovery of the reservoir prevents other flows/releases?
    - ***Response***: Operators have been following the decision tree – making small releases that result in low reservoir elevation at the start of every water year. There have been multiple dry and below average water years. Even in a great water year, there would be challenges in meeting flow recommendations because

it is a struggle to recover the reservoir. If the starting elevation can be raised, then there will be more opportunity in the future to use good water years for the environmental flows.
    - The idea is to get more of the higher flow years by shifting the operations to target the bigger releases. The bigger flows become the focus by avoiding having to "dump" water in dry years when there is no real benefit to putting that water in the river. If the reservoir can be kept higher, then there will likely enough to release something even in poor years. This is a good interim solution until the flow recommendations can really be revised.
    - Realistically, there won't be any spring peak releases anyway during bad drought years. But under the proposed methods, there would have been some water in 2016 available to make some releases (assuming 2016 is a near normal year).
    - The current path is a "death spiral" unless something changes. The flow recommendations need to be revised, but we have this interim period that has to be addressed.
    - There have been no releases over the last 2 years but that is because there has been no water. Current lake elevation is 6038 ft.

- ***Comment:*** Keller-Bliesner Engineering worked with Reclamation, reviewed the model, and developed a revised decision tree based on model used by in this analysis. The major difference is the lack of look-backs. In the current decision tree past releases are used to in make decisions on the current years release. The new method doesn't really account for past releases.
    - However, the proposed method accomplishes getting rid of some of the ineffective, smaller releases (Type 1 – 1-week at 5,000 cfs).
- ***Comment:*** The statistics from the period of record may very well not apply now, but the proposed method makes the best of what is coming in. Another thing to keep in mind is that if the drought conditions stay as is, then this is moot since we can't make the high releases anyway.
    - ***Response:*** The experience we are having now is outside of history.
    - The past can't just be "thrown out" but the future is going to be a lot different.
    - The adaptive management framework can be modified to incorporate the ability to "look back" while making decisions on releases.
    - Decision makers need to stay away from "just the year we are in" but to make determinations based on the "best way to assist" the fish with what is given.
    - The target elevation has to be "set" in order to calculate the Available Water. Managers will have the opportunity to determine what to release given the constraints.
    - Some attendees see this as a 2-step process: (1) make the collective decision to implement the EOWYST and create additional carry over storage; and (2) available water will be used for a spring peak or other environmental flows or experiments.

- ***Question***: Were any "stress tests" run?
    - ***Response***: Yes; the 5-year drought sequences with 2002 conditions back-to-back. Running 2002 conditions 5 years in a row was the most severe and is assumed to be "off the charts" and would result in no "rescuing" the reservoir.

- ***Question:*** Regarding the potential modification of the base releases, those still won't go above 1,000 cfs? Just moved up toward that upper limit? The low end (500 cfs) is not optimum for the backwater habitats.
    - ***Response:*** Increasing base flows toward the upper limit of 1,000 cfs could be investigated but this has not been modeled.

- ***Comment:*** Keep in mind that these fish evolved many years ago and have experienced horrendous drought in the past. There is a reason the fish live to be 30-40 years. They are resilient to environmental "changes." Adults might only successfully spawn every 10-15 years. Why release small amounts of water with little benefit when "give an all you've got" releases in intervals could have the most impact. Bank as much water as possible to support maximum releases that can create conditions for successful spawning.
- ***Comment:*** It is intriguing to compare both methods – the differences are "not that far off" when graphed. But there is a paradigm shift occurring. In terms of the biology of the fish, they no longer live to be 40 years old. They evolved to handle the good times for a while as well as the bad times for a while. But they are now dealing with contaminants, non-native fish and vegetation, etc. The biology component needs to be considered. What are the real stressors the fish can stand up to? Avoiding shortage is a good thing – but until the elevation is built up, the fish might be the ones "getting shorted."
    - The fish that were resilient to drought lived in certain areas, but this means we need better management of the water we do have.
- ***Comment:*** Currently, low reservoir elevation means that high flows can't be released even in wet years. Once the EOWYST is reached and held, there will eventually be the situation where more frequent high flows are possible.
- ***For Consideration:*** If there is less than 90,800 ac-ft of available water, how should it be used? "Bumping up" base flow or holding the water (for a spike or higher EOWYST)? Thoughts?
    - ***Comments:***
        - The Biology Committee could determine experiments/testing/research opportunities (such as releasing smaller amounts for a set duration). The BC could spend time "fine turning" what is done with the monitoring, looking at specific questions, management tools, non-flow alternatives, etc.
        - Maintaining flows around 1,000 cfs means more consistent habitat. Longer periods between higher flows mean that non-native vegetation is able to encroach and establish on the habitat. That in turn might increase the duration of dry periods and loss of habitat quality.
        - 750 cfs seems to be a critical level. There is the need to increase the baseflow if the hypothesis of losing the secondary channels is true. There is a lot of sand "stuck" in the system. This exasperates the system by not providing flushing flows.
            - ***Response:*** The 5,000 cfs flows are not enough to move the sediment and keep the secondary channels open. It takes the bigger flows to accomplish that work. But the frequency is too infrequent without help from the Animas. It suggests that some combination of keeping nursery habitat and increasing base flow may be the best option.
    - ***Comment:*** One of the strengths of the original flow recommendations is the look-back. A look-back should be included in order to monitor the response of fish and habitat to flows.
- ***For Consideration:*** If the baseflow is increased and we target a higher EOWYST, what are the thoughts on how the system is managed?
    - ***Comments:***
        - If the base flow is set at 750 cfs, then there will be less available water.

- There is a tradeoff but if available water is <90,000, baseflow can be raised to 1,000 cfs. There would be more wetted area but some of the backwaters would be lost (more flow). However, every one of the River Ecosystem Restoration Initiative (RERI) sites would be flowing at 1,000 cfs (they don't at 750 cfs).
- This is not a long-term setting, but a yearly decision.
- If the group agrees to move forward with these recommendations – even as an experiment - there won't be any releases in 2015.
    - Using the most probable and maximum probable forecasts, there would be no releases in 2015 and limited water for some adaptive management in 2016.
- There is a wide range of variability in the forecast even in May. While there are outlying years (2005 – wet; and 2002 – dry), the system is usually trending in some "known" direction by May.
- ***Question:*** How did the lake elevation change with not having a spring release in the last 2 years? How long away are we out from getting to a higher (selected) elevation?
    - ***Response:*** The lake elevation has been on the road to recovering the last two years because there has been no spring peak release. However, it is below average for this time of year. The reservoir is currently at 6038 ft.
    - In response to a question regarding the total volume of diversion every year, it was shared that the total volume of diversions out of the river every year are ~350,000 ac-ft but the total outlet release averages ~600,000 ac-ft not including NIIP (around 230,000 af right now) – a lot of that is for the base flow.

- ***For Consideration:*** The proposed changes make an effort to minimize the shortage risk but from a biological perspective, do we know how "bad" delaying releases are for the fish?
    - ***Response***: There have been 0 (zero) flow days at Bluff prior to the Flow Recommendations implementation (in 88-years of continuous record at Mexican Hat there were 16 days of 0 cfs flow). The fish have survived past droughts but a lot has changed since then (ex. invasive non-natives).
    - Lower flows can be detrimental to non-native fish especially in the summer. However, lower flows mean loss of habitat for the native fish as well. And the native fish don't really have the option of traveling kilometers to find suitable habitat.
    - There needs to be sufficient water (baseflow) to entrain the eggs in the nursery habitat in order to see recruitment to Age 1 (example given of Kevin Bestgen's work in the Green River).
        - It was countered that the Green River is a very different system than the San Juan and it is not known if they are comparable from a larval perspective. But larvae and juveniles can end up "stuck" once flows recede.

- ***Comment:*** It is assumed that increasing base flow results in increased low velocity habitat by keeping secondary channels connected to the river. It is not necessarily "a given" though that increasing base flow helps fish in low velocity habitat (ex. razorback sucker, mosquito fish, etc.)
    - Distinctions need to be made on the different habitat types: in-river low velocity; off channel; or side channel habitat; etc.

        - The numbers of days with less than 500 cfs have decreased and the non-native fish population crashed. It appears to be detrimental to non-natives but this does not necessarily make it beneficial to the natives.

- ***For Consideration:*** The goal is to come to some agreement on the calculation of available water and EOWYST. Then hold discussions about what the 2015 flows and releases could look like.
    - ***Question:*** What is the volume difference between the lake elevations?
        - ***Response:*** It depends on where the elevation is but loosely: 1 foot = 10,000 ac-ft in the reservoir for lower elevations and 1 foot = 15,000 ac-ft at higher elevations.
        - It was clarified that the lake elevation will be managed so it will return to that target by the end of the water year (same starting and ending point). An early runoff can be stored causing the reservoir to rise (e.g., from starting point of 6050ft. to 6080 ft.). But that water will then be managed – and released as a spring peak. The lake elevation may go below 6050 ft. as a result of the release, but the remainder of the year is managed to bring the elevation back to 6050 ft. if hydrology allows. The risk occurs when the elevation drops too low.
        - It was also clarified that Reclamation is not proposing storage of any specific flow target (ex. Type 4 flows = 344,000 ac-ft).
        - The EOWYST method and the annual hydrology determines the available water for the next year – the idea is to be able to adaptively manage what is available. Upper and lower targets may provide flexibility to move water.

    - ***Question***: If there is little flexibility to store water for environmental releases, won't that force us into "perpetual" small releases?
        - ***Response:*** According to the statistic runs, the proposed method actually has less risk of perpetual small releases than the original method; the tradeoff is that there is higher probability of years without *any* release. This has to do with size of the releases targeted and calculations of how much water is available - which is dependent on the hydrology. There could be multiple years of no releases, but a big release could be accomplished in the first "good year." Big, longer duration releases would have a better chance of "tracking" the Animas peak.
            - In the proposed method, the time between big events actually decreases. Within the proposed decision framework, the timing between really big events (Type 3 and Type 4 releases) decreases from every 5 to 6 years to every 3 years, even during drought.
            - It was pointed out that from a biological stand point; the reduction in time between the big flow events actually helps to reduce/prevent the cementing of the Russian Olives.
            - The statistics on the 10,000 cfs flows didn't vary significantly between the original method and the proposed method. The real benefit comes at the 5,000 and 8,000 cfs range – there is a higher probability of having 3-week releases more often.
        - Concern was expressed that setting an EOWYST could produce a "use or lose" situation instead of more flexibility with carry over.

    - ***Question***: Is there a difference – in terms of the target elevation – between 6063 ft. and 6050 ft.? Does it matter in terms of how often there will be a release?

- ***Response***: No, not for the big releases; there is basically no difference. The difference comes when the original method is compared to the proposed method.

- ***For Consideration:*** To address the biologist's concern about flexibility, it was suggested attendees consider setting a "standard" elevation target of 6063 ft. but if a bigger release is needed in some years, then target elevation could be lowered to 6050 ft..
  - The objective is to consider the cost-benefits between the different target elevations and the amount of shortage "risk insurance." For example, 6045 ft. would still "buy" 2-years of insurance against shortage under the 90% exceedance hydrology (1999 -2013).

4.0 GROUP DISCUSSION: Develop draft recommended available water calculation/end-of season volume

- After a break, Jim Brooks reconvened the group and highlighted the major discussion topics that were identified during the previous Question/Answer session. Attendees were reminded that the proposals and suggestions are "short-term fixes" until the fish responses to management actions can be analyzed (flow recommendation review). The goal is to develop interim strategies to address 2015 releases. Highlights from the morning discussions include:
  - Flexibility in the system;
  - Ability to alter base flow is important;
  - Decisions regarding the proposed method changes and setting of an EOWYST; combined with adaptive management to determine annual releases;
  - Release decisions need to include monitoring to measure species responses;

- The current proposals for consideration are:
  - (1) Setting a "standard target" elevation of 6,063 ft. with a flexibility range to reduce to 6,050 ft. for biological flexibility (ex. extend flow duration from 3 weeks to 5 weeks).
  - (2) Set EOWYST at 6,050 ft. for the next 2 to 5 years as an interim level, to have water available for environmental purposes sooner. Increase the elevation to 6,063 ft. after a few years or with the next big water year.
    - Realistically, unless 2015 is a really big water year, a lake elevation of 6,050 ft. won't be achieved this year.

  - ***Comment:*** Unless there are significant changes in the predicted hydrology, there will be no spring peak release for 2015. However, the decisions reached today could inform/guide the potential process for future years. There are concerns that a lack of inflow will limit the testing/monitoring that should occur during this interim process period. How could/should baseflow be altered this year?
    - In both the proposed and original methods, the prediction is the same: no spring peak releases for 2015. More than likely, the EOWYST won't affect operations for 2015. Therefore, a higher EOWYST could be aimed for.
    - The reason this decision is important now (instead of postponing since operations are likely to be unaffected) is that (1) under the original methods, the Decision Tree would call for a 1-week release and (2) there is need to have the agreed-to process in place prior to April 1.
      - In support of the proposed changes, the key is to not just "send water down the river" this year if it is not expected to accomplish anything.
      - It was pointed out that the Program has decided to forego the 1-week release before without setting reservoir elevation targets.

        - In response it was shared that while true, the setting of EOWYST has added benefit in terms of decreasing risk of shortage in future years.
    - ***Question:*** How would a late monsoon affect operations?
        - ***Response:*** A late monsoon could result in a fall spike release at the end of the water year in order to reach EOWYST. However, with enough advanced notice, the excess would be released incrementally as increased baseflow.

- At this time in the discussion, Jim Brooks facilitated a poll on the agreement to accept the proposed method (decision tree) changes. It is recognized that the current decision tree results in an unintended "loop" of 1-week releases during below-average water years that are not thought to be beneficial to the fish or habitat maintenance.
    - As a point of clarification, the probability of meeting flow recommendations of 10,000 cfs would not really change under the proposed method but the probability for the 5,000 and 8,000 cfs flows increase. Under the proposed method, more full hydrographs will be released compared to the original method.
    - The assumption is that the fish will benefit from longer, higher releases at the appropriate times. Going to this new approach creates the likelihood of reaching those longer, higher flows more often given the same hydrology.
    - Given the current lake elevation and most probable forecast, foregoing the 1-week release and basic operations in play (base flows), ~ 8 to 9 ft could be gained in the reservoir this year.
    - Between 2012-2014 when there were no releases, the habitat didn't change significantly. Periods of no release might keep the non-native fish population down. The smaller spring releases are not showing a strong relationship with the native fishes.

- ***Decision Item: Forego 1-week release in 2015***
    - In a call for responses, attendees supported forgoing a 1-week release for 2015, regardless of other decisions. No objections or disagreements were voiced.

- ***Decision Item: Accept Proposed Methods and Revised Decision Tree***
    - With support of the majority of attendees, it was recommended that the Program accept the proposed methods and revised decision tree.

5.0 PRESENTATION: Flaming Gorge Environmental Releases Experiment

- Ms. Beverly Heffernan, with Reclamation, was introduced. She began the Flaming Gorge Environmental Releases Experiment presentation.

- *Description and Background:*
    - Rising 502 feet above bedrock, Flaming Gorge Dam (FGD) impounds waters of the Green River to form the reservoir. The reservoir has a total capacity of ~3.9 million ac-ft At full elevation of 6,045 ft., it has a surface area of 42,020 acres.
    - There are 3 reaches:
        - Reach 1: Flaming Gorge Dam to the Yampa River confluence;
        - Reach 2: Green River confluence with Duchesne and White Rivers; and
        - Reach 3: Green River confluence with the Colorado River.
        - There is spawning and nursery habitat for both the Pike Minnow (PM) and the Razorback Sucker (RZB) in Reaches 2 and 3.

        - Keep in mind that during spring runoff, the Yampa is responsible for 65% of the volume (on average).
    - In 2005, impact analysis of the Flow and Temperature Recommendations for Endangered Fishes in the Green River Downstream of Flaming Gorge Dam (Flow Recommendations) from 2000 were finalized.

- *Flow Recommendations:*
    - According to the 2000 Flow Recommendations, spring peaks are focused on the importance of 18,600 cfs in Reach 2 in average years;
    - FGD releases should be timed to match peak, or immediate post-peak of the Yampa river; and
    - FGD releases should be timed to coincide with the presence of sucker larvae.

- *2014 Larval Trigger Study Plan (LTSP):*
    - The LTSP was implemented as part of the Upper Colorado River Endangered Fish Recovery Program Spring Flow Request. It was a 6-year study of the larval triggers and timelines.
    - One of the important goals of this program is the entrainment of larval RZB in designated wetlands. However, the flow recommendations put emphasis on the timing of peak flows with the Yampa River rather than on the timing of larval drift. In 2012, most wetlands dried up before juvenile fish could be returned to the river.
    - This lead to the recommendation to pursue flow revisions (shifts) which would better support the species needs.

- *Conclusions:*
    - The Service supports the research – the larval trigger study provided the biological benefit that is equivalent to meeting the peak. While Reclamation is still under the existing Decision Tree and therefore has to meet the first peak, increased flexibility has allowed for more focus on the second peak.

5.1 Discussion and Questions

- There is an acknowledged trade-off between "matching the Yampa's peak" and getting as much water as possible to as much habitat as possible.
- The flow and temperature recommendations are specifically aimed at avoiding thermal shock at the confluence.
    - The original thought was that "matching" the timing with the Yampa peak would be the correct timing for the entrainment of the larvae. That turned out to be incorrect and operations needed to shift the releases from Flaming Gorge to accomplish larval habitat and entrainment.
- The value of the Flaming Gorge example is not the differences between the systems, but the recognition that there are other things that can be used to determine how to manage the use of available water other than just following the path of spring peaks magnitude/frequency/duration. It is an example of thinking "outside the box."
    - As an example, the Flaming Gorge Flow Recommendations were put into effect, but it was subsequently determined that changes were needed. This is conceptually the same process that the SJR RIP is experiencing now.
- The Flaming Gorge example also highlights the need to determine the benefits of base flow versus peak flows.
- In response to a question on the timeline of the FGD Flow Recommendations to the initiation of the larval study, it was responded that the Flow Recommendations were completed in 2000, the EIS in 2001, and the ROD in 2006. Spring 2006 was the first

spring of operation and the larval study was completed in 2012. As a 6-year study, it ran in parallel with the recovery program.

6.0 GROUP DISCUSSION: Discuss development of process for determining 2015 Navajo Dam environmental release, including but not limited to identifying information that will be needed (what), the sequence for decision-making (who), and timelines (when)

- In a working session, workshop attendees brainstormed and discussed potential process(es) for 2015 (and potentially future interim years).
- Attendees were reminded that the process for release determinations will need to follow the San Juan procedural process. Once recommendations are developed and passed through the Program office, the preferred actions would be provided to Reclamation and the Service.
- Concerns were raised on whether or not to include the 1999 Flow Recommendations in the Process Flowchart. Some members expressed the opinion that the intent was to move away from the flow recommendations and metrics and therefore they would not be required on the flowchart. However, other attendees expressed the opinion that the 1999 Flow Recommendations are the "foundation" and driving force of the existing process and therefore should remain as a part of the interim process until they have officially been revised.

- Identified "component" parts of the 2015 Process Flowchart included:
    - SJR Technical Working Group (a.k.a. Biology Committee) – will make the 2015 E-Flow recommendation(s) to the CC;
        - The recommendation will be based on:
            - (1) the 1999 flow recommendations;
            - (2) SJR hydrology;
            - (3) Available water calculations; and
            - (4) default recommendations (Reclamation's model).
            - Attendees debated whether or not to keep or remove the 1999 Flow Recommendations from the 2015 Process Flowchart. It was agreed that until the Flow Recommendations are revised, they should remain in the process. It is recognized that the metrics were valid even if not current.
        - An Adaptive Management component will be added in the form of a "feedback" loop that incorporates "new knowledge/new information/planned experiments" into the BC's recommendations.
    - The CC – as the deciding body of the Program will then "bless" the preferred actions and submit them to Reclamation and the Service.
    - Reclamation and the Service as the action and regulatory agencies – to work out the final details toward accomplishing the preferred actions (including ESA compliance).
    - Reclamation as the implementing agency.

- In support of the recommended process for 2015, the Service specified that as long as the "preferred actions" (or recommendations) come from the Program and they are in compliance with the ROD, then the Service will accept them as the best available science with which to move forward with recovery.

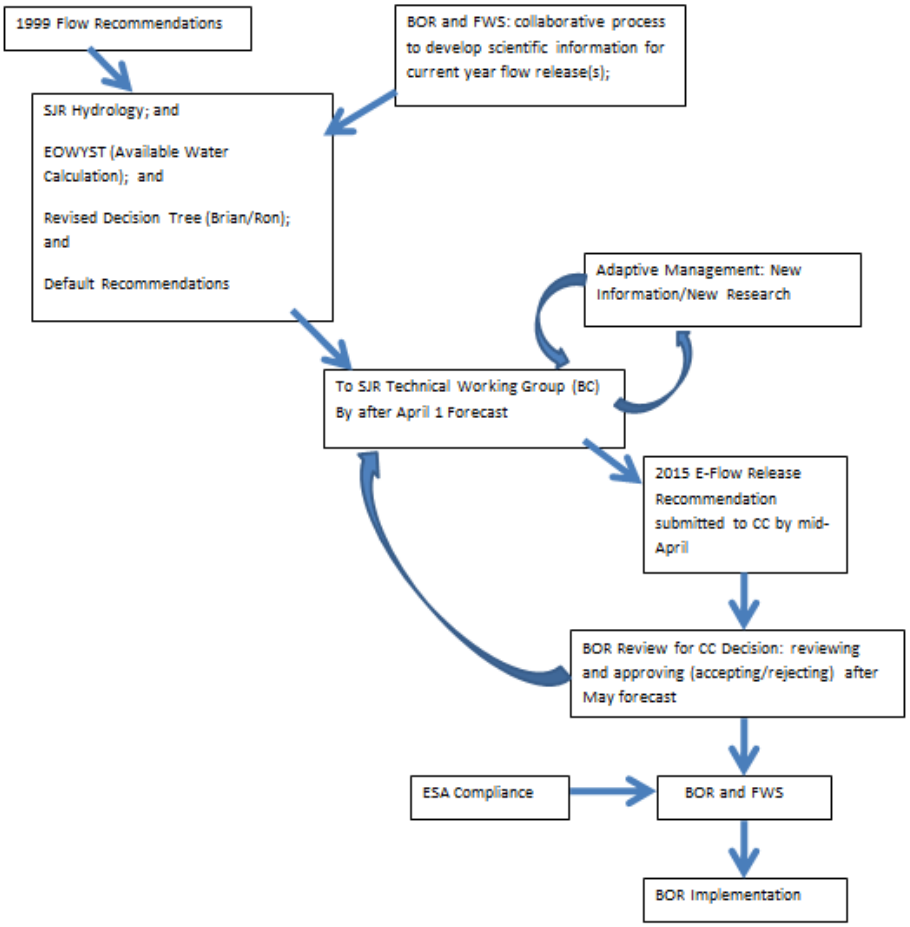


Figure 1. Draft Proposed 2015 Process Flow Chart

- ***Question:*** For a number of projects, consultation compliance depends on meeting specific flow recommendations (Section 7/ESA issues). This is a change from how those projects were analyzed – could it potentially trigger reconsultation with those projects?
    - ***Response:*** Service representatives shared that it is not necessarily a conflict. The preferred actions will be based in part on what water is available to move down system. And no, reconsultation is unlikely.
- ***Question:*** Is there enough scientific information on the benefits of increasing base flow from 500 to 750 or 1,000 cfs? What are the benefits to the fish?
    - ***Response***: Increased base flow opens up the secondary channels. But it would be prudent to treat this as an experiment and actually measure the effects (test the effects at lower flow and higher flows).
        - On-the-ground monitoring of restored sites will occur in 2015.
- ***Question:*** Flaming Gorge set their elevation target in the spring. What is the difference in meeting elevation in the spring or the fall?
    - ***Response:*** For Navajo Dam, the water year ends in the fall (September 30th). There needs to be reservoir space for the possibility of monsoons, and early run off.
- ***Comment:*** From a NEPA perspective, the goal is to avoid the necessity of having to redo NEPA analysis on flow recommendations by remaining in compliance with the last environmental impact statement.

- *Contracting Considerations*
    - In response to a question regarding the ability to complete experiments and hypothesis testing this year, it was shared that there would be limited ability to use existing contracts to accomplish new work.
    - The BC could discuss what flexibility, if any, is available in relevant/existing scopes of work and contracts.
    - ***Question:*** What latitude, if any, exists under current scopes of work? It may be a moot point for 2015, but should be considered in the process in order to be availed in 2016.
        - There is no flexibility within the Habitat Restoration (HR), stocking, monitoring, or non-native fish removal projects. However, it is not necessarily impossible to find flexibilities within other contracts.
        - Before any modifications are attempted, the BC needs to first identify the pertinent questions that are to be addressed through the change in work.
            - It was suggested the BC develop a list of questions that can be addressed during appropriate years. This would enable crews to have contingencies built-in in order to mobilize in time.
        - With some "cleverness" and relatively "simple tweaks" it could be possible to test certain hypotheses under existing constraints. For example, monitor the changes in wetted habitat when base flow is at 500 and when it is increased.
        - Identified actions, activities, and hypotheses have already been captured in the Long-Term Plan (LTP). However, the BC can develop additional information requests and research needs every fall.

- ***Decision Item: 2015 Process Flow Chart***
    - Attendees agreed to the brainstormed 2015 Process Flow Chart for 2015. Use of the Process Flow Chart after 2015 is not a given but is subject to extension only upon further review.

7.0 PRESENTATION: Overview and Update of SJR Hydrology Model Gen2 and Gen3

- Ms. Behery provided an update on the San Juan River Hydrology Models.
- *Background and Evolution:*
    - Gen2 was a monthly timestep model while Gen3 is a multi-model approach with conversion to a daily timestep for application of the flow recommendations. However, Gen3 is difficult to maintain and impractical to operate. As a result, a simplification process was begun and Gen4 is in progress.
    - Gen 4 uses StateMod natural inflows. The states provide their own evapotranspiration (ET) data and irrigated acres which are used to calculate diversions and depletions.
        - Riverware calculates depletions (implemented upstream of Navajo).
        - Everything above Navajo has been consolidated to the Pine, Piedra, and San Juan.
    - The ET - acres method is being implemented downstream of Navajo. Further simplifications for users included:
        - Additional Riverware updates and improvements to simplify the interface for transparency and ease of data updates. These changes will not change calculations or results.
        - The documentation process is underway and the model will be calibrated.

- *Next Steps:*
    - The updated natural flow data (StateMod runs and ET and acres data from states) should be available in mid-March.
    - The model will be calibrated over incidental losses in spring/summer 2015.
    - Further simplifications to user interface and model transparency are scheduled for summer 2015.
    - Documentation should be completed by summer 2015 with review to occur late summer/fall 2015.
    - Any identified "loose ends" are to be fixed/addressed by the end of FY2015.
    - Gen4 should be completed as early as this summer and available for use while is being reviewed.

7.1 Discussion and Questions

- ***Question:*** What is the most current year?
    - ***Response:*** The hope is to have 2014 data included but some state data may only be available through 2013.

8.0 Group Discussion: Finalize Recommended Available Water Calculation (Workshop Outcome #1)

- Returning to the discussion on the calculations for available water, attendees revisited several key points that had been identified earlier.

- The current proposals for consideration are:
    - (1) Setting a "standard target" elevation of 6,063 ft. with a flexibility range to reduce to 6,050 ft. for biological flexibility (ex. extend flow duration from 3 weeks to 5 weeks).
    - (2) Setting EOWYST at 6,050 ft. for the next 2 to 5 years as an interim level, to have water available for environmental purposes sooner. Increase the elevation to 6,063 ft. after a few years or with the next big water year.

- ***Comment:*** If an EOWYST is set for 2015, even at a lower elevation, there will be no water available to do any releases. However, we either have to set the EOWYST or find another way to calculate available water for 2015.
    - ***Response:*** There is a chance for more snow and moisture, even if slim, and there needs to be a plan in place for such a situation.
    - We need to agree on a method for calculating available water but that method can have flexibilities built in.
    - Why put off the decision to set an EOWYST? What is there to lose? Even if there is no immediate difference this year, that does not justify "pushing it down the road." The sooner the decision is made, the faster we reach the pattern of higher flow releases.
    - There is no knowing how long the drought will continue. The probability of not moving toward wetter years is one reason why Reclamation has developed this proposed change(s).
    - Based on the discussion, it was advocated that the EOWYST be set at 6063 ft. with the caveat to lower that elevation if there were compelling biological needs.

- ***Comment:*** Set the "standard" EOWYST high (6063 ft.) but allow the elevation to be decreased to 6050 ft. at the discretion of the Program. This introduces flexibility to call for up to an additional 160,000 af of water.
    - ***Response:*** If the EOWYST was set lower (6050 ft.) a peak flow could be released sooner. The fish will not be getting the needed large flows while the reservoir

volume is building to 6063 ft. It has been too long since any big release has occurred and an EOWYST of 6050 ft. increases the likelihood of available water for environmental flows sooner instead of later. The reservoir would recover faster at the lower EOWSYT.

- ***Recommendation:*** It was suggested that Reclamation provide two water calculations: (1) one for EOWYST of 6050 ft. and (2) one for EOWYST of 6063 ft. The BC then determines which has the best species benefit for that year.
- If the EOWYST is set at 6050 ft. and a great late winter/early spring is realized, then the elevation could potentially exceed the target resulting in "excess" water having to be "dumped."
- At 6063 ft., there is virtually 0% chance of spill while the reservoir is in average water years but the higher the EOYWST the higher the probability of spill in a really good water year. It is much easier to release water than it is to create it. Shortage is Reclamation's bigger concern.

- ***Decision Item: Setting of the EOWYST***
  - With a majority support, attendees agreed to a "standard target elevation" of 6063 ft. with a flexibility range to reduce to 6050 ft. for biological flexibility.
  - The final decision will be up to the Program Office and the Service, with the consideration of the opinions and recommendations of the workshop.

9.0 NEPA/ESA compliance check:

- Discussion on NEPA and ESA compliance occurred earlier in the meeting, during other discussion. Please refer to Section 6.0, pages 18 and 19 for details pertaining to the compliance discussions.

10.0 Conclusions and Wrap-up:

- Jim Brooks brought the meeting to conclusion with a very brief summary of the agreements reached today:
  - Attendees supported forgoing a 1-week release for 2015, regardless of other decisions;
  - With support of the majority of attendees, it was recommended that the Program accept the proposed methods and revised decision tree for 2015 with the understanding that.
  - Attendees agreed to the draft 2015 Process Flow Chart developed in working session;
  - With majority support, attendees agreed to a "standard target elevation" of 60ft. with a flexibility range to reduce to 6050 ft. for biological flexibility..

- Jim then briefly reviewed the intent for tomorrow's agenda.

- No Action Items had been assigned during the meeting. Several items were recommended for BC considerations/future discussion (in no particular ordering or ranking):
  - (1) The Biology Committee (BC) could determine experiments/testing/research opportunities (such as releasing smaller amounts for a set duration). The BC could spend time "fine tuning" what is done with the monitoring, looking at specific questions, management tools, non-flow alternatives, etc.
  - (2) The BC could discuss what flexibility, if any, is available in relevant/existing scopes of work and contracts.
  - (3) It was suggested the BC develop a list of questions that can be addressed during appropriate years. This would enable crews to have contingencies built-in in order to mobilize in time.

- (4) Identified actions, activities, and hypotheses have already been captured in the Long Range Plan (LRP). The BC can develop additional information requests and research needs every fall.

- The floor was opened, but no public comment was given.

DAY TWO: February 13th, 2015

1.0 Opening and Re-Cap of Day One

- Jim Brooks welcomed everyone back for the second day of the San Juan River Environmental Flows Workshop #1.
- After briefly reviewing the agenda for today's session, Brooks summarized the significant discussion and agreements reached at yesterday's session. He then opened the floor for any outstanding comments, questions, or additional discussion pertaining to yesterday's session.
  - ***Concern:*** A concern was raised that yesterday's decision (to set EOWYST at 6063 ft.) basically translates into "giving up" the potential for Type 3 or 4 release this year if one accounts for carry-over storage, current lake elevation, and other accounting.
    - It was clarified that all the diversions and uses have to be accounted for. A 1-week release is the most probable for this year given the Decision Tree and the hydrology. The original calculations would call for a 1-week release – not a Type 3 or 4 release.
    - The shift from one paradigm to a new paradigm could be viewed as temporarily "resulting in the loss of water" but the shift to a new protocol will increase the likelihood that the program will be able to make a large flow release and reduce the likelihood shortage sharing given persistent drought.
    - The 2,500, 5,000, 8,000 and 10,000 cfs flows have not been met for some time. The fish have been dealing with very little water and very little releases for a while now. Yesterday, we agreed to conserve that water to provide security for users and to have potential in 2016 for some type of beneficial release (possibly a 3-week peak depending on hydrology).
  - ***Concern:*** Concern was expressed that what is modeled doesn't actually translate into "what we see in the actual river." A model doesn't necessarily predict what is on-the-ground, so how can we say the proposed changes are "better?"
    - It was clarified that in Reclamation's work, the actual hydrology was modeled to see how the methods compare. (The same hydrology is used for both; what came into the reservoir was used).
    - The same constants were used for both methods in order to make "apples to apples" comparisons. The result is that the proposed method increases the frequency of the higher flow releases while decreasing the Type 1 flows.
    - Realistically, with the given hydrology (dry) it remains likely that there won't be enough available water to make large flow releases this year under either option.
  - ***Concern:*** Concern was expressed that it will be the fish that have to "absorb the sacrifice" while waiting for the lake to reach higher elevation.
    - As mentioned earlier, regardless of method, it is very unlikely that releases could occur in 2015. Moving to the proposed method actually increases the chances of releases and larger releases in the near future (maybe even 2016). This seems to be the best available information and the best option for this continued severe drought.

        - The changes are not sacrificing anything when compared to the recent years. We haven't been able to achieve beneficial higher flows for several years now.
        - Once the Flow Recommendations are revised, everything will have to be revisited again.
        - The alternative is to continue "business as usual" and have to address the Decision Tree's call for a 1-week release and get to a shortage situation or try the proposed changes and "bank water" to improve the situation as early as next year.
    - ***Clarification:*** The agreement yesterday was to set a "standard" target elevation of 6063 ft. with a flexibility that comes into play once elevations actually reach 6050 ft. This means that once the lake elevation has reached an EOWYST of 6050 ft., the BC has the ability to recommend releases. If there are no biological needs for releases at the time, then the water is "banked" toward the next season, towards the standard EOWYST of 6063 ft.

2.0 Group Discussion: Discuss options and objectives for evaluating and modifying the 1999 San Juan River Flow Recommendations during Workshop #2 including but not limited to goals, requirements, outstanding questions, needed analyses/information, stakeholders, and timelines

- In this session of Workshop #1 Day 2, attendees began discussions and planning for Workshop #2.
- It has been suggested that Workshop #2 be focused on the development of new Flow Recommendations. Suggest agenda items included:
    - A) develop proposed updates to the 1999 flow recommendations;
    - B) determine Workshop #2 deliverables;
- In order to accomplish Workshop #2 goals, the following list captures some of the needed information and preparation:
    - a) evaluate the effectiveness of current 1999 Flow Recommendations including:
        - i) understand/characterize/determine fish response(s);
        - ii) understand/characterize/determine habitat response(s);
    - b) understand/characterize fish and habitat response to other factors (e.g. non-native fish, non-native vegetation, fish passage, water quality and temperature, engineering constraints, habitat restoration, etc.);
    - c) process to accomplish A & B for workshop 2
- ***Considerations for Revised Flow Recommendations:***
    - *Review/summarization of the flow ecology relationships (flow with the riparian vegetation)*
        - For example, design flow releases that are not beneficial to non-natives (Russian Olive). Understand the inter-relationships with management.
        - The 2012 Habitat Workshop explored this topic and how it relates to ii) understand/characterize/determine habitat response(s). The Habitat Workshop "sketched out" ways to approach what kind of flows are needed to help restore some of the habitat.
        - The history of the encroachment of vegetation: where the non-natives are located now, how fast they "spread" and encroach, where they are predicted to get worse, what magnitude and frequency of flows are needed to make headway against encroachment, how encroachment has armored the banks and constrained flow and flow effectiveness, etc.

        - It might be useful to divide the river sections into types such as: (1) areas where Russian Olive is already established and flow isn't expected to accomplish anything there; (2) RERI sites where there has been mechanical intervention and the relationship with flows and river characteristics that maintain (limit the encroachment of) those sites; and, (3) sites where Russian olive has established but at sufficiently low densities that flows may still be used to limit further encroachment.

- *Review Flow Recommendation Assumptions*
    - There are assumptions in the Flow Recommendations that certain flows will accomplish certain things – but recent information indicates they don't.

- *Review/Discuss important factors that weren't considered in 1999 and assess their relationship with/to flow*
    - 1) proliferation of non-native fish;
    - 2) climate change and climate induced changes in hydrology and the constraints put around the flow releases; and,
    - 3) changes in flood plain vegetation dynamics and implications for habitat along the river;

- *Investigations into data sets on fish response*
    - This should not be a massive effort since this type of work has been on-going for a while. The restored secondary channels could provide useful information for modifying the Flow Recommendations. Monitoring in-river flow regimes at the RERI and Phase II sites should be the primary focus.

- *Review "Outstanding Questions" that need to be addressed and moved forward*
    - The BC could be the venue to identify the specific questions and outstanding data needs.

- *Suggestion: Focus of Workshop #2 should be on the review and summation of everything we know*
    - There is so much that we don't collectively know; therefore, the focus of the next workshop should be on generating a common understanding of "what we do know" and if it can be connected to flows use the information during for modifying the flow recommendations.
    - Pull the "pieces" together and then address the conditions to model (integration with the hydrograph).
    - List/identify all the pieces of habitat and fish response that still need hydrology/geomorphology/habitat analysis.
    - Investigate the temperatures in the San Juan River and at tributary confluences.

- *Contracted Work/Scopes of Work*
    - It is too late to have new contracts move forward this year. Contracts for next fiscal year will need to be completed and in system before December 2015. Examples of potential contracted work could include: exploring temperature/collecting temperature data; reanalyzing any existing data; or run new model(s). Contracted work has to go through the award process: scope of work developed, on the streets for bidding, review bids, negotiate and award.
    - The goal is to develop an adaptive management strategy to manage flows from the available water that we get. The desired conditions need to be

defined upfront. Basically, update the original 1999 desired conditions to reflect the changing system.

- If we can define the desired conditions in a quantitative way, then we can "back track" through performance metrics and conservation actions to arrive at the actions to test.
- The power of adaptive management is that it addresses some of the uncertainty.
- Take what we think we know (flow of certain magnitude/duration) and assign performance metrics to arrive at what we think that action will be.

- *Data Gaps*
  - Identify data gaps, poorly understood relationships, poor correlations between parameters and identify what is responsible.
  - Starting with the 1999 Flow Recommendations, determine if there are data gap. Can surrogates be used?
  - This does not need to be completed/identified in a large group but can be assigned to a smaller group to draft and then have the larger group review/input.
  - It was cautioned that the group not get "hung up" on data gaps and lack of data. The flow recommendations have to be adjusted even if there are "holes." But the adaptive management process is about refining things in the future as new information becomes available.
  - A concern was raised that the flow recommendations are being evaluated because they do not work but in actuality flow targets were not always met because of below average hydrology. This could make it difficult to evaluate the flow recommendations.
- *Recovery Considerations*
  - One major impediment to recovery is the long-range movement of some fish. Individuals travel long distances but can't return. This is related to habitat and not just flow.
    - Remember, however, that the fish population as a whole can exist in a "confined" [or "bracketed"] area. There would be a large portion of the population that remains in a certain area.
  - Concerning larval drift and loss of smaller fish over the waterfall, how can flows be used to move cobble bars to create more upstream usable habitat for the fish?
  - How can flows be used to create more braided channels to warm the water temperature? How can we influence the fish to move upstream?
  - The group should not just consider a set of flow targets but also produce other recommendations that are not strictly flow related (non-native vegetation management, waterfall, etc.).

- ***Suggested Workshop #2 Goal(s) and Objectives:***
  - The goal of the second workshop needs to be clearly defined. One overarching goal is the recovery of the fish. Thus, **the goal of Workshop #2 is to define the flows or range of flows that best support recovery of the 2 endangered fish**. Any agenda item that does not support this workshop goal should not be included on the agenda.
  - The starting points for discussion are the current 1999 Flow Recommendations.
    - What is known about the fish and habitat response to those Flow Recommendations? What information is still unknown? What don't we have

data for? Use that knowledge to determine the best options for achieving those conditions in the river.
        - The 1999 Flow Recommendations were based on the assumption that mimicry of the natural flow regime is the best path forward. But given the system changes (ex. Russian Olives) mimicry may not make the most sense. We need to be open to the possibility that important ideas are not necessarily captured in the existing recommendations.
    - *Objective: review and evaluate the content of the 1999 Flow Recommendations.*
        - Confirm agreement that 1-week releases of 5,000 cfs provide no benefit to the species or system. The needed higher flow of 8,000 and 10,000 cfs cannot be achieved without the Animas.
        - Review the justifications for the 1999 Flow Recommendations.
        - Ask: (1) did the system get the recommended flows and (2) what response was observed to the flows that were realized?; (3) what constraints have changed since 1999 and do these constraints still apply? This gets to the question of how things are different today from when the original conclusions were made.
    - *Objective: what existing (new) flow targets are out there that could be the basis/foundation for new recommendations?*
        - Going back to the biology of the fish, we have subsequently learned that (1) they need high spring flows for spawning, but (2) they can spawn almost anywhere. This means that retention and recruitment might become more important.
    - *Funding Urgency*
        - Congressional funding runs out in 2019. There is a presumed "hard target" of recovering the fish by 2023. There has to be significant progress in down- and delisting by then if funding is to be continued.
        - Some attendees shared the opinion that the Program has actually made huge strides toward recovery.

4.0 Group Discussion: Develop draft conceptual framework/outline (or possibly draft agenda) for Workshop #2

- Attendees determined that it would not be feasible to develop the Workshop #2 agenda during the remaining time today. It was thus recommended that the Program Office take the lead and convene a small workgroup to develop the requested information "packets" and elevate those to the BC:
    - (1) pull together and provide the documents/reports for the full BC;
    - (2) identify the top 10 hypotheses;
    - (3) a list of "known" fish responses:
        - What are the documented fish habitat relationships?;
        - What has been shown as positive responses from native fish and negative responses from non-natives (ex. native fish show a positive response to increased habitat complexity; non-native fish show a negative response to negative flows)?;
        - The effect of Flow X versus Flow Y on native fish/vegetation and non-native fish/vegetation.
- *Workshop Contracting*

- Contracting for Workshop #2 is partially dependent on the types of analyses and data sets that are desired. Much of the work may already be done but anything new (such as additional temperature data) will have to go through the contracting process or be accomplished "in house." Additional modeling is considered new or additional work.
    - Additional modeling does not necessarily have to be completed this year, but could be acknowledged as a limitation. Additional research and analyses could be identified and initiated in preparation for Workshop #3.
        - It may be an informative exercise to model/analyze the constraints of Navajo Dam releases to see if the high release flows are even able to achieve the intended results (ex. with an armored bank, will a 10,000 cfs flow create/modify the habitat desired?). This might provide a "reality check" about the flows necessary to facilitate habitat changes.
        - Identify any opportunities for hypothesis testing or field investigation for the next year or 2 (ex. increased base flow).
    - Adaptive Management provides the flexibility to adjust as needed and provides opportunity to revise the flow recommendations, implement them, and test upon implementation.

- ***Suggested Objectives:***
    - Attendees continued discussion on the potential objectives for the second workshop:
        - Workshop #2 should not just be about the flow recommendations and their implications. Keep in mind that flow recommendations and data integration have been going on for years but were tabled in 2008 for the 2012 habitat workshop. The most important recommendations may not necessarily center on flow.
        - There are 2 big issues that should be included in Workshop #2:
            - (1) connectivity – huge implication and issue for any aquatic system.
                - Connectivity with tributaries and Lake Powell is of particular importance and will be very instrumental in successful recovery; utilize the Population Model to provide guidance.
            - (2) Flow considerations are not just magnitude/duration/frequency but also temperature.
        - Research and data and outstanding questions have been identified during other workshops and small groups. Those should be revisited instead of reinventing. Past workshops may provide relevant recommendations and/or data gaps.
        - Fundamentally, the ability to meet flow recommendations depends on how much water is in the basin. The conditions are likely to be different come 2025. There may be enough existing information to make preliminary "stabs" at the future water supply in the San Juan River Basin to say whether we are going to be in real trouble in 20 to 30 years from now and possibly speak to trends in temperature and precipitation. Forward projections might influence the recommendations now.
            - Current understanding of climate change should be considered in the review of flow recommendations. The group can discuss how to incorporate climate change forecasts into the new flow recommendations or adaptive management process.

        - Projected water use by humans and how increases will affect the available water calculations (ex. full depletions) also needs to be considered.

- *Objective 1: Reiterate the Goals of the Program*
- *Objective 2: Review the 1999 Flow Recommendations and the Basis/Justifications for those Recommendations*
- *Objective 3: Hydrologic Conditions to be Modeled*
    - Modeling of the baseline (consulted) depletions and modeling of potential future development depletions can inform operations on how continuing water development in the basin could impact the system.

- *Objective 4: Incorporate Climate Change Projections/Forecasts into the Available Water Calculations and New Flow Recommendations*
    - Does the system need flows greater than 10,000 cfs? We may need to look at other management options for obtaining the needed habitat. How do we accomplish the recovery goals if we don't have the water?
    - We need to have a clear understanding of the "needed flow" even if it will be hard to achieve. The purpose is to determine what is needed and then figure out how to accomplish it.

- *Objective 5: Draft Desired Hydrologic (flow) Conditions*
    - The agreement to implement the EOWYST is a "temporary" solution, but the interim years should be used to develop and test hypotheses about the current range of flows. The results of that testing would then drive/inform the flow recommendation revisions.
        - It was clarified that the hypotheses development and testing would be a task of the BC (or a subgroup). Testing could include how to best use available water (ex. higher base flows).
        - It was pointed out that there is already a lot of data that has been collected that can inform the flow recommendations. However, one of the next steps would be to continue hypotheses testing after the new framework has been applied (within the bounds of the EIS).
        - Given the response time for long-lived species to show impacts, it might be worthwhile to (1) synthesize the data we already have to identify/determine the range of flows that are needed/desired; and then (2) go into hypotheses testing. In revising the flow recommendations, the unknowns and the assumptions should be clearly stated. The overall framework of how the system "should look" is then developed and the specifics are tested over the years. But it is not prudent to delay new flow recommendations – they need to be revised on the best available knowledge to date. We move forward with hypotheses testing afterward.
            - In response, a concern was voiced that strict/stringent flow recommendations could result in constraints on the hypotheses that could be tested in the future. There needs to be a range and flexibilities instead of "overly prescribed" flow numbers.
        - It is the biological response(s) that need to be tested – it is already known how much habitat is produced with a 1,000 cfs flow. It is the biological "link" that needs to be strengthened.
        - Attendees were reminded that any flow released in the next year or two will delay the raising of the lake elevation and therefore the

opportunity to pass higher flows. Very little water is expected and the channel is changing. The testing of certain hypotheses will be dependent on the hydrology (ex. a good water year means more can be tested).

- *Objective 6: Characterize Fish and Habitat Response to Observed Flows Regimes*

5.0 Group Discussion: Finalize recommendations for conducting Workshop #2 to evaluate and modify the 1999 San Juan River Flow Recommendations to best meet the Recovery Program goals (Workshop Outcome #3)

- *Workshop #2: Planning and Preparation: Small Group Tasks and Assignments*:
  - Attendees brainstormed the tasks and topics for the small working group to complete no later than mid-April, for review prior to the May meeting.
    - Develop workshop agenda
    - Develop list of data sets (known)
    - Make list of hypotheses of 1999 Flow Recommendations – did they do what they were supposed to? Do we know?
    - Review past workshop products to identify gaps
    - Develop list of known biological responses – negatives and positives
    - Identify/list factors that were not considered in first flow recommendations:
      - Proliferation of non-native fish
      - Encroachment of non-native vegetation
      - Climate change and resulting constraints
      - Floodplain vegetation dynamics
      - Temperature
      - Connectivity (mainstem to Lake Powell at the waterfall, and mainstem to tributaries)
    - Tie flow targets to the life stage(s) of the fish
    - Consider non-flow targets (e.g., temperature, floodplain vegetation management, and channel morphology restoration).

- *Workshop #2 Suggested/Potential Objectives (in no particular order or ranking):*
  - Reiterate the Goals of the Program
  - Review the 1999 Flow Recommendations and the Basis/Justifications for those
    - What existing (new) flow targets are out there that could be the basis/foundation for new recommendations?
  - Identify hydrologic Conditions to be Modeled
  - Incorporate Climate Change Projections/Forecasts into the Available Water Calculations and New Flow Recommendations
  - Draft Desired Hydrologic (flow) Conditions
  - Characterize Fish and Habitat Response to Observed Flows Regimes

- *Workshop #2 Deliverable(s)*
  - Draft desired flow conditions

- *Workshop #3: Finalize the Revised Flow Recommendations to Best Meet Recovery Goals*

6.0 Workshop Conclusions and Wrap-Up: assignments; set a date for Workshop #2, if possible; public comment period

- Jim Brooks thanked everyone for their participation and support of this first Environmental Flows workshop. Several tasks were "assigned" to the Program Office and BC for further work and development:
  - The BC could be the venue to identify the specific questions and outstanding data needs in preparation for Workshop #2, including identification of data gaps;
  - Hypotheses development and testing would be a task of the BC (or a subgroup). Testing could include how to best use available water (ex. higher base flows).
- The details of the next workshop will be further developed and refined over the next several months. The intent is to host Workshop #2 within a year – tentatively next winter.
- There was no public comment, but several attendees expressed appreciation for the opportunities, dialog, and accomplishments of this first workshop.

San Juan River Environmental Flows Workshop 1: Attendees

	Name	Affiliation	Date	
			Thurs 2/12	Fri 2/13
1	Bill Miller	Southern Ute Indian Tribe/**B.C. Chair**	✓	✓
2	Jim Brooks	**Facilitator**	✓	✓
3	Martin Schluep	Alliant Environmental, LLC (contractor)	✓	
4	Marta Wood	Alliant Environmental, LLC (contractor/**note taker**)	✓	✓
5	Howard Brandenburg	American Southwest Icthyological Researchers (ASIR)	✓	✓
6	Michael Farrington	American Southwest Icthyological Researchers (ASIR)	✓	
7	Steve Platania	American Southwest Icthyological Researchers (ASIR)	✓	✓
8	Henry Day	Arizona Public Service	✓	✓
9	Rudy Keedah	Bureau of Indian Affairs (BIA) – Gallup	✓	✓
10	Michelle Garrison	Colorado Water Conservation Board	✓	✓
11	Brian Bledsoe	Colorado State University/TNC	✓	✓
12	Harry Crockett	Colorado Parks and Wildlife/State of CO	✓	✓
13	Tom Wesche	Habitech, Inc. (Water Development Interests)	✓	✓
14	Ron Bliesner	Keller-Bliesner Engineering	✓	✓
15	Brian Westfall	Keller-Bliesner Engineering for BIA	✓	✓
16	Bill Miller	Miller Ecological Consultants	✓	✓
17	Jacob Mazzone	Jicarilla Apache Nation	✓	✓
18	Vincent Lamarra	Navajo Nation (Ecosystem Research Institute)	✓	✓
19	Stanley Pollack	Navajo Nation	✓	
20	Chris Cheek	Navajo Nation Department of Fish and Wildlife (NNDFW)	✓	✓
21	Eliza Gilbert	New Mexico Department of Game and Fish (NMDGF)	✓	✓
22	Mike Ruhl	New Mexico Department of Game and Fish (NMDGF)	✓	✓
23	Mel Warren	Peer Reviewer/ U.S. Forest Service	✓	✓

24	Steve Ross	Peer Reviewer	✓	✓
25	Mike Green	Public Service Co. of NM (PNM)		✓
26	Catherine Condon	Southern Ute Indian Tribe	✓	✓
27	Steve Harris	Southwestern Water Conservation Board	✓	✓
28	Carrie Lile	Southwestern Water Conservation Board	✓	✓
29	Dave Gori	The Nature Conservancy (TNC)	✓	✓
30	Patrick McCarthy	The Nature Conservancy (TNC)	✓	✓
31	Dale Lyons	The Nature Conservancy(TNC)	✓	✓
32	John Pitlick	University of Colorado (Peer Reviewer)	✓	✓
33	Nathan Franssen	University of New Mexico (UNM)	✓	✓
34	Brent Uilenberg	U.S. Bureau of Reclamation (BOR)	✓	✓
35	Susan Behery	U.S. Bureau of Reclamation (BOR)	✓	✓
36	Beverly Heffernan	U.S. Bureau of Reclamation (BOR)	✓	✓
37	Ryan Christianson	U.S. Bureau of Reclamation (BOR)	✓	✓
38	Ed Warner	U.S. Bureau of Reclamation (BOR)	✓	✓
39	Mark McKinstry	U.S. Bureau of Reclamation (BOR)	✓	✓
40	Todd Vandergrift	U.S. Bureau of Reclamation (BOR)	✓	✓
41	David Campbell	U.S. Fish and Wildlife Service, Region 2 (FWS)	✓	✓
42	Jason Davis	U.S. Fish and Wildlife Service, Region 2 (FWS)	✓	✓
43	Scott Durst	U.S. Fish and Wildlife Service, Region 2 (FWS)	✓	✓
44	Dale Ryden	U.S. Fish and Wildlife Service (FWS)	✓	✓
45	Benjamin Schleicher	U.S. Fish and Wildlife Service, Region 6 (FWS)	✓	✓
46	Tom Sinclair	U.S. Fish and Wildlife Service (FWS)	✓	✓
47	Sharon Whitmore	U.S. Fish and Wildlife Service (FWS)	✓	✓
48	Leland Begay	Ute Mountain Ute		✓

Appendix III. Notes for Planning Meeting

San Juan River Basin Recovery Implementation Program
Environmental Flows Workgroup Meeting
Planning for Workshop #2
3-4 December 2015, Durango, Colorado

Meeting Summary

Bill Miller – Miller Ecological Consultants
Brian Westfall – Keller-Bliesner Engineering
Jason Davis – Fish and Wildlife Service
Mark McKinstry – Bureau of Reclamation
Benjamin Schleicher – Fish and Wildlife Service
Vincent Lamarra – Ecosystems Research Institute
Harry Crockett – State of Colorado
Mike Ruhl – State of New Mexico
Tom Wesche – HabiTech, Inc.
Dave Gori – The Nature Conservancy
Sharon Whitmore – Fish and Wildlife Service
Scott Durst – Fish and Wildlife Service
Brian Bledsoe – Colorado State University
Keith Gido – Kansas State University
Dave Propst – University of New Mexico
Steven Platania – ASIR
Susan Behery – Bureau of Reclamation
Ryan Christianson – Bureau of Reclamation
Henry Day – Arizona Public Service
Michael Farrington – ASIR
Nate Franssen – Fish and Wildlife Service
Ron Bliesner – Keller-Bliesner Engineering
Dale Lyons – The Nature Conservancy
Matt Zeigler – State of New Mexico
Carrie Lile – SW Water Conservation District
Marc Miller – Bureau of Reclamation

Environmental Planning for Flow Workshop #2

At Flow Workshop #1 held on Feb. 12-13, 2015, attendees recommended that the Program Office take the lead on planning for and organizing the second workshop by convening a workgroup to deal with workshop details and logistics such as pulling together relevant documents and reports, identifying information needed prior to the workshop, and developing priority hypotheses.

On October 28, 2015, the Program Office sent out an email to the individuals who had indicated interest in being on the workshop planning workgroup. The date for a workgroup planning meeting was set for Dec. 3-4, 2015, immediately following a Biology Committee meeting on Dec. 1-2. Attached to the email was a draft outline that described the Program Office's thought process going into Workshop #2 and details of a path forward (https://www.fws.gov/southwest/sjrip/sjrippwd/documents/SJW2/Draft_Outline_for_SubGroup.pdf). The intent was to use the outline as a starting point for developing an agenda for the workgroup planning meeting. The workgroup was asked to provide comments and thoughts on the strategy. No comments were received.

On Nov. 12, a draft agenda for the 3-4 December planning meeting was sent to the workgroup. After receiving feedback, a slightly revised agenda was sent out on Nov. 18 along with a handout of reference materials for use during the workgroup meeting. Additional reference materials were also posted to the Program website's working documents link (https://www.fws.gov/southwest/sjrip/sjrippwd/PWD_SJW2.cfm). The following goals and objectives were included on the agenda as a path forward for the workgroup meeting recognizing that it might not be possible to complete them all during the two-day workgroup meeting.

1) Summarize existing information on flow-habitat-fish relationships and other relevant large-scale patterns
2) Identify outstanding analyses
3) Review history of flows: why the flow recommendations have not been met
4) Devise means to better meet flow recommendations and determine what to do with available water (e.g., high spring targets, elevated base flows, fall spike flows)
5) Develop new decision tree or long-range plan for flow releases; logistically determine how we can meet flow recommendations
6) Develop research program to assess effects of flows

Environmental Flows Workshop #2 Workgroup Meeting 3-4 December 2015

Overview of pre-workshop history and goals (Scott Durst)
https://www.fws.gov/southwest/sjrip/sjrippwd/documents/SJW2/SJRIP_e-flows_workshop_2_workgrp_meeting_overview_(Durst).pptx

Prior to Flow Workshop #1, Reclamation proposed an alternate way to implement San Juan River flow recommendations which utilized an End of Water Year Storage Target (EWYST of 6,063 feet) for Navajo Dam (with option to lower the target to 6,050 feet in some years). The volume of water in excess of EWYST is deemed "available water" that can be released from Navajo Dam for environmental purposes (given the release constraints of the dam). Consensus was reached on using the EWYST method during Workshop #1; however, the process for using the available water into future (e.g., revised decision tree) still needed to be determined.* Outstanding tasks from Flow Workshop #1 included:

(1) Determining how to "use" available water
(2) Evaluating the effects of flows from the 1999 Flow Recommendations
(3) Revising the 1999 Flow Recommendations, as necessary

The 1999 Flow Recommendations decision tree resulted in frequent low-magnitude spring releases and limited releases occurred that met high flow targets. Miller (2006 Integration Report) found that the 2,500 cfs and 5,000 cfs flows did not appear to maintain habitat as expected in the absence of 8,000 and 10,000 cfs flows. The question in front of the committee was: how do we attain higher spring peaks on a more frequent basis? We are also limited in our ability to evaluate the effects of the 1999 Flow Recommendations because limited information is available on how the various flow targets (that may or may not have been meet since 1999) have affected the habitat and fish. The priority need is to develop the new process for implementing EWYST (per Behery's modeling in Workshop #1).

Durst explained that the path forward for the workgroup meeting was to review and reach agreement on flow relationships and flow history, identify outstanding analyses, prioritize flow releases based on available water, develop new decision tree or long range plan for flow releases, and identify what monitoring and research will be needed to assess the effect of flows. Other agenda items identified by the workgroup included a step-by-step review of the 1999 flow targets for future applicability and planning for Workshop #2.

* Workshop #1 notes are available on the SJRIP website (http://www.fws.gov/southwest/sjrip/SJREFW.cfm) but the document is not a BC consensus product.

SECTION: SUMMARY, REVIEW, AND AGREEMENT OF CURRENT STATE OF KNOWLEDGE

Presentation - Habitat responses to flow (Vince Lamarra)
https://www.fws.gov/southwest/sjrip/sjrippwd/documents/SJW2/Flow_Recs_Historical_Perspective_(Lamarra).ppt

Lamarra said he would not be talking about if or how the flow recommendations were met or not met.

Lamarra gave an historical perspective of the 1999 Flow Recommendations. The intent was to provide a magnitude of flow (e.g., days greater than 10,000 cfs), a duration (e.g., 5 days between March 1 and July 31), and a frequency of occurrence (e.g., 20% of years, no longer than 10 consecutive years), and to mimic a natural hydrograph (timing). They were based on habitat and observed geomorphic changes during the research period and observations of fish community changes. A breakdown of the 1999 Flow Recommendations includes:

Flows > 10,000 cfs during runoff period, minimum of 5 days, 20% of years on average, no longer than 10 consecutive years without meeting 9,700 cfs – The flow recommendations were based on a 65-year period of hydrologic record, 1929-1993. Franssen asked why we were trying to attain a flow target based on 65 years when we only have an 18-year period of implementation and data. Lamarra said we were monitoring for the purpose not monitoring for response. The data shows that more islands formed after big flows but the number of islands has decreased over time.

Flows > 8,000 cfs, minimum of 10 days, 33% of years, no longer than 6 consecutive years without meeting 7,760 cfs – Lamarra evaluated a stated purpose that flows at >8,000 cfs would move cobble and build cobble bars for spawning but found the data cannot confirm if cobble habitats increased with 8,000 cfs flows. When the flow recommendations were developed, bank full was considered to be 8,000 cfs but has bank full changed? Bliesner said it did not change between 1997-2007. Lamarra said he thinks it may have changed now.

Flows > 5,000 cfs, minimum of 21 days or more, 50% of the years on average, no longer than 4 consecutive years without meeting 4,850 cfs – Data shows that 5,000 cfs for 70 days did clean backwaters but bigger flows would have also occurred during that time frame. The 5,000 cfs benefit, to clean and maintain backwaters, cannot occur without also having the bigger flows. Islands are also important for backwater formation and you get islands from high flows. Big volumes of water are needed.

Flows > 2,500 cfs, minimum 10 days or more, 80% of the years on average, no longer than 2 consecutive years without meeting 2,425 cfs – Westfall said the going theory when the flow recommendations were developed was that 2,500 cfs would provide clean cobble for spawning. The original focus of the flow targets was that spawning habitat was limited. Is spawning habitat limited? This may need to be re-visited. The flow recommendations operations should probably have been modified back in 2006 when Keller-Bliesner first pointed out that we should not be trying to attain the 2,500 flow target and should be focusing on trying to attain more frequent, high flows.

Lamarra said numerous factors make post-hoc analysis challenging including nature not providing a full spectrum of available water and flow recommendations criteria being interrelated. Also, monitoring was focused on recovery and response of the fish and not on evaluation of the flow recommendations and response of the habitat. As a result, specific parameters identified in the flow recommendations have not been monitored consistently. As a result, there are a lot of zeros in the data set especially in the higher flow categories which makes evaluating the effects of the 1999 Flow Recommendations on habitat and fish difficult.

There were few years where all flows targets were met or almost met. From 1992-2014, flows at >10,000 cfs for 5 days were met 13% of time; >8,000 cfs for 10 days met 22%; >5,000 cfs for 21 days met 48%; and, > 2,500 cfs for 10 days met 91%. All flows were met in 1995, 1997, and 2005 and almost met in 2008 (one day short at >10,000 cfs). The results are too many zeros in the data set. From 1992-

2014, 78% of the years in the data set are zeros at >10,000 cfs for 5 days; 52% are zeros at >8,000 cfs for 10 days; 26% are zeros at >5,000 cfs for 21 days; and, 9% are zeros at > 2,500 cfs for 10 days.

Habitat mapping was conducted from December 1992 to September 2014 (no mapping was conducted from 2008-2010). Mapping events had flows ranging from 479 to 9,453 cfs. A total of 670 channels have been defined in 26 mapping events. These may or may not exist today. These channels included 228 (34%) Secondary Channel Splits, 69 (10%) Main Channel Splits, 204 (31 %) Island Splits, and 169 (25%) Cobble/Sand Bar Splits. To better understand habitat-flow relationships, use of antecedent flow parameters was expanded. Lamarra pointed out that the current habitat mapping does not measure certain parameters such as river depth and sediment build-up in the lower canyon. Miller said the flow recommendations did not consider temperature but it should be factored in. McKinstry questioned whether temperature should be a factor considering Razorback Sucker are spawning at lower temperatures than the literature says in other parts of the Colorado River Basin such as the Grand Canyon.

Presentation - Larval fish response to flow (Mike Farrington)
https://www.fws.gov/southwest/sjrip/sjrippwd/documents/SJW2/Larval_fish_data_discharge_perspective_(Farrington).pdf

Farrington said ASIR switched from using CPUE to examine larval fish survey data to using mixture models in 2013. Mixture models are good for analyzing data with a lot of zeros. For this exercise, the covariates used in the models, in addition to year and reach for Razorback Sucker, were mean April flow and temperature, mean May flow and temperature, annual number of fish stocked, cumulative number of fish stocked and fall monitoring captures (1999-2014). For Colorado Pikeminnow, additional covariates included mean June flow and temperature, mean July flow and temperature, and captures of 450+ mm TL and 300-449 mm TL during Adult Monitoring (2003-2014).

Mixture model estimates for Razorback Sucker show that models with the covariate "cumulative number of fish stocked" for both delta and mu received the most support. Higher May flow resulted in lower larval Razorback Sucker captures. In the early years of sampling, Razorback Sucker spawned from mid-April to mid-May before spring peak at temperatures above 10° C but better at 13° C. The spawning period has been expanding. Using back calculated spawning dates, in 2014 spawning occurred from mid-March to end of June. For this reason, he does not think we want to dump a lot of cold water (correlated with high flows) into the river in spring.

Mixture model estimates for Colorado Pikeminnow show that models with the covariates "year" for delta and "monitoring 450+" for mu received the most support. The covariate "fall monitoring captures 450+" can be viewed as a surrogate for Colorado Pikeminnow augmentation. We do not have much data for Colorado Pikeminnow; however, so model results are not as good. Pikeminnow need 20° C mid-June to early July on the descending limb of the hydrograph.

Presentation - Small-bodied fish response to flow (Keith Gido)
https://www.fws.gov/southwest/sjrip/sjrippwd/documents/SJW2/Flow_response_SJR_fishes_(Gido).pptx

Gido identified two papers that looked at relationships between San Juan River flow variation and small-bodied fish, Propst and Gido (2004) and Gido and Propst (2012). They looked at various flow attributes and their potential association with the recruitment of fish. Duration of low flows (less than 500 cfs) and magnitude of high flows are important. For catfish, there is a weak relationship with flow. He thinks they may be density dependent. Red shiners may come back if flows drop below 500 cfs. Results of the studies included:

Flow response of 2° channel fishes (1993 – 2001) – Propst and Gido (2004)

- Higher spring flows related to higher densities of native fishes
- Prolonged low flows during summer related to increased densities of some nonnative fishes

Flow response of 2° channel fishes (1993 – 2001) – Gido and Propst (2012)

- Relationship between native suckers and mean spring discharge present but weaker
- Strong association between nonnatives and prolonged summer low flow

Quantifying flow–ecology relationships with functional linear models - Stewart-Koster et al. (2014)

- Timing of high flows might influence fish response
- Functional linear analysis uses a "moving window" to assess flow-density relationships
- Similar results to Propst and Gido (2004) and Gido and Propst (2012)

Presentation - Temperature depression (Bill Miller)
https://www.fws.gov/southwest/sjrip/sjrippwd/documents/SJW2/SJRIP_e-flows_Water_Temp_(Miller_Dec_2015).pptx

Miller reported that initial work on water temperature monitoring started in 1992. Flow recommendations for a natural snow melt hydrograph with high spring/summer releases were formalized in 1999. Water temperature modeling in Navajo Reservoir and the San Juan River was conducted in late 1990s and early 2000s and has continued to present. River modeling looked at water temperature changes at Shiprock. Hydrology in the model was only for lower flows released from Navajo Dam. To look at flow and water temperature relationships, he assembled water temperature and discharge data for the Mexican Hat gage from 1945-2013 and segmented the analysis into pre-dam, post-dam, and post flow recommendation time periods.

Water temperatures have shifted down through time. Water temperature depression during release of peak flows is shown in the monitoring data downstream to Mexican Hat, Utah. Is this a result of low hydrology or flow recommendations operations? Water temperature did not show a depression during peak flows prior to construction of Navajo Dam. What are the potential implications for recovery? Temperature depression could delay or suppress spawning in Colorado Pikeminnow, reduce growth rates for larvae of both Razorback Sucker and Colorado Pikeminnow, and reduce reproductive success if spawning occurs prior to temperature drop. Between 1987-1997, Colorado Pikeminnow were captured in the San Juan River and recruitment was occurring. Water temperature needs to be considered in Navajo Dam release decisions. For example, you may not want to make high releases when Animas is low because cold water from the San Juan would exacerbate temperature depression downstream. If there was a temperature control device (TCD) at Navajo Dam, warmer water could be released from higher in reservoir to prevent temperature depression during spawning or cold water could be released from lower levels to disadvantage nonnative fish (e.g., Grand Canyon is cold and fish seem to do fine and they don't have catfish).

Miller said the next steps are to continue investigating the relationships between water temperature and timing, number and size of larvae; complete additional thermal modeling of Navajo Reservoir and San Juan River, develop a preferred water temperature regime as part of the flow recommendations; and develop a range of potential alternatives for ways to obtain water temperature modifications during Navajo Dam releases to moderate the water temperature depression. Considerations for a TCD on Navajo Dam include: cost and practicality of constructing a TCD, potential impact to trout water downstream of the dam, entrainment and release of non-native predators from Navajo Reservoir into the San Juan River, and establishment of those species in critical habitat.

SECTION: REVIEW HISTORY OF FLOWS

Presentation - Navajo Operations and Flow History and Decision Tree Options (Susan Behery)

https://www.fws.gov/southwest/sjrip/sjrippwd/documents/SJW2/SJRIP_e-flows_workshop_2_workgrp_meeting_(Behery_Dec2015).pptx

Behery reviewed operating procedures to meet flows targets, the history of flows including why we haven't met flow recommendations, and new processes for determining environmental releases as described in Reclamation's proposal and notes from E-flow Workshop #1.

There are a lot of operating limitations and guidance that must be followed to operate Navajo Dam. There are Dam limits, Flow Recommendations limits, and COE flood control limits. Guidance documents include SJRIP 1999 Flow Recommendations, Shortage Sharing Agreement (2013-2016), 2015 Interim Operations, and Corps of Engineers Water Control Manual (2011). Flow recommendations have only been officially followed since Reclamation adopted the Record of Decision (ROD) in 2006 but have been unofficially followed since the 1990's. Releases between 250 and 5,000 cfs are considered in compliance. Real time operations are based on forecasts and river flow forecasts are based on weather forecasts. The difference between minimum, most likely, and maximum forecast narrow through time. During spring operations (decision-making time), the May 1forecast spread is wide and actuals typically fall between predicted minimum and most lately. Forecasts have a lot of variability and error.

ORIGINAL 1999 FLOW RECS DECISION TREE IMPLEMENTATION: We have tried to achieve flow recommendation statistics based on a 65 year period of hydrologic record. Difficulties in implementing flow recommendation include: using imperfect forecasts, timing Navajo releases with Animas peak, and dealing with erratic runoff. Reclamation followed the original decision tree that was developed to meet the flow targets. Were the flow recommendations met? Yes and no. Over the past 15 years, we've experienced a dry spell rivaling the 1950's. The minimum flow targets have been met with a few exceptions. However, the 65-year flow distribution has not been replicated during the period of flow recommendation implementation. Why have we not been successful meeting the higher flow targets? This was mostly due to not timing releases with the Animas peak, trying to deal with multiple Animas peaks, lack of adequate water for a peak (Navajo Dam is only half of the equation; need the Animas to contribute), and/or the peak being too short in duration. Other reasons could be forecast error, gage shifts causing reduced releases, the decision tree's prioritization of frequency of any size releases over frequency of Type 3-4 releases, looking at only 10-15 (mainly drought) years rather than a 65 year period of implementation that flow statistics are based on. We did our best with what we had but the water just hasn't been there. Could our success have been improved with better hydrology, better forecasts, timing, decisions, etc.? Yes, but also the original decision tree limited our ability to achieve flow targets.

2015 INTERIM OPERATIONS AND DECISION TREE – Back in early 2014, Reclamation first proposed an alternate method to implement San Juan River flow recommendations. The proposed method uses an End of Water Year Storage Target process for Navajo Dam (EWYST of 6,063 feet with option to lower the target to 6,050 feet in some years). The volume of water in excess of EWYST is deemed "available water" that can be released from Navajo Dam for environmental purposes (given the release constraints of the Dam). Based on the EWYST method, Westfall developed a decision tree, based on Reclamations operation model, for making release decisions that do not include "look backs" (Figure 1). During E-flows Workshop #1 in February 2015, the EWYST method and this decision tree was adopted as an interim method until the BC could further develop the new process for implementing EWYST.

Under the EWYST method, available water for a spring peak release is calculated using an EWYST of 6,063 feet (with an option to use 6,050 feet). The method minimizes the risks of both shortage and spill in the reservoir. Navajo Dam will be operated to meet EWYST by the end of each water year (with all contracts and target base flows met). Any volume over the EWYST is available for Spring Peak

Releases or other adaptive management deemed useful by the SJRIP. Available water will be released by the rules set in any revised Flow Recommendations. In dry years, the reservoir may come short of EWYST (i.e., contracts and target base flows will be met, but no water available for spring peak release).

Behery showed the four types of hydrographs and volume of water available for each peak flow, Type 4 (344,000 af), Type 3 (236,000 af), Type 2 (166,000); and Type 1 (114,000 af). The Type 4 hydrograph includes a ramp up and down as per the flow recommendations. The release volumes can be classified as follows:

- Base Release: The volume required to maintain the target base flow minimum.
- Spring Peak Release: Release volume on top of the base release that is designed to mimic a natural runoff hydrograph.
- Operational Spill: Release volume on top of spring peak release and base release designed to make room in the reservoir. Examples of possible releases include shaping the nose of the spring peak release, increasing the target base flow, and doing a fall spike release.

Behery showed several model runs comparing releases under the Original 1999 Flow Recommendations Decision Tree and the 2015 Interim Operations Decision Tree. She pointed out she used the operations model for runs that are based on actual conditions not the SJRB hydrology model.

Miller asked about effects on geomorphology and said he would like more detail. Lamarra suggested doing away with the nose and increasing days @ 5,000 cfs. Behery said they may have to start making releases earlier to get rid of water. She emphasized that everything is trumped by flood control rules. Bliesner voiced concern about baseline depletions because the 1999 Flow Recommendations were based on baseline depletions for determining frequency.

NEW FLEXIBLE EWYST AND DECISION TREE – For this workgroup meeting, Behery said she worked with Durst and Franssen to see what happens if Type 1 and 2 releases were eliminated in favor of only making Type 3 and 4 releases. They came up with a decision tree that uses the two EWYSTs at the same time. Available Water is calculated using the 6,050 feet EWYST. If this results in sufficient available water for a Type 3 or Type 4 release, that release is made. If there is not available water for a Type 3 or 4 release at EWYST at 6050, then an EWYST of 6,063 is used and any water available at that target is released via Operational Spill. This is nearly what we have with the Interim Operations, i.e., 6,063 feet EWYST with the option to go to 6,050 feet EWYST, but the 6,050 feet part had not been modeled previously because it would be a real-time decision. This method puts rules on the 6,050 feet option. She pointed out that she made some changes to the decision tree since first working on this with Durst and Franssen so the tree in her presentation (Figure 2) is different than Figure 6 in the workshop handout. Model runs of the three decision trees show that the Flexible EWYST method allows for eight more Type 4 releases (2 per decade on average) compared to the 6,063 feet EWYST alone.

The possible downsides of the Flexible EWYST method are that no Type 1 and Type 2 releases are made and an increased risk of shortage at EWYST of 6,050 feet (though the risk is still fairly low).

SECTION: STEP-BY-STEP REVIEW OF THE 1999 FLOW RECOMMENDATIONS FOR THE SAN JUAN RIVER (Holden 1999)

A. Category: Flow > 10,000 cfs during runoff period (March 1 to July 31).

Duration: **A minimum of 5 days between March 1 and July 31**.

Frequency: **Flows > 10,000 cfs for 5 days or more need to occur in 20% of the years on average for the period of record 1929-1993.** Maximum number of consecutive

years without meeting at least a flow of 9,700 cfs (97% of 10,000 cfs) within the 65-year period of record is 10 years.

Purpose: Flows above 10,000 cfs provide significant out-of-bank flow, generate new cobble sources, change channel configuration providing for channel diversity, and provide nutrient loading to the system, thus improving habitat productivity. Such flows provide material to develop spawning habitat and maintain channel diversity and habitat complexity necessary for all life stages of the endangered fishes. The frequency and duration are based on mimicry of the natural hydrograph, which is important for Colorado pikeminnow reproductive success and maintenance of channel complexity, as evidenced by the increase in the number of islands following high flow conditions. Channel complexity is important to both Colorado pikeminnow and razorback sucker.

B. Category: Flow > 8,000 cfs during runoff period.

Duration: **A minimum of 10 days between March 1 and July 31.**

Frequency: **Flows > 8,000 cfs for 10 days or more need to occur in 33% of the years on average for the period of record 1929-1993.** Maximum number of consecutive years without meeting at least a flow of 7,760 cfs (97% of 8,000 cfs) within the 65-year period of record is 6 years.

Purpose: Bankfull discharge is generally between 7,000 and 10,500 cfs in the San Juan River below Farmington, New Mexico, with 8,000 cfs being representative of the bulk of the river. Bankfull discharge approximately 1 year in 3 on average is necessary to maintain channel cross-section. Flows at this level provide sufficient stream energy to move cobble and build cobble bars necessary for spawning Colorado pikeminnow. Duration of 8 days at this frequency is adequate for channel and spawning bar maintenance. However, research shows a positive response of bluehead sucker and speckled dace abundance with increasing duration of flows above 8,000 cfs from 0 to 19 days. Therefore, the minimum duration was increased from 8 to 10 days to account for this measured response. Flows above 8,000 cfs may be important for providing habitat for larval razorback sucker if flooded vegetation and other habitats formed during peak and receding flows are used by the species. This flow level also maintains mimicry of the natural hydrograph during higher flow years, an important feature for Colorado pikeminnow reproductive success.

Discussion – 10,000 and 8,000 flow targets and their purposes remain a high priority. We have not achieved these targets and need to develop decision trees to increase the magnitude, frequency, and duration of flows in the San Juan River, i.e., flows >8,000 cfs to achieve the purposes stated in the original flow recommendations. The hypotheses that >10,000 cfs provides out-of-bank flows and flows >8,000 cfs provide bank-full flows are still valid. Additional purposes not in the original purposes that need to be added include delaying and/or suppressing the establishment of non-native vegetation and promoting cottonwood recruitment/regeneration. To determine at what point wetted area is maximized, discharge and amount of area that gets inundated needs to be plotted. A new estimate is needed on the degree of nonnative vegetation encroachment. Hypotheses identified that should be developed and tested include: what is needed for improving fish recruitment and productivity, are high flows detrimental to nonnative fish, will flows >10,000 cfs cause out-of bank flooding and promote cottonwood

establishment, and is there enough flow to create new, long secondary channels or to increase complexity.

C. Category: Flow > 5,000 cfs during runoff period.

Duration: **A minimum of 21 days between March 1 and July 31.**

Frequency: **Flows > 5,000 cfs for 21 days or more need to occur in 50% of the years on average for the period of record 1929-1993.** Maximum number of consecutive years without meeting at least a flow of 4,850 cfs (97% of 5,000 cfs) within the 65-year period of record is 4 years.

Purpose: Flows of 5,000 cfs or greater for 21 days are necessary to clean backwaters and maintain low-velocity habitat in secondary channels in Reach 3, thereby maximizing nursery habitat for the system. The required frequency of these flows is dependent upon perturbating storm events in the previous period, requiring flushing in about 50% of the years on average. Backwaters in the upper portion of the nursery habitat range clean with less flow but may be too close to spawning sites for full utilization. Maintenance of Reach 3 is deemed critical at this time because of its location relative to the Colorado pikeminnow spawning area (RM 132) and its backwater habitat abundance.

Discussion – If we don't have mid-range flows (Category C flows) as often, are there negative effects? The group agreed that relaxing mid-range flow requirements would do no harm. These flows will increase if you optimize getting >8,000 cfs. Mid-range flows (5,000 cfs) work better in association with high flows that include a tail. If you do mid-range flows by themselves, they don't do much. These flows are still important when in combination with higher flows but should not be targeted with operations. Should the Animas peak be in the operational model?

D. Category: Flow >2,500 cfs during runoff period.

Duration: **A minimum of 10 days between March 1 and July 31.**

Frequency: **Flows > 2,500 cfs for 10 days or more need to occur in 80% of the years on average for the period of record 1929-1993.** Maximum number of consecutive years without meeting at least a flow of 2,425 cfs (97% of 2,500 cfs) within the 65-year period of record is 2 years.

Purpose: Flows above 2,500 cfs cause cobble movement in higher gradient areas on spawning bars. Flows above 2,500 cfs for 10 days provide sufficient movement to produce clean cobble for spawning. These conditions also provide sufficient peak flow to trigger spawning in Colorado pikeminnow. The frequency specified represents a need for frequent spawning conditions but recognizes that it is better to provide water for larger flow events than to force a release of this magnitude each year. The specified frequency represents these tradeoffs.

Discussion – Targeting Category D flows, > 2,500 cfs, did not do what they were expected to do, i.e., trigger spawning. The original purposes also said flows > 2,500 cfs for 10 days provide sufficient movement to produce clean cobble for spawning. Spring peak flows are important for this. This category is no longer needed.

E. Category: Timing of the peak flows noted in A through D above must be similar to historical conditions, and the variability in timing of the peak flows that occurred historically must also be mimicked.

Timing: Mean date of peak flow in the habitat range (RM180 and below) for any future level of development when modeled for the period of 1929 to 1993 must be within 5 days ± of historical mean date of May 31 for the same period.

Variability: Standard deviation of date of peak to be 12 to 25 days from the mean date of May 31.

Purpose: Maintaining similar peak timing will provide ascending and descending hydrograph limbs timed similarly to the historical conditions that are suspected important for spawning of the endangered fishes.

Discussion – Category E, timing of the peak, is important but it is also important to keep in mind that we are trying to mimic a natural hydrograph with the flow recommendations not replicate it. We have observed a shift in the peak so rather than setting peak releases around a specified day; releases should match the Animas River peak. Trying to match the Animas peak is difficult because of limitations in forecasting. Reclamation has to give a one week notice to basin residents of increased Navajo Dam releases (ramp-up). Is there a time or flow requirement to ramp up to peak releases?

F. Category: Target Base Flow (mean weekly non-spring runoff flow).

Level: 500 cfs from Farmington to Lake Powell, with 250 cfs minimum from Navajo Dam.

Purpose: Maintaining low, stable base flows enhances nursery habitat conditions. Flows between 500 and 1,000 cfs optimize backwater habitat. Selecting flows at the low end of the range increases the availability of water for development and spring releases. It also provides capacity for storm flows to increase flows and still maintain optimum backwater area. This level of flow balances provision of near-maximum low-velocity habitat and near- optimum flows in secondary channels, while allowing water availability to maintain the required frequency, magnitude, and duration of peak flows important for Colorado pikeminnow reproductive success.

Discussion – Category F base flows, 500-1,000 cfs, should be potentially increased to 1,200 cfs to increase the amount of low velocity habitat. Specific base flows based on desired outcomes need to be identified (e.g., X amount of low velocity habitat will be provided at X flows). Time frames for flows need to be set (e.g., runoff - August 15 for low velocity habitats, August 15 – September for higher flows to disadvantage nonnative fish). These are hypotheses that need to be tested (e.g., targeting consistently higher base flows at 1,200 cfs will trigger more spawning and/or provide more nursery habitat). Farrington said this could not be tested under the current larval monitoring design because larval habitat can always be found at various base flows. If you increase backwater habitat or lose wetted habitat at the lower base flows, the benefit cannot be measured. Lamarra said he has data but would need to look at it in a different way. Farrington said he has monitoring site data but it will not answer the question. Backwaters have the highest numbers of larval suckers but they shift to other habitats as juveniles (around fall). Propst said red shiners have moved out of backwaters by early August. Purposes identified for base flows were favoring backwaters after the descending limb and disadvantaging nonnative fish. The group agreed that the current purposes are still valid but that they need to be testable.

G. Category: Flood Control Releases (incorporated in operating rule).

Control: Handle flood control releases as a spike (high magnitude, short duration) and release when flood control rules require, except that the release shall not occur earlier than September 1. If an earlier release is required, extend the duration of the peak of the release hydrograph. A ramp up and ramp down of 1,000 cfs per day should be used to a maximum release of 5,000 cfs. If the volume of water to release is less than that required to reach 5,000 cfs, adjust the magnitude of the peak accordingly, maintaining the ramp rates. Multiple releases may be made each year. These spike releases shall be used in place of adjustments to base flow.

Purpose: Historically, flood control releases were made by increasing fall and winter base flows. This elevates flows above the optimum range for nursery habitat. Periodic clean-water spike flows improve low-velocity habitat quality by flushing sediment and may suppress red shiner and fathead minnow abundance.

Discussion – Category G, flood control releases are Operational Spill. We will need to work with Behery to determine how operational spill can be used to best benefit the fish and habitat. The original flow recommendations say that spike releases shall be used in place of adjustments to base flows to above the target range (great than 1,000 cfs). Past options for Operational Spill included increasing the nose of the peak release and fall spikes. New options discussed include shaping the peak by adding additional days at peak, decreasing the nose or adding a tail to the peak release, and increasing base flows.

SECTION: MODIFY/DEVELOP DECISION TREE AND REACH AGREEMENT TO MOVE FORWARD

Summary/General Agreements:

- The 1999 flow recommendations still provide the fundamental basis for the flow release categories. After 18 years of flow recommendations, the BC determined that the methodology to reach flow targets needed to change. A new method for implementing the flow recommendations needs to allow for more flexible decision-making based on hydrologic and other conditions. The modified flow recommendations are still based on mimicking a natural hydrograph (not replicating it) and species and habitat needs but how they are implemented needs to be more flexible and testable under the current hydrology and system limitations and constraints.
- Purposes, hypotheses, level of supporting data, and questions we want to answer need to be identified and part of the modified flow recommendations.
- Targeting mid-range flows at the expense of high flows is not good. The BC agreed to eliminate Type 1 and 2 releases as operational targets because those lower flow categories are met when Type 3 and 4 releases are made.
- Attaining the frequency of high flows as described in the flow recommendations is still dependent on Animas flows; therefore, trying to time the Animas peak needs to be an integral part of the operational target.
- The group decided to further develop Flexible EWYST Method prioritizing Type 3 and Type 4 releases, their associated ramp-downs and increased base flows. Details of each will need to be worked out (e.g., shape of peak flows, higher base flow targets)

- All flow recommendation parameters identified during discussions need to be part of the target(s) and should have hypotheses developed to clarify expected responses. The accompanying hypotheses need to answer priority questions of what magnitude, timing, and duration is needed to benefit fish and habitat (e.g., what flows are needed to best disadvantage Russian olive establishment, when do high flows cause temperature depression that negatively affects spawning).
- Implementation of specific monitoring to measure effects of the targeted releases and flows on fish and habitat must be an integral part of the flow recommendations. Fish need to be well represented in the hypotheses. A scientifically-sound research program is needed that can assess the effects of releases and flows on fish and habitat. For example, monitoring needs to occur before and after high flows to determine channel changes that occur from major flow events.

Outstanding Issues/Questions:

- How should the peak releases be shaped? Adding a nose on Type 3 and Type 4 (both 3 weeks) is a way to get rid of water. Extending peak releases to 4 weeks causes operational insecurity. Is "available days at peak" a priority over having a nose? The original nose was based on sediment transport not biology. We could start at a Type 3 release, go to 30 days then start adding to the nose, if needed. At 30 days, Reclamation will need to have a shutdown period for safety purposes.
- Does temperature need to be part of the flow target(s)? To measure, a flow test could be implemented that targets temperature to improve spawning success. Can something be done right now to test this? We could look at big release years and see what the temperatures were and what the next year's larval results were. Coordinating spring releases with high Animas flows should minimize the effects of temperature depression. In the future, spring peak releases should not be made when there are not corresponding high flows from the Animas.
- Is spawning habitat limiting in the San Juan River?
- Should base flow targets be higher than they were (e.g., 1,500 cfs for 3 weeks would provide more wetted surface area possibly disadvantaging nonnative fish and vegetation)?
- Is a connection to Lake Powell needed for recovery?
- Are there releases (temporally, duration, etc.) that could negatively affect fish (e.g., would making releases in early spring before Razorback Sucker spawning negatively affect spawning)?

Action Items/Tasks to be completed prior to Flow Workshop #3:

- Develop a draft modified flow recommendations table based on the workgroup meeting comments/input – Program Office (see **Table 1)**
- Develop a detailed description of EWYST Operating Rules for inclusion in the new flow recommendations including operational spill. Model runs are needed to see what targets are met under various options for operational spill water including options for shaping peak releases and flexible duration peaks – Behery and Program Office
- Compare SJRB Hydrology Model Gen 2 to Gen 4 depletions. Reclamation and Service will meet in Jan/Feb to discuss baseline depletions in the model – Reclamation/Service
- Include a parameter for previous year/following year in mixture models – Farrington
- Describe the basis for changes to the flow recommendations and provide justification – Program Office and P.I.'s.
- Revisit safety operations required at the Dam when maximum amounts of water are being released – Behery

- Do model runs of various days at peak flow – Behery
- Schedule Workshop #2 in March/April to include both BC and CC – Program Office
- Develop agenda for Flow Workshop #2 – Program Office

  Agenda items identified during the workgroup meeting included:

  - Summarize progress that has been made (e-flow workshop #1 and workgroup meeting). Describe changes and recommendations.
  - Review results of model runs to see effects of various release options (e.g., elevated base flows at 750 and 1,000 cfs).
  - Formalize the new decision tree and revised flow recommendations.
  - Identify structure of end product for revised flow recommendations and operations
  - Identify flow recommendations for 2016.
  - Get input/comments.

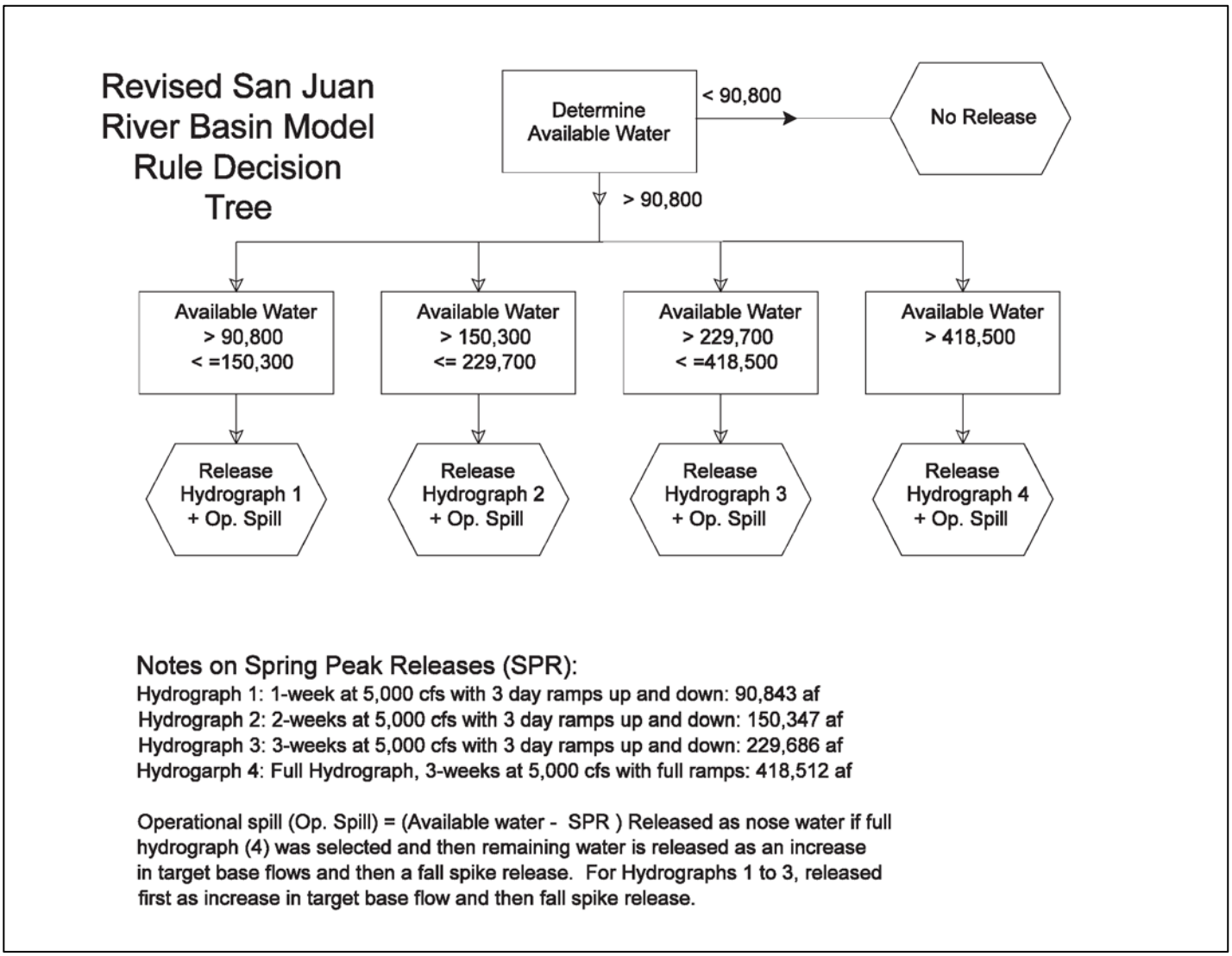


Figure 1. 2015 Interim Operations (EWYST 6,063 feet)

Calculate Available Water (AW) under EWYST 6050. Is Available Water < 229,700?	--YES-->	No release. EWYST changes to 6063 ft.
| NO | V		
229,700 af <Available Water <418,500 af	--YES-->	Release Type 3. EWYST changes to 6063 ft after release.
| NO | V		
Available Water > 418,500 af	--YES-->	Release Type 4. EWYST changes to 6063 ft after release.

Figure 2. Flexible EWYST Method (uses same AW calculation as the Interim 2015 Method)

Table 1. Draft Modified Flow Recommendations and Predicted Responses

This table summarizes the hypothesized abiotic and biotic effects of flow recommendation metrics and targets along with evidence and assumptions supporting those hypotheses. Highlighted hypotheses were not included in the original flow recommendations document. The BC should add relevant hypotheses and provide evidence and assumption behind those and existing hypotheses.

10,000 cfs Flow Metric

Duration: **A minimum of 5 days between March 1 and July 31.**

Frequency: **Flows >10,000 for 5 days or more need to occur in 20% of the years on average for the period of record 1929-1993.** Maximum number of consecutive years without meeting at least a flow of 9,700 cfs (97% of 10,000 cfs) within the 65-year period of record is 10 years.

Hypothesized effects ≥10,000 cfs:	
Abiotic	**Evidence and assumptions**
1. Out of bank flow	
2. Generates new cobble sources	
3. Changes channel morphology and maintains channel complexity	Increased number of islands after high flows (Lamarra ####)
4. Increases nutrient loading and productivity	
5. Suppress nonnative vegetation in the bank full channel	
Biotic	
1. Colorado Pikeminnow reproductive success	
2. Important to Colorado Pikeminnow and Razorback Sucker	
3. Promote native fish abundance	Gido and Propst (2012)

8,000 cfs Flow Metric

Duration: **A minimum of 10 days between March 1 and July 31.**

Frequency: **Flows of > 8,000 cfs for 10 days or more need to occur in 33% of the years on average for the period of record 1929-1993.** Maximum number of consecutive years without meeting at least a flow of 7,760 cfs (97% of 8,000 cfs) within the 65-year period of record is 6 years.

Hypothesized effects ≥8,000 cfs:	
Abiotic	**Evidence and assumptions**
1. Maintenance of channel cross section	Bankfull discharge is between 7,000 and 10,500 cfs below Farmington, with 8,000 cfs being representative of the bulk of the river.
2. Moves cobble and builds cobble bars	
3. Create larval Razorback Sucker habitat during peak and receding flows	
4. Suppress nonnative vegetation in the bank full channel	
Biotic	

1. Increase abundance of native fish	Bluehead Sucker and Speckled Dace showed a positive response to flows above 8,000 cfs for 0-19 days. Gido and Propst (2012)
2. Colorado Pikeminnow reproductive success	

5,000 cfs Flow Metric

Duration: **A minimum of 21 days between March 1 and July 31.**

Frequency: **Flows of > 5,000 cfs for 21 days or more need to occur in 50% of the years on average for the period of record 1929-1993.** Maximum number of consecutive years without meeting at least a flow of 4,850 cfs (97% of 5,000 cfs) within the 65-year period of record is 4 years.

Hypothesized effects ≥5,000 cfs:	
Abiotic	**Evidence and assumptions**
1. Clean backwaters and maintain low velocity habitat in Reach 3	Increases nursery habitat
Biotic	

2,500 cfs Flow Metric

Duration: **A minimum of 10 days between March 1 and July 31.**

Frequency: **Flows of > 2,500 cfs for 10 days or more need to occur in 80% of the years on average for the period of record 1929-1993.** Maximum number of consecutive years without meeting at least a flow of 2,425 cfs (97% of 2,500 cfs) within the 65-year period of record is 2 years.

Hypothesized effects ≥2,500 cfs:	
Abiotic	**Evidence and assumptions**
1. Moves cobble in high gradient areas	
2. Cleans cobble for spawning	
Biotic	
1. Triggers spawning by Colorado Pikeminnow	

Timing of the peak flows noted above must be similar to historical conditions, and the variability in timing of the peak flows that occur historically must also be mimicked.

Timing: Mean date of peak flow in the habitat range (RM 180 and below) for any future level of development when modeled for the period of 1929-1993 must be within 5 days +/- of historical mean date of May 31 for the same period.

Hypothesized effects timing of peak flow:

Abiotic	Evidence and assumptions
Biotic	
1. Important for endangered fish spawning	

Target base flow (mean weekly non-spring runoff flow)

Level: 500 cfs from Farmington to Lake Powell, with 250 cfs minimum from Navajo Dam.

Hypothesized effects target base flow:	
Abiotic	**Evidence and assumptions**
1. Enhances nursery habitats	
2. 500-1000 cfs optimizes backwater habitat	
3. Target base flows need to be higher to achieve desired effects.	Long-term decline in total channel area (Lamarra)
Biotic	
1. Important for endangered fish spawning	
2. Suppress nonnative fish abundance (red shiner, fathead minnow and mosquitofish).	Gido and Propst (2012)

Operational Spill, formerly flood control releases (incorporated into operating rule)

Control: Handle flood control release as a spike (high magnitude, short duration) and release when flood control rules require, except that the release shall not occur earlier than September 1. If an earlier release is required, extend the duration of the peak of the release hydrograph. A ramp up and ramp down of 1,000 cfs per day should be used to a maximum release of 5,000 cfs. If the volume of water to release is less than that required to reach 5,000 cfs, adjust the magnitude of the peak accordingly, maintaining the ramp rates. Multiple releases may be made each year. These spike release shall be used in place of adjustment to base flow.

Hypothesized effects of flood control releases:	
Abiotic	**Evidence and assumptions**
1. Improve low velocity habitat quality by flushing sediment	
Biotic	
1. Suppress Red Shiner and Flathead Minnow abundance	

Appendix IV. Executive summary and notes for Workshop II

San Juan River Environmental Flows Workshop 2
April 5th and 6th, 2016
Action Items and Meeting Summary

Actions

- Susan Behery was asked to develop a table that contrasts the duration of time that goes by without a big flow versus how many times such a flow is "hit" during the same timeframe. (For example, for 2016 if Run C is the target, there can be more big events but there is a longer maximum period between those events.)
- A copy of all the workshop presentations will be emailed to meeting attendees (Program Office assignment?).
- The Program Office was asked to draft a narrative that will accompany the Revised Decision Tree (*Revised Flexible EWYST Decision Tree Releasing Maximum Days At 5,000 cfs)* with explanations and justifications. It was requested that a biology component be included in the narrative. (For example, how much water is needed in the river to keep larval habitat inundated for a desired amount of time? How does the timing of the shut down impact inundated nursery habitat? Etc.).
- The Program Office will draft a 2016 Operations memo for the Biology Committee to have as a read ahead for the decision call.
- Scott Durst will poll the Biology Committee to schedule a conference call to review Workshop #2 recommendations and make official 2016 Operating decisions.
- Nate Franssen will revise the threshold flow hypotheses with the revisions recommended during the group discussion.
- Bill Miller and Vince Lamarra will generate methodologies for hypotheses #3 and #5 for the 10,000 cfs threshold flows.

Suggestions

- Schedule a separate workshop to focus on and address monitoring.
- Schedule a separate workshop to compare and discuss the Gen 2 versus Gen 4 models. How to evaluate the model to make sure it is "ok?" And to make sure interpretations aren't against the hydrology used to generate the flow recommendations in the first place.

Upcoming Dates and Deadlines

- April 1 – Reclamation to provide Available Water calculations based on April 1 forecast; - *completed April 6*
- Now - A draft explanation paper, with Workshop #2 recommendations is basically needed now
    - Workshop Recommendation for approval: produce a 21 day minimum Spring Peak Flow, releasing 5,000 cfs; if available, maintain the peak for as long as possible (estimated to be ~35 days) with end-of-year reservoir elevation of 6,050. Baseflows will not be increased as part of the 2016 operations. Releases will be "shut off" when the Animus flow decreases to ~2,000 for several days.

- Soon – Biology Committee meeting to discuss/approval recommendations and elevate to CC
- Mid-April – Coordination Committee Review and Approval;
- Mid- to Late-April - Final Program recommendations are due to Reclamation

MEETING SUMMARY

DAY 1: Brief Summary and Highlights

- In the agenda review, some attendees pointed out that no final or official change has been made to the flow recommendations in response to the agreements from Workshop #1 and subsequent meetings. Some attendees expressed the concern that modifying the Decision Tree is in effect changing the flow recommendations. Others disagreed. Some concern was also expressed regarding the lack of sufficient documentation to support the revisions to the flow recommendations including more background and documentation on how we arrived at those suggestions.
    - The changes need to be well documented and supported scientifically in order to be robustly defensible.

- Scott Durst then briefly shared a summary of environmental flow workshops to date and an overview of Workshop #2 goals and objectives.

- Susan Behery presented on several model runs (Navajo Operations Modeling) for 3 Decision Tree options and 3 summer baseflow options (500 cfs to 750 cfs; 750 cfs to 1000 cfs; 1000 cfs to 1200 cfs) – resulting in 9 total scenarios.
    1. Run A: 2015 Interim Operation Decision Tree, AWST 6,063 ft (for each of the 3 baseflow options)
    2. Run B: Type 3 And Type 4 Release Only (remove Type 1 & 2), AWST 6,050 ft; (for each of the 3 baseflow options) and
    3. Run C: Maximum Days at 5,000 cfs, AWST 6,050 ft. (for each of the 3 baseflow options)
        - Run C puts the most water toward a spring peak release and has the most volume attributed. (Run C mimics a Type 3 flow with a minimum of 21 days at 5,000 cfs.). There is almost no operational spill under Run C as all available water is going to the spring peak.
        - Runs A and B are similar to each other and lower in volume than Run C.
        - Potential shortage situations are driven by the potential baseflow changes.
    - Attendees briefly discussed the comparison of the "new" model with the Gen 2 model. Comparison of the models has not been completed. This is a functional model but it is unknown how to compare it to the basis for the flow recommendations.
    - In summary, Run C does not use the prescribed hydrograph like Runs A and B so Run C with target baseflow of 500 to 1000 cfs is the "best" in terms of meeting the most "beneficial" situations (available water, days above 5,000, etc.). But this run also has the lowest excess target baseflow available.
        - By comparison, Run A with baseflow of 1000 to 1200 cfs shows the more "worst" case scenarios.
    - It was pointed out that there is a NEPA consideration for several of the scenarios. Several runs could be accomplished within the existing Record of Decisions, but anything that exceeds 60s could be challenged.

- Attendees then discussed the "tradeoffs" between focusing on spring peak flow, baseflow, or a combination of both (suggested matrix). What are the "tradeoffs" in terms of accomplished work between maximizing days of peak (for nearly-bank full events for work in channel; rework channel, rip out non-native vegetation, etc.) compared to elevated baseflows for maintenance and secondary channel (creating habitat) support.

- It was suggested that key hypotheses be identified and documented for each of the matrix options (i.e., fill out the matrix with identified appropriate hypotheses for each quadrant).

Lo ← Spring Pulse Flow → High		
	High/Low	High/High
	Low/Low	Low/High
	Lo ← Baseflows → High	

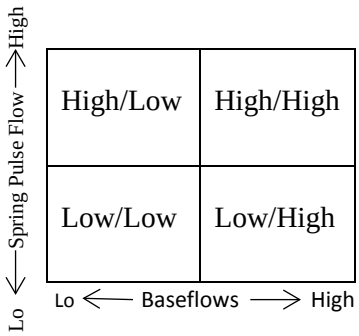
- In the afternoon session, attendees reviewed the proposed *Revised Flexible EWYST Decision Tree Releasing Maximum Days At 5,000 cfs*.
    - This "tree" or diagram incorporates all the flexibilities previously discussed.
    - This tree is flexible in that there is a range of target reservoir elevations for the available water calculations. A ballpark Type 3 hydrograph requires at least 229,000 ac-ft and is used to determine options for any given year. If above (or greater than) 229,000 ac-ft, there is a 3-day ramp up, minimum of 21 days at 5,000 cfs with attempt to match the Animus peak, and a 2-week ramp down.
        - Available Water less than 229,000 ac-ft is not sufficient to support a spring peak and can be used for elevated baseflows in that year.
    - Regarding the proposed, revised "Decision Tree", there was general support to attempt a 2-week ramp down period. There was also general agreement to recommend the chart's approval with (1) the removal of the specification of "up to 60 days" due to the concerns over the Period of Record; and (2) a note or clarification to be added that the Biology Committee can decide to lower the 6,063 ft ending reservoir elevation in years deemed necessary to bolster the baseflows for years with no spring peak flow.
    - Attendees discussed inspection schedules and potential impacts to flow decisions for 2016.

- Susan Behery presented 2016 calculations (based on the March forecast) and initiated discussion regarding 2016 operations.
    - 2016 Available Water calculations:
        - Minimum: 206,942 ac-ft for 14 possible days @ peak, so no modeled peak
        - Most Probable: 412,416 ac-ft for 36 possible days @ peak, 36 days modeled peak
        - Max: 647,239 ac-ft for 62 possible days @ peak, 60 days modeled peak.
        - Under the "most probable" forecast: 0 days of 10,000 cfs flow; 4 days of 8,000 cfs flow; *****41 days for 5,000 cfs flow.
            - ***** With the April decrease of 50,000 ac-ft, there will probably be closer to 31 days at 5,000 cfs.
        - Using Run C and the "most probable" calculations:
            - After meeting the minimum requires (500 cfs baseflow, downstream uses and minimum commitments) there is 412,416 ft left over. This is greater than 292,000 ac-ft so the Revised Decision Tree calls for a 3-day ramp up and 2-week ramp down with the reminder divided by 5,000 cfs per day. This means a spring peak flow of ~36 days. End the year reservoir elevation is 6,049.7 (6050) ft.

- After discussion options to focus on an extended spring peak flow or combination of spring peak flow and elevated baseflow, many attendees supported utilizing all available water to extend the spring peak flow for as long as possible. One justification is that it has been so long since there was a "high" spring peak, the most benefit will be achieved by holding the peak for as long as possible (i.e., do as much work as possible). No additional water will be applied to elevating baseflow this year.

DAY 2: Brief Summary and Highlights

- Attendees began Day 2 with continued discussions on the 2016 Operations Planning.
- Susan Behery ran the model overnight using the April 1 forecast. It was agreed that decisions will be made off the "most probable" predictions.
  - The most probable Available Water, given the April 1 forecast, is 401,000 ac-ft. This translates into a 21-day Spring Peak Flow (of 5,000 cfs; Type 3 flow) leaving 125,800 of AW.
    - If all the AW were to be applied to a Spring Flow pulse, there could be a maximum of 35 days at 5,000 cfs and ending the year with 6,050 in the reservoir.
    - Attendees then discussed possible uses for "excess" water remaining after 21 days at 5,000 cfs. The two (2) options are: (1) sustain the 5,000 cfs flow for as many days possible; or (2) ramp down flow after 21 days and then elevate baseflow using the remaining water.
      - Regarding the option to increase baseflows for the entire summer, some attendees questioned the benefit of increasing baseflow to 750 cfs at the expense of ending the year with water in the reservoir to put toward a spring pulse next year.
        - The question is: "Is the extra ~7 days of peak flow more valuable compared to 21-days of peak flow along with elevated baseflow?
        - It was pointed out that baseflow if often above 500cfs (and approaching 1,000 cfs in the critical habitat areas) with regular spring/summer operations and storm events.
      - Attendees discussed the desire to utilize the high spring flow this year to accomplish monitoring and hypothesis testing. However, from a contracting position, it will be difficult (if not impossible) to modify existing contracts with enough time to mobilize this spring. Also, any hypotheses to be tested would need to be well-thought out, well defined, and agreed to.
      - Attendees briefly discussed the suggested "matrix" of pulse and baseflow options:



      - Given the predictions for this year, there is the possibility of being able to achieve 8,000 cfs flows (maybe even 10,000 cfs flow if the weather contributes favorably). This could prove the opportunity to test the

hypothesize "resetting" of the system – but would take monitoring and data collection prior to the high flows in order to determine changes.

- Attendees discussed the "pros and cons" to attempting both options this year. Main discussion points have been summarized in the table below:

	Pros	Cons
Maximum days Spring Pulse Flow	• Lack of high flows for several years translates into greatest need; • If the Animus and weather cooperate, could achieve very high flows	
Increased Targeted Baseflow	• Higher baseflows benefit native fishes; and don't benefit the non-natives; • Secondary channels come on-line, increasing diverse habitat availability;	• Based on estimates, if dry could require more water to achieve (possible "waste?") • Uses water that could be "banked" toward next year • Complication with interpretations due to interacting variables (compared to attempting just one treatment)

o

- Attendees also discussed the need to identify when releases out of the reservoir are to be "shut off" (i.e., when ramping down should begin).
    - The suggestion is to "shut off" releases when the Animus flow declines to ~2,000 cfs for 2 or 3 days in a row (when *total* flow at the Four Corners declines to between 6,000 and 7,000 cfs for several days).

- Nathan Franssen then briefly presented "*Hypotheses And Assumptions Behind the Flow Recommendation Benchmarks – Or - How Do We Evaluate Flow Benchmarks?* and initiated discussion on reaching agreement on how high flows (and the response to high flows) will be monitored, including how to make the physical monitoring more effective and focused on the key questions.
    - It was cautioned that there is a "scale" affect when looking at the magnitudes of flows. For example, the smaller flows impact areas of interest on the 5 to 20 feet range while the larger flows can rework areas that are miles in size.
    - It was also cautioned that site evolution itself can potentially impact (change) the thresholds over time (ex. flow resistance, vegetation shade, etc.).
    - There was general agreement that the larger flows (and related processes) are still important to the system. The lower flows are just not helpful (or as important without the subsequent higher flows; as support by information in 2006 Integration Report) and might even be detrimental by (1) "irrigating" the young invasive vegetation and (2) depositing (building up) sediment at the mouths of the secondary channels.
    - Vincent Lamarra and Bill Miller will be producing a "menu" of potential monitoring tools that can be considered, depending on the targets. The overall objective can be framed as to "maintain and create habitat for the benefit of the native fish community (particularly the endangered species) in the San Juan River."
        - The general hypothesis is that "maintain these flows (5,000cfs, 8,000 cfs, and 10,000 cfs) will create and maintain the habitat in the complexity needed to maintain and support the fish.

- It was suggested that there should be a "suite of parameters" that are measured every year in order to determine the variability, even in poor water years with the absence of flows. This provides the background information and measurement errors.
    - There has to be some "base" monitoring that is maintained every year and builds the data sets.

- Additional questions and possible hypotheses (no particular order) captured during discussions included:
    1. Despite "big" flows, is channel complexity still being lost at key habitat locations? Do the "big flows" hold the system "steady?"
        a. If complexity is being lost, what is the causality between the flow and the location of concern (potentially including: channel migration, scour, Russian olive, incision, inundation, etc.).
    2. If the larger flows are maintained, will degradation be prevented over time?
    3. Do all the necessary/required habitat for the life-history stages exist within the river system? Is there enough habitat in the river system to support the full recovery the fish?
        a. How can sampling (capturing) of the intermediate and sub-adult life stages be accomplished/targeted? Are they not present? Are they missing habitat?
        b. Are there all the habitats needed for all the life stages for it to be a self-sustaining system?
    4. How many fish can each particular habitat site/type support?
    5. How many fish, of each life stage, are needed to reach adulthood and contribute to recruitment?
    6. How can the system recover from the "simplification" (loss of wetted area by 12 to 15%) that has occurred over the last 15 years?
    7. Can non-native vegetation be suppressed on restored sites to contribute to site longevity during certain/targeted flow?
    8. Can "new" habitat be created with just water?
    9. What is the species and habitat response to (a) flows and (b) flows plus mechanical intervention? How is that determined? Measured?
        a. What is the ideal flow and mechanical combination that optimizes site longevity before mechanical work is needed again?
    10. There is half the amount of islands (~150) as there were at the beginning of the Program. Why? Lack of "high enough" flows? If those flows are provided, will there be an increase in islands?
    11. Are the fish spawning in the same (or different) sites compared to the known locations of the 1990s? Are changes the result of the number of adults available? Do the fish have site/condition preferences for site selection?
        a. Can radio-telemetry be used to determine where the sizable fish going?
    12. What is not being done now (that used to be done) for the fish?
        a. Intensive Cross-Sections and Surveys – at the really complex, high priority sites to understand the response to flows; haven't been done for the past 12 years
    13. What is occurring on the "micro" scale in terms of vegetation and site armoring?
    14. What is the "window of opportunity" to use flow/water to remove/rip out non-native seedlings?
    15. How does created habitat respond to high flows?

16. How often are high flows needed (ideal frequency)? Is the system "maintained" given the inter-event period of the recent years? Does the assumed frequency need to be revised given the changes in the river system?
17. Given that the river is becoming more simplified and homogenous (as indicated by the loss of features, decreasing number of features, etc.), what is river-wide analysis aimed at answering?
    a. Will the river continue to lose channel complexity with time?
18. River-wide, how many secondary channels are flowing?
    a. Are secondary channels being lost in the absence of mechanical intervention? If so, at what rate?
    b. Of the 158 secondary channels (not sand bars), 25% have always flowed from day 1 while another 25% are not flowing now – what is the difference between those? Why does one work while another doesn't? Can that inform the work necessary to get additional secondary channels flowing?
        i. Why do some secondary channels persist and others don't? Junction angles? Bifurcate at a certain place? Certain channel invert relative to the main channel invert? Relationships to the apex of the bend? This insight can be used to prioritize which channels to work to keep open.
19. Spawning habitat is probably not limiting at this time, but nursery habitat is (based on the river situation prior to the dam and the resulting changes). There is a need for more nursery habitat that the system has now.
20. What types of habitat are needed for more recruitment? And where should that habitat be located?
    a. Focus on the reaches of river that appear to be most resistant to change(s) and use the information gathered there to inform potential work (needs) in other reaches.
    b. Fish monitoring for existing habitats is needed to better address the population density and site utilization questions.
    c. If there is recruitment, how many individuals can be supported by certain areas of habitat? Size? Type?
21. How does vegetation encroachment behave over time? And to what extent does it impact the ability to accomplish the same work with the same amount of water? (i.e., vegetation encroachment changes between events?)
        a. If there are more than 3 years between 10,000 cfs events, the next one will not be as effective at maintaining the habitat?
22. With greater flows of more duration and power, the "system reset" will be greater and more persistent over time.
23. What effect/extent if depression in temperature having on the fish?

- Additional activities/needs/considerations and potential projects (in no particular order) also discussed include, but are not limited to:
    - There is 1 dataset of described vegetation on both sides for the entire river as part of the original vegetation work. Vegetation could be remapped along the corridor to indicate detailed vegetation changes. There is also no data on vegetation at the "microscale."
    - Use GIS layers to compare to track cobble bar movement (spatial) within the river to determine if they are armoring; and postulate what would be needed to keep them dynamic.

- Photo documentation of site vegetation seedlings could be accomplished this summer as single data points under existing projects; quadrant counts could be considered as well.
- Monitoring of Channel Migration and Geometry – accomplished with mapping; aerial photography. Related decisions: river wide? Focus on complex reach(es) only?; Photography – cameras; Scour chains; Cross-sections;
- Monitoring Sediment Transport (Load) -
- Backwater Island Count – gets to the complexity of habitat issue/concerns.
- Monitoring of Backwater/Secondary Channel Scour – was done years ago but storm events resulted in immediate fill back. Abandoned because it wasn't providing useable data. Could be reexamined if completed in summer (not fall).
- Simultaneous habitat mapping and fish sampling is needed to speak to the population density and site utilization questions. After a site restoration, how do the fish respond?
    - Intensive monitoring of potential nursery habitat (with detailed larval and juvenile sampling to determine densities), could density be extrapolated or predicted for other sites? The entire river?
- Complete a stream-power analysis - recalculate based on existing data (slope by reach, channel width, depth) to look at the total amount of work that is done over a time period integrating all the flows. Flows can then be weighted for comparisons (ex. a 5,000 cfs flow for 2 days versus a 10,000 cfs flow for 1 day).

- Acknowledged challenges included:
    1. previous work (research and studies) justified/supported the decisions to cease certain monitoring activities – that work needs to be cited/referenced and
        a. has the system undergone enough changes since those studies that would warrant reexamining needs?
    2. funding and budget constraints; and the associated resulting priorities
        a. the Program needs to have an idea if/what restoration will work before a lot of money is spent
    3. separating the effects of flow on habitat versus the effects of flow on fish versus how habitat availability/quality effects the fish response?
    4. determining "life stage" densities and utilization at different sites; study size and scale would have to be appropriate for the targeted life-stage (intensity, short- versus long-term, etc.).

- Several attendees suggested a first step be to synthesize the existing data and analyses.
    - There is 20 to 25 years of work and research that has been accomplished but there is no summary document or table that neatly outlines the questions addressed, what was measured, and the resulting answer.
    - Identified and referenced reports/studies/documents/data included (please note these are not full citations nor complete titles):
        - 2008 Implementing Critical Reach Study
        - RERI site and associated a priori information

- Cross sections for the RERI Phase I and II (recently within the last 2 to 3 years)
- Original vegetation research with mapped vegetation for both sides of the river
- Original (2006?) Integration Report
- Habitat Report

- Bill Miller then projected a draft outline summarizing the monitoring draft scope of work that is currently under development, titled "*Conceptual Habitat And Water Temperature Monitoring Draft Scope Of Work.*"
    - The proposed approach uses some of the same techniques as current monitoring but different implementation in certain cases. New techniques are being proposed for other tasks.
    - The implementation of the techniques would be based on water-year type (and hydrograph) and annual study needs.
    - The Biology Committee will be able, based on the previous water year, determine what work and monitoring is to be accomplished. They will be able to select from the options and drive the proposed hypotheses and approaches.
        - It was suggested that key hypotheses be identified and documented for each of the matrix options (i.e., fill out the matrix with identified appropriate hypotheses for each quadrant).
        - Attendees discussed determining what needs to be done annually (i.e., core monitoring), data gaps, guidance needs for repeated work/monitoring, and how funding could limit options in any given year.
- Attendees reviewed the threshold flow hypotheses and providing suggested revisions.
- Scott Durst then presented a suggested process to finalize the e-flow workshops. There was general agreement among attendees that the suggest process was sufficient for the time and could be modified as needed in the future.

San Juan River Environmental Flows Workshop 2
Draft Meeting Notes

April 5th and 6th, 2016

Prepared For:
San Juan River Recovery Implementation Program

2105 Osuna Road NE
Albuquerque, NM 87113

On Behalf Of:
U.S. Bureau of Reclamation

125 South State Street
Salt Lake City, UT 84138

Prepared By:
Alliant Environmental, LLC

7804 Pan American Fwy, NE, Suite 5
Albuquerque, NM 87109

Table of Contents

Read Aheads and Preparatory Documents i

Acronyms and Abbreviations List ii

DAY ONE: April 5th, 2016 1

1.0 Introductions and Overview 1

1.1 Environmental Flow Workshops Summary and Overview of Workshop #2 Goals and Objectives 2

2.0 Decision Tree Options and Model Runs 5

2.1 Questions, Comments, and Discussion 8

3.0 Continued Discussion on Decision Tree Options 12

4.0 2016 Operations 16

5.0 Conclusions and Wrap-up 18

DAY TWO: April 6th, 2016 19

1.0 Opening and Re-Cap of Day One 19

2.0 Revised Flexible EOWYST Decision Tree Releasing Maximum Days at 5,000 cfs 19

3.0 Continued 2016 Operations Planning – Updated Model 19

4.0 Monitoring to Evaluate the Flow Recommendations 22

5.0 Monitoring Scope of Work Overview 26

5.1 Questions, Comments, and Discussion 27

6.0 Review, Revise, and Develop Hypotheses for the Flow Recommendations 28

7.0 Process to Finalize E-Flow Workshops 34

7.1 Questions, Comments, and Discussion 35

8.0 Workshop Adjournment and Wrap-Up 36

San Juan River Environmental Flows Workshop 2: Attendees 37

ATTACHMENTS 38

Action Items and Meeting Summary Document 39

Read Aheads and Preparatory Documents

In advance of the San Juan River Environmental Flows Workshop #2, read aheads and preparatory documents were posted on the San Juan River Recovery Implementation Program webpage. Additional information may be found there as well: **http://www.fws.gov/southwest/sjrip/**

- **Specific Workshop #2 documents included:**
  - **Agenda**
    - *www.fws.gov/southwest/sjrip/pdf/SJREFW2/WorkshopMeeetingAgenda_draft_V3.pdf*
  - **Handouts**
    - *http://www.fws.gov/southwest/sjrip/pdf/SJREFW2/WorkshopHandout.pdf*
    - The Handouts pdf contained the following:
      - 2015 interim operations Decision Tree, EWYST 6,063
      - Flexible EWYST Decision Tree releasing Type 3 and Type 4 releases
      - Flexible EWYST Decision Tree releasing maximum days at 5,000cfs
      - Hypothesized effects of flow recommendation benchmarks
  - **2015 Interim Process**
    - *http://www.fws.gov/southwest/sjrip/pdf/SJREFW2/Interim_Process_for_Determining_2015_Navajo_Dam_E-flow_Releases.pdf*
  - **Eflows Meeting 2 Supplemental Plots**
    - *http://www.fws.gov/southwest/sjrip/pdf/SJREFW2/Eflows_Meeting_2_Supplemental_Plots.pdf*

Acronyms and Abbreviations List

Ac-ft	Acre-feet
AM	Adaptive Management
AW	Available Water
AWST	Available Water Storage Target
BC	Biology Committee
CBRFC	Colorado Basin River Forecast Center
CC	Coordination Committee
cfs	Cubic feet per second
EOWYST	End of Water Year Storage Target
Ft	Feet
HR	Habitat Restoration
NEPA	National Environmental Policy Act
Pike Minnow or PM	Colorado Pike Minnow
Program	San Juan River Recovery Implementation Program
Reclamation	U.S. Bureau of Reclamation
RERI	River Ecosystem Restoration Initiative
RIP	Recovery Implementation Program
ROD	Record of Decision
RM	River Mile
SJR	San Juan River
SPR	Spring Peak Release(s)
Sucker or RZB	Razorback Sucker
TBF	Target Baseflow
USGS	U.S. Geological Survey

DAY ONE: April 5th, 2016

1.0 Introductions and Overview

- Mr. Jim Brooks opened the workshop and welcomed everyone. He explained meeting logistics and introductions were made. The general purpose of this two-day workshop is to discuss and decide on a long-term Decision Tree and 2016 Operations during Day 1 and focus monitoring during Day 2.

- In a brief agenda review, a concern was raised that while there was general agreement with the need to revise the 1999 Flow Recommendations (Flow Recommendations) as documented in Workshop #1 meeting notes, those changes were not formally/officially implemented.
    - ***Comment:*** There is no analysis on what flows have been available and how they are working. There needs to be supporting data to justify and drive the recommended changes to the Flow Recommendations. What is the basis for those changes – just the workshop and meeting discussions?
        - ***Response:*** The changes were based on the 2006 Integration Report.
        - There needs to be a written report that specifies the changes and provides the justifications. Otherwise, it is really non-robust scientifically. There needs to be documentation, not just the presentations, explaining the reasoning and basis.
        - There appears to be confusion with the Decision Tree versus the Flow Recommendations: the Decision Tree outlines how to operate the dam (to meet the Flow Recommendations) and the other is the recommendations on actual volume/amount of flow for biological (and geomorphological) purposes.
        - ***Response:*** The "driving force" behind the acknowledgement that the original Flow Recommendations need to be modified is that given the recent (10 to 15 years) "dry" hydrology, the higher flows are not being achieved with the current Decision Tree and Dam Operations. Instead, the system gets "stuck" in a more frequent, low magnitude "loop" of smaller flows that don't accomplish the work (or objectives) of the higher flows. This group was convened to examine and discuss what can be done differently to support the fish population and lead to down- and de-listing.
        - But there have been no permanent flow recommendation changes made yet. We need to have the decisions written on paper – with background information, justifications, and narrative on how we arrived at those decisions. There is no detailed analysis, in terms of support, for those changes. What are the "new" Flow Recommendations based on? What is the biology component? Geomorphology component? Etc.
    - One opinion shared was that the Decision Tree cannot be changed without inherently changing the Flow Recommendations.
        - Others disagreed and pointed out that since it has been recognized that the small flows aren't as important as originally assumed, modifying management as soon as possible (that is, the Decision Tree) is the most responsive and effective path forward while the Flow Recommendations undergo the necessary revisions and documentation process.

        - The intent of the Decision Tree is to provide the "look back" every year and use the best available data at that time.
        - Traditionally, operations have been successful at meeting the lower flow targets – it is the larger, less frequent flows that do more work that are desperately needed at this time.
        - It was also pointed out that if the larger flows are not realized, they can't be evaluated so it could be difficult to have current information and documentation to include in the revised Flow Recommendation justifications.
            - In response, some attendees reminded the group that there is a lot of data from the past and the original research and studies. Much of the documentation and supporting data might already exist but needs to be compiled for use in a Revised Flow Recommendations Report.
        - It is well known that the lower flows are not doing much geomorphically. However, it is relatively unknown how important they may be in dry years in terms of triggering spawning. Biologically, the fish rely on flow cues to move into to spawning areas but what is the lower-end threshold of that cue? (In other words, "how low can you go?") This could be an important issue for dry, inter-event periods.
            - There is data from previous years with documented spawning with flows under 2,500 cfs.

1.1 Environmental Flow Workshops Summary and Overview of Workshop #2 Goals and Objectives

- Scott Durst briefly shared a summary of the Environmental Flow Workshops to date and an Overview of Workshop #2 Goals and Objectives.
    - Through subgroup meetings and the December Flow Workshop #1, participants discussed the 1999 Flow Recommendations and the potential need to revise/modify those and the Decision Trees.
        - The original 1999 Flow Recommendations have an associated complicated Decision Tree that led to situations where frequent, small magnitude releases were accomplished but at the expense of retaining water to put toward bigger flows in subsequent years. Management was "handcuffed" in the ability to attain the larger flows within the same Flow Recommendations.
    - Outcomes of Workshop #1 include:
        - A flexible End Of Water Year Storage Target (EOWYST) range from 6,063 feet (ft) with option to lower that target to 6,050 ft.
        - Available Water (AW) uses in the future – revised Decision Tree?
        - Interim process for 2015 releases
        - Additional meetings convened
    - 2015 Interim Operations
        - AW for Spring Peak Release (SPR) calculated using EOWYST of 6,063 ft (with 6,050 ft option);
        - Minimizes the risk of both shortage and spill in the reservoir;

        - Navajo Dam will be operated to meet EOWYST by the end of each water year (with all contracts and target baseflow (TBF) met);
        - Any volume over the EOWYST to be managed/used as determined by the San Juan River Recovery Implementation Program (Program; SJR RIP);
        - AW not used by the Program will be released by the rules set in the Flow Recommendations;
    - 2015 Interim Operations (EOWYST 6,063 ft.) Decision Tree
        - More simplified in comparison to the original;
        - If AW calculated is below the agreed volume of 229,700 acre-feet (ac-ft), no releases; if water is above the set volume, releases will be made and the flow type determined;
    - Workshop #2 Subgroup Planning Meeting
        - Reviewed existing information;
        - Recognition that existing Flow Recommendations have their basis in mimicry and benchmarks are valid;
        - Any modification of the Flow Recommendations are intended to better attain the high flow metrics (Type 3 and 4 flows);
        - Eliminate Type 1 and 2 releases in order to have more frequent Type 3 and 4 releases (by "banking" water toward larger magnitude releases in future years).
    - Suggested Revised Flexible EOWYST Decision Tree Releasing Maximum Days At 5,000 cubic feet per second (cfs)
        - Discussion occurred in December about moving away from the "type" of releases and focus more on the duration (days).
        - If AW is above an agreed volume, then do a release of at least 21 days with a 3-day ramp up period and identified ramp down period, timed to match the Animus peak.
            - Navajo Dam releases to be "shut down" when the Animus peak is spent; and could result in AW for elevating baseflows;
            - The "shut down" process and triggers have yet to be determined and agreed to.
    - Workshop #2 Goals And Objectives Day 1
        - Review model run results comparing various Decision Trees and reach consensus on implementation of a Decision Tree;
        - Determine the duration of spring peak releases and the shape, magnitude, and volume of nose and tail of releases (i.e., the ascending and descending limbs of the hydrograph)
        - Agree when and how to implement elevated target baseflows (> 500 cfs) in any revised Decision Tree
    - Workshop #2 Goals and Objectives Day 2
        - Identify the key hypotheses of Flow Recommendation benchmarks and develop a monitoring program to test them;
        - Develop a structure for the end product for the revised Flow Recommendations and operations;
        - Discuss 2016 operation decisions

1.1.1 Questions, Comments, and Discussion

- ***Question:*** It has been discussed that "mimicry" isn't necessarily valid given all the geomorphological changes the river has experienced. Issues of suppressing non-native vegetation and habitat restoration (HR) are not included in the original Flow Recommendations. Is mimicry "the way to go" given the river changes and Russian Olive establishment?
  - ***Response:*** The correct approach would be to form hypotheses prior to deciding operating rules and monitoring rules.
  - The intense complexity of the original Decision Tree was included to meet some need as identified in the original documents. The foundation for Flow Recommendation changes are there but are lacking sufficient, scientific documentation and analyses necessary to be robustly defensible.
  - Everything, including the Period of Record, has changed. It is not that these changes aren't necessarily valid, but there was reason for the complicated Decision Tree originally. There could be tradeoffs to meeting the larger flows at the expense of the smaller flows.

- ***Question:*** Back in December, there was discussion on elevating baseflow. The original Flow Recommendations targeted a baseflow between 500 and 1,000 cfs. The minimum target has been to keep baseflow at 500 cfs. What are the potential impacts (benefits and tradeoffs) of elevated baseflow?
  - ***Response:*** Water used to elevate baseflow is not contributing (i.e., banked) toward potential spring peak flows for the future years. However, increased baseflow can create more habitat through secondary channels.
  - There needs to be monitoring for the effects of increased baseflow – to have the data available to justify increasing it or not.
    - It was pointed out that there is information on the baseflow conditions and resulting habitat.

- ***Comment:*** We know we are losing channel width (sand bars and cobble bars are being produced) and secondary channels are being abandoned (between 500 to 1,000 cfs). At 1,500 cfs, we see an increase in island count and an increase in channel complexity; but we don't see an increase in backwaters. The good news is that the Colorado Pike Minnow (pike minnow) need and use the large backwaters that are created with the ramp down to baseflow.
  - ***Response:*** There is an assumption that backwater is critical for these fish but have we shown that? How much backwater is needed? What is the density of fish in those areas? A rigorous analysis to show the biologic response has not been done.
  - Some work exists that indicates "higher" low flows reduce the abundance of non-native fish. There is some biologic information but it is not related to a particular flow regime (not a specific baseflow target study; just higher versus lower flows).

- ***Discussion:*** Attendees discussed the vagueness and "testability" of existing hypotheses and key questions. Several attendees offered the opinion that many of the flow recommendation hypotheses are unclear (life stage specifications?) and possibly not testable without refining. Others expressed the opinion that

while they might not be "quality," they are clearly stated (what each flow threshold was expected to accomplish and the associated importance thereof).
        - Difficulties in testing (proving) could be related to: lack of specified life stage, lack of fish back in the 1990s for comparison and data, etc.

2.0 Decision Tree Options and Model Runs

- Susan Behery presented several model runs (Navajo Operations Modeling) that were completed with various Decision Tree and EOWYST options. Each model run was conducted with varying summer baseflows (500 to 750 cfs; 750 to 1,000 cfs; and 1,000 to 1,200 cfs).
    - 3 operational Decision Tree scenarios for each of the 3 summer target baseflow scenarios resulted in 9 total scenarios:
        - Run A: 2015 Interim Operation Decision Tree, AWST 6,063 ft (for each of the 3 baseflow options)
        - Run B: Type 3 And Type 4 Release Only (remove Type 1 & 2), AWST 6,050 ft; (for each of the 3 baseflow options) and
        - Run C: Maximum Days at 5,000 cfs, AWST 6,050 ft. (for each of the 3 baseflow options)
    - Baseline Model (previous modeling runs used the Operations Model)
        - Depletions are higher (Operations Model used current depletions and shorter time range; higher by 20,000 ac-ft – dryer hydrology, higher Colorado depletions, tribal considerations)
        - Time period is longer (1929-2013) – showing the additional 20 years of dry conditions
        - The model is still centering the predicted releases on June 4th – which is typically matched closely to the Animus peak. (Because Run B and C are longer releases, they are almost always hitting the Animus peak.)
    - Prioritization of Releases
        - The model predicts the releases to meet TBF. The remaining water is applied to a SPR and any leftover water is applied as operational spill (that can be added to the peak ramp up or nose, increased TBF, or fall spike).
            - Please note that if there is an operational spill or excess, it is applied to the nose first, then TBF, and finally toward a fall spike – in that order.
    - *Run A*
        - AWST and EOWYST are same: 6,063 ft
        - SPR Options: all 4 (Type 1, Type 2, Type 3, and Type 4)
        - Operational Spill: nose, increased TBF, and fall spike
        - Run A results in more frequent SPRs; but the overall size of the releases is on the smaller end (more, smaller releases). Excess water for other purposes is typically available.
    - *Run B*
        - AWST is 6,050 ft, and EOWYST is 6,063 ft
        - SPR Options: only Type 3 and Type 4
        - Operational Spill: more water is put toward spring releases so it is unlikely to have spill;
        - Run B results in overall less frequent releases.
    - *Run C*
        - AWST is 6,050 ft, and EOWYST is 6,063 ft (same as Run B)

        - SPR Options: 21-60 days at 5,000 cfs
        - Operational Spill: most water is put toward spring releases so excess (spill) is not typically available;
        - Run C results in a SPR frequency between Run A and Run B.
            - Please note that releases for spring peak are not done if the Animus River is not contributing.
    - Cumulative Available Water
        - Lower TBF means more water is available for other uses. In general terms, increasing TBF from 500 cfs to 1,000 cfs is effectively going to cut water availability in half (half as much water available for spring peak releases).
        - Presented graphs are based on 85 years including the last 20 years that were very dry.
        - The patterns are similar for each Decision Tree run but the volume of water changes between the options.
    - Cumulative Spring Peak Release Volume
        - Run C has the most volume attributed. Remember, Run C has to have a minimum of 21 days at a flow of 5,000 cfs (mimicking a Type 3 release).
        - Run C puts the most water toward a SPR. Runs A and B are similar to each other and lower than Run C.
        - Adding in water for the ramp up (nose) basically extends the flow time.
    - Cumulative Excess Volume (All Operational Spill)
        - Run C has almost no operational spill – all available water is going to the SPR.
        - There is a lot more operation spill under Runs A and B because of the step hydrographs.
        - The lower the TBF, the more water is available for other options.
    - Cumulative Shortage
        - When TBF is elevated to 1,000 cfs, the model is shorted 40% of the time. However, the reservoir tends to recover faster with the year-to-year decisions compared to the original Decision Tree.
        - There is not a lot of difference between the 3 runs, although Run C does go into shortage situations a bit more.
        - "Shortage" is defined as end-of-water-year storage of 5,995 ft for the model (and 5,990 ft for real-time operations).
        - ***Question:*** How does the San Juan-Chama Project change when there are shortages in the San Juan basin? Can it take as much water as it wants?
            - ***Response***: The San Juan-Chama Project is mostly "naturally" shorted. They will take what they can but if deliveries cannot be made, then federal law says other federal projects will take an equal shortage. Some analysis shows it is a rare occurrence – the San Juan-Chama could be naturally shorted in poor water years. It could be a rare situation where a big snow year occurred after a series of drought years that would allow the San Juan-Chama to take something greater but then there is inability to meet all the demands below the dam.
    - Four Corners Flow Statistics
        - Type 1 and 2 flows were eliminated in order to target more frequent, larger flows (Type 3 and 4). The model is always targeting 500 cfs.

- Target Baseflow of 500 to 750 cfs
    - Anytime TBF is increased, there is less water available for spring peak flows. This is indicated in each run with decrease in the spring flow volume (lowered) and duration (decreased).
    - However, Run C doesn't use a prescribed hydrology (Type 3 or 4) which means Run C can be more customized.
        - Attendees discussed the importance of "high enough" flows needed approximately every 3 years in order to scour out non-native vegetation at it roots. Once established, they are very difficult to remove. High flows, if frequent enough, could help to prevent establishment. At a 33% frequency, scour flows would be accomplished every 3 years.
        - It was cautioned that a 33% doesn't preclude the situation where there is a long time between such flows.
- Target Baseflow of 750 to 1,000 cfs
    - Run C still shows the same pronouncement of reducing the low flows in (Type 1 and 2) favor of the higher flows. It is most pronounced in the 8,000 cfs flows and somewhat in the 10,000 cfs flows. Run C also has the higher cap.
    - Run A and B are using the same hydrograph and are very similar to each other. They do not really show any distinct patterns.
- Target Baseflow of 1,000 to 1,200 cfs
    - For this scenario, all runs are indicating the same patterns – which are shifted in that the flows are achieved much less frequently.
- Maximum Duration Between Events
    - 10,000 cfs SPF
        - With Runs A and B and TBF of 500 cfs, there can be 16 years without hitting a 10,000 cfs flow. Run C with TBF 500 cfs can go up to 18 years between events.
        - The duration between events only increases (gets worse) as TBF is increased to 750 cfs and greater. In this situation, there can be 21 years between events.
        - Increasing the TBF, even for just part of the summer, makes a significant difference.
- Summary Table
    - A summary table with compilation of all the "important parameters" and flow statistics was projected as part of the presentation. In the table, the "sum" of all these parameters was calculated to arrive at a "total accumulative" plot. There are 9 months of "operations" so each was ranked from 1 to 9:
        - Run C with TBF 500 cfs had the "most" in terms of best scenarios (AW, SPR + nose; Days >5,000 cfs; Days >8,000 cfs, Days >10,000 cfs) but this run also has the lowest excess TBF available.
            - The lowest excess TBF is a function of extending the SPF but the tail of that peak could be decreased in any giving year to have more excess available.
        - Run A with TBF of 1,000 to 1,200 cfs has to most "worst" case scenarios.

2.1 Questions, Comments, and Discussion

- Attendees discussed the model runs and predicted flow probabilities. The desired outcome from this presentation and resulting discussion was to understand and make informed decisions on selecting a Decision Tree and inform possible operations for 2016.
- Attendees were reminded that they are being asked to consider the long-term Decision Tree.

- Concern was expressed that while this is a functional model (Gen 4), it is unknown how to appropriately compare it to the model that the Flow Recommendations were based on (Gen 2). Have depletions increased compared to the Gen 2 model? Are there different hydrologies, with more dry years, between the models? Other differences between the models that could cause issues?
    - It was suggested that a "model comparison" exercise needs to be done – using the same conditions as used in the Gen 2 model in order to determine if the Gen 4 model is representing the system in a similar way as the Gen 2 model. One reason for this is the intended use of the Gen 4 model in Section 7 consultation.
    - However, others asked what the confidence is that the Gen 2 model itself was accurately representing the system.
    - Concerns include: (1) the initial results (that informed the initial Flow Recommendations) cannot be compared to current runs and (2) the Gen 4 model hasn't been agreed to or evaluated by the group.
    - Running the models with the same data set will be challenging since the system has changed significantly over the years.
    - There is one very fundamental difference between the assumptions of models Gen 2 and Gen 4 – which is full development. Gen 4 includes all the depletions in the system.
    - For this workshop, the model runs were intended to investigate the feasibility and probability of implementing the kind of flows important (necessary) to the recovery of the fish. Other considerations for model use are outside the scope of the workshop (such as consultation). Regarding "reality checks," the Gen 4 model can be run with hydrology for the last 15 years and the probability of achieving target flows with more recent conditions. This can inform options for revising the Flow Recommendation.
        - It has been agreed that the needed results and frequencies are not being achieved under the hydrology from the 2000s. We can't meet the "goals" that we originally said were needed.
        - Others pointed out that the model is intended to "indicate some agreed-to flow statistics" going forward but the real "indicator" of success is the biologic response (species status).

- ***Question***: Is there a table that contrasts the duration between events (duration of time that goes by without a big flow) versus how many times that flow occurs during the same timeframe? For example, in Run C with TBF 500 cfs there can be more "big" events but there is a longer maximum period between them. It could be helpful to be able to quickly compare/contrast those. And inform the potential need in the Decision Tree for options on system operation changes to address multiple years without a big flow (i.e., how to start operating the system differently to ensure we get one before 18 years has passed).
    - ***Response:*** This comparison is not built into the model. But remember, we don't have any control on the Animus.

        - It was pointed out that this is what the original Decision Tree was set up to accomplish - by storing water for big releases. But the feedback loop resulted in many low volume peaks that have since been identified as not accomplishing work and just "wasting" water by releasing in years when the Animus wasn't producing.

- ***Question***: We have an underlying assumption that the high volume flows are needed to maintain channel complexity. If those assumptions are off (or wrong), maybe channel complexity could be maintained by higher baseflows (that prevent encouragement). We need to consider the underlying hypotheses that accompanied the original Flow Recommendations.
    - ***Response:*** Analysis on total wetted area has been done using aerial photography.
    - But was the progression already occurring? There was no salt cedar or Russian Olive in 1963. But in the subsequent years, there was higher baseflow until that was changed in the Flow Recommendations.
    - What maintenance might be accomplished by raising the minimum average baseflow to ~1,000 cfs?

- Several participants expressed support of Run C with TBF 500 cfs – real time manipulations could address the excess by shutting down releases to match the Animus. This option provides the most possible flexibilities and most likely accomplishes the much-needed higher flows this year.
    - After each high flow year, there was an increase in wetted area. The recommended changes in the Decision Tree are to obtain more frequent higher flows with the purpose of "maintaining complexity" and keeping the channel clean/clear. Eliminating the low flow releases allows more of that water to be put into high flow situations.
    - Other participants brought other potential mechanisms available to accomplish such work in conjunction with (or absence of) higher flows.
        - The hypothesis is that more frequent high flows are best, but what happens when those increased flows result in lower baseflows – could that be detrimental? In what ways? To what extent? Are there analyses that need to be done? There is a tradeoff and we don't have the information or analyses on the impacts (and system response) of those tradeoffs. This gets back to the concerns about revising the Decision Tree without clear basis for the "what and whys."
            - There is data indicating decline in channel complexity and wetted area. It has been hypothesized that flows of a certain magnitude will maintain channel complexity and this is viewed as biologically important.
            - However, system decline could be a result of both lack of high flows and decreased baseflows.
                - In a brief review, specific island count data was reported. The lowest number of islands occurred in 1992. Between 1962 and 1992 several things changed significantly in the system: it was post-dam resulting in changes in the flow regime, salt cedar and Russian Olive were encroached, etc. Implementation of the higher flows is based on the channel responses to the 1993 and 1995 higher flow years. There are not the same supporting

observations that increased baseflow will increase complexity, including secondary channels flowing.
- Could the tradeoff between high spring flows and keeping channels wet during the summer be an important one?
- There needs to be a balance of maintaining sufficient flows in the river for the fish and creating/maintaining habitat (secondary channels) for various life stages.
    - It was pointed out that secondary channels and other features could be maintained and reopened mechanically.
    - It could be important to distinguish between "new habitat" versus "maintaining existing habitat." Does the maintenance occur through inundation or scouring? If the focus is on creation and scouring, does that limit the opportunity for maintenance from inundation?
    - The articulation of specific hypotheses and appropriate testing is critical to teasing these apart.

- ***Question***: The question should be: "do any of these Decision Trees facility being able to develop and test specific, key hypotheses?"
    - ***Response:*** Most of the Decision Tree options do not preclude the ability to test hypotheses.
    - No one voiced an objection or disagreement when participants were polled to determine support of the idea that some high flows are needed at some frequency.
    - Run C appears to give the least flexibility in terms of adding to baseflow; however, the emphasis is the higher flows and Run C best provides for those.
        - A compromise could be to consider Run C with TBF of 750 cfs – to achieve high flows for an acceptable duration but preserve the geomorphic work done by increasing the baseflow. The tradeoff comes down to total days for the spring peak flow.
        - It was pointed out that annual assessment (meetings and forecasts) allows for selection of important targets that year – each year can be shaped accordingly to the forecasts and most pressing needs. The objective is to achieve more frequent flows of 8,000 cfs and 10,000 cfs than have been accomplished under the previous operating rules.
    - Conceptually, these Decision Trees (Run A, B, and C) are very different. With Run C, all the "eggs" are in the spring peak "basket" and elevated baseflows come second. Run B is more conservative with 21 days of 5,000 cfs but that means more flexibility for elevated baseflows.
        - Both Runs B and C are focused on higher flows. But Run C could be "tweaked" to provide more excess for baseflow options (i.e., a variation on C allowing flexibility on duration). The channel is very "simple" at 500 cfs – there aren't many secondary channels flowing and only a few backwaters.
        - There may need to be testing of the baseflow ranges to determine the optimal baseflow for preventing encroachment of non-native vegetation.

        - Opportunities for any given year will be dependent on the Animus, but the longer the releases are "stretched," the more likely we are to catch the peak. It is opportunistic to some extent.
        - It was suggested that a flow "matrix" of SPR and TBF be developed to help support the systematic testing of the hydrographs. At its simplest, the matrix would have 4 options or "boxes": (1) high SPR/high TBF; (2) high SPR/low TBF; (3) low SPR/high TBF; and (4) low SPR; low TBF.

- ***Comment:*** Remember, the target releases of 8,000 cfs and 10,000 cfs seem to be "cemented" but flows close to those are equally valuable. For example, a "big year" can be 7,500 cfs or 9,500 cfs. The point is that 8,000 cfs is better than 5,000 cfs which is better than 3,000 cfs. The combination of vegetation suppression and scouring is one of the most critical issues in the system. In years with little water available, there is nothing to suppress the vegetation which "hangs on" and thus even more water is required in the next year to accomplish the removal. There needs to be a monitoring program to determine if/when baseflows should be increased.
    - ***Response***: In terms of releases for spring peaks and baseflows, elevating baseflow pulls water that could be applied to the peak. The priority needs to be agreed to: baseflows or spring releases? This will make a difference in driving the decisions.
    - April through August is the timeframe for young-of-year and juvenile production and rearing (before they become mobile and move to the river). This is also the time period of the highest flows. The system is managed for baseflows primarily after the fish are out of the backwaters.
        - The end of June/first of July is the typical window for pike minnow spawning. It takes 2 to 3 weeks for the fry to grow enough to relocate – so by mid-July they are out of the backwaters. This is on the tail end of the hydrograph by then and if kept up, could provide secondary channel for them.
        - Zero velocity habitat can also occur at the tips of islands.
        - There are 2 ways to add complexity, and both are needed for full flexibility: (1) high flows to rework the channel and rip out non-natives; and to (2) elevate baseflows to keep channels running and create/keep secondary channels.
    - Attendees discussed avoiding fixed, rigid processes but supporting habitat needs on an annual basis that considers the Animus flow, accomplishments of the previous year, habitat work done, etc. This means some years will maximize bank-full opportunities while others years will have elevated baseflow.

- Some attendees pointed out that National Environmental Policy Act (NEPA) details need to be considered when making decisions and/or changes. Runs A and B at 500 cfs to 750 cfs and 750 cfs to 1,000 cfs baseflow can be done within the existing Record of Decisions (ROD). But Run C at 1,000 cfs baseflow would trigger consultation as would the 60-days at 5,000 cfs. Anything documenting such an extended duration would be challenged.
    - It is acknowledged that flexibility is needed but that flexibility has to be found within the existing parameters.

- ***Comment:*** There is a balance between important fish reproduction cues and sufficient high flows for geomorphic reasons. Biologically, a longer ramp up period with shorter duration of peak flows matches the pre-dam conditions. (Of course a managed ramp

down is also needed to minimize stranding.) This hydrology might be more important to the fish, biologically, than high flows for longer duration. But how does this impact the geomorphic work needing to be accomplished?

    - ***Response***: Maximum fish reproduction is not an annual requirement as the fish are a "long-lived" species. In those years, management can focus on other things that "set" the fish up for success in subsequent years.
    - Both the biologic and geomorphic components/responses need to be tested and documented in the matrix or scenario box.

  - ***Comment:*** Some attendees expressed that "doing away" with the Type 1 and 2 flows is, in fact, a decision.
    - ***Response:*** But one of the worse things to do is to make a "half-release." If a release is to be made, it needs to be 5,000 cfs or not at all. Anything less won't accomplish the necessary river work and will, in effect, just "waste" the water.

- In summary, Mr. Brooks reiterated the group's general agreement to look to the most flexible Decision Tree and consider a "matrix" to provide guidance on hypotheses and spring peak/baseflow combinations based on available water.
  - Attendees discussed whether or not "Decision Tree" still accurately describes the decision process. While it doesn't resemble a "tree" anymore, it really is a semantics issue and "tree" or "process" or "guidance" or "chart" could all be used.
  - Shifting to an "annual" process (including EOWYSTs and AW calculations combined with Animus forecasts) will mean needing timely Program processes to inform the BC about volumes to release and hypotheses to test. Based on similar program examples, this may take more meetings (and coordination) than currently on the BC calendar.
    - Some concern was expressed that the Program will end up repeating the same conversations and potential gridlock every year.
    - In response, it was shared that with more coordination and agreement on the objectives then each year's work can be achieved on a real-time basis. It won't be a "free-for-all" situation each year. If the matrix can be developed and approved in advance, it will also provide continuity between years.

3.0 Continued Discussion on Decision Tree Options

- Jim Brooks opened the afternoon discussion with a review of the issues identified earlier this morning. There is a need for a flexible guidance and process, regardless of the actual title (suggestions included: "annual evaluation" or "Decision Diagram" or "Decision Process").

- *Revised Flexible EOWYST Decision Tree Releasing Maximum Days At 5,000 cfs*
  - This "tree" or diagram incorporates all the flexibilities previously discussed including a range of reservoir elevation targets for the available water calculations. If AW is anticipated to be ≥ 229,000 ac-ft (which is a ballpark Type 3 hydrograph and includes the 350 cfs minimum releases in its calculation), there is a 3-day ramp up, minimum of 21 days at 5,000 cfs, and a 2-week ramp-down. If/when the Animus flows drop, the releases from the reservoir will be "shut of" to conserve water that might be used for other purposes.
  - This Decisions Tree has added flexibilities when AW is ≥ 292,000 ac-ft: a peak flow can be accomplished and excess water can be applied to the peak, to baseflow increase, or both depending on the volume of excess. Right now, the Decision Tree is "sequential" and decisions on baseflow are not made until after the decisions on peak flow.
    - *Please note that the revised Decision Tree projected during the meeting included a range of flow days from 21 minimum to 60 maximum. The reasoning was that*

for 90% of years, the Animus peak flow can be matched within a 60 day period. Some attendees requested a predictive modeling (or statistical analysis) exercise to determine the "typical" flow patterns and when the last high flows regularly come out of the Animus, including likelihoods and predictors.

- *NEPA*
  - Some attendees returned to the NEPA concerns and suggested that the "60-day" maximum be removed from the printed materials. The water volume will dictate the maximum days possible and flood control operations don't need to be specified in the Decision Tree.
- *Flow Release Shut Off*
  - Attendees discussed the need to have the "shut off" determination process codified in the operating scenario(s) in order to avoid having unnecessary meetings.
    - Some attendees would like to see a biology component to the shut off/ramp down decisions. For example, how much water is needed in the river to keep the larval habitat inundated for a desired amount of time (for larval development)? What are the potential differences, biologically, between a 3-day ramp down and a 5-day ramp down?
      - For example, selecting a target date such 1 month after spawning. Or target an "indicator" in the critical habitat instead of the Animus gains and losses.
    - The spring peak and releases are really based on the Animus contributions. The goal is high spring flows. If the Animus is spent, then Navajo Dam releases need to be "shut down" to save the water for next year.
    - A 5,000 cfs release out of Navajo is intended to "match" the Animus peak of ~3,000 cfs (total 8,000 cfs). For a "flow" indicator, it was suggested that the Animus be considered "spent" at 1,000 to 2,000 cfs (total 6,000 to 7,000 cfs) for 2 or 3 days in a row.
- *Spring Peak Release – 21-Day Minimum*
  - In response to a question on the "21-day minimum," it was shared that (1) anything less than 21 days is actually a Type 2 flow (Type 2 = 2 weeks; Type 3 = 3 weeks); (2) it increases the likelihood to be synchronized with the Animus; and (3) it provides sufficient duration to address sediment transport questions and targeted geomorphology work. But there is nothing "magic" about 21 days in and of itself.
    - Some attendees expressed the desire to have a physical or scientific basis, if possible, for this recommended time frame (and for all the numbers in the Decision Tree).
    - 21 days is also an observed timeframe to accomplish secondary channel cleaning. Shorter peaks don't transport enough sediment out of the river which then end up "eddying out" in the secondary channel mouths. The actual duration is dependent on (1) sediment transport that year, (2) sediment transport in previous years, (3) how many years since high flows, etc. But in general, the longer the duration, the better secondary channel mouths get cleaned.
    - The duration of the release is important to sediment control and matching the Animus. Achieving both is maximum effectiveness.

        - 60 days provide a 90% probability of hitting the Animus peak.
    - If there are some years with high confidence of knowing and hitting the Animus peak, does it make sense to stick to the 21 days (compared to a shorter time)?
        - Forecasts and predictions keep getting more and more accurate (in general). But the 21 days at 5,000 cfs has biological and geomorphological considerations. Matching the peak doesn't necessarily take 21 days but what is the river work that needs to be done simultaneously?
    - If releases have been made for 17 days before the Animus is spent, would releases be increased to compensate for the remaining 5 days (to maintain the 5,000 cfs for 21 days)?
        - Yes; less than 21 days doesn't make much sense given the research and observations that informed the original Flow Recommendations. But going forward, we can examine the conditions and test the amount of water savings, negative impacts (sediment issues), etc.
        - This is why it behooves the Program to have a rational basis, to the extent possible, for every number in the Decision Tree. There needs to be clearly defined agreement on when to "shut off" and save water for other future activities.
        - In terms of modeled frequency, a 21-day at 5,000 cfs flow (for Run C with 500 cfs TBF) occur in 44% of years (or 2 out of every 5 years).
        - Attendees discussed temperature considerations. There is going to be a temperature depression downstream anytime a large proportion of flow comes out of the Navajo reservoir.
            - Consequences of long-duration flows also include incision (especially around island complexes). Channel incision can then disconnect secondary channels and impact overbanking. Past monitoring efforts had difficulty detecting aggradation and degradation.

- Currently, 21 days is used as a general measure to determine the feasibility of spring releases or not. There was general agreement to retain the 21-days benchmark for now with intent to evaluate it in the future and refine it as necessary.

- *Spring Peak Release – 5,000 cfs Target*
    - Attendees then discussed the 5,000 cfs target. Past observations and tracking of "higher" flows indicated that 5,000 cfs in the river alone doesn't do the expected amount of river reworking. It takes a 5,000 cfs flow followed by a subsequent increase to 8,000 cfs to be effective.
    - There is also an increased chance of hitting 8,000 cfs if releases are made for 21 days.

- *Spring Peak Releases versus Elevated Baseflow*
    - Operationally, it would take a huge hydrology year to have both big spring peak flows and elevated baseflow while keeping the reservoir level at 6,063 ft.

        - An elevation difference between 6,050 ft and 6,063 ft translates into 160,000 ac-ft. For every day that releases are shut down early, baseflow can be elevated for 10 days.
        - It was noted that baseflow can be increased for operational purposes (space) and not environmental reasons (per se). This will be done as necessary in any given year.
            - For the species, there is a biologic need to have the elevated baseflow during the summary for maximum backwater habitat. Operational spill in the fall doesn't support the biology needs.
    - Regarding the timing of decisions. Forecasts are updated every 2 weeks, starting in January. Modeling indicates that peak flows can begin as early as March; but technically, they could even start in January if it were a huge water year (and flood control rules). The forecasts are used to "back calculate" and determine starting times.
        - If flood control operations are in effect, the system will be managed differently.
    - Data indicates that there may need to be more flexibility in the baseflow numbers. And there is a lot of documented information that 21 days is a "good" target number as is accomplishes the geomorphic work.
    - It was suggested that the 21-day minimum be met with AW but move back to the 6,063 ft elevation before calculating potential baseflow releases. In other words, suspend the 5,000 cfs flow after 21 days, bring the reservoir elevation back up, and then consider baseflow elevation.
    - Alternatively, the volume for 21 days could be calculated and the remaining water (difference between maximum 36 days and 21 days or 15 days "extra) could be used to calculate days of elevating baseflow to 750 cfs.
    - Baseflow elevation is an option for years without a spring peak release
- *Suggested Changes*
    - Suggested changes to the Revised Decision Tree included:
        - Consider adding a conditional "box" to allow selecting an elevated baseflow (from 500 cfs to 750 cfs) out of the 292,000 ac-ft. This flexibility might be preferable in the situation where there have been several years of high peak flow. Right now, if there is 292,000 ac-ft the Decision Tree calls for a spring peak release regardless of previous years.
            - This also goes back to the matrix and provides the BC with the decision making ability to determine which year to test the 4 water year options.
            - For example, it might be that 550 cfs (not 500 cfs) is needed to increase the number of secondary channels that are flowing.
                - According to current data, 18% more secondary channels begin to flow when baseflow is increased from 500 cfs to 1,000 cfs.
            - In terms of biological significance, non-native fish respond positively to lower flow. Increased flow could be one way to suppress the non-native species.

        - Some attendees expressed the following concerns:
            - (1) it is perceived that there is potential for a "free-for-all" during the decision making process every year;
            - (2) there is perception that we are crafting a decision document that is departing from the record and is not just forcing larger magnitude peaks but does a lot more; and
            - (3) the direction we are heading, puts all the "eggs" in the "spring basket" and while there might be some exceptional years, it is most likely that baseflows will not be elevated in years with peak releases;
    - *Dam Inspections*
        - Attendees then reviewed dam inspection requirements.
        - 4,800 cfs can be released for 21 days before an inspection is required. If flow releases are 5,000 cfs then inspections are required every month and result in a facility shut down for 1 week. The auxiliaries have to be inspected every 2 weeks. Once the jets run for 30 days, they also have to be shut down for inspection; this is the case even if the 30 days is non-sequential.
    - *2-week Ramp Down*
        - The 2-week ramp down is to address stranding concerns and provide a safeguard for fish in secondary channels and backwaters. It also attempts to keep habitats available for the fish for longer periods of time.
            - General guidelines (from the Wyoming Game and Fish Instream Flow Coordinator) is that declining rates are not to exceed 20% in a 24-hour period (per day). In Colorado, it is based on changes in stream stage and restricted to 2/10ths (1/5 ft) per hour for the juvenile fish. This usually results in a 5-day ramp down, compared to the 2-weeks allotted here.
            - The 2-week ramp down came out of the original Flow Recommendation Flow Type descriptions (Type 1 and Type 2 had 1-week descending limb and Type 3 had 2-weeks).
            - However, a "natural" ramp down is a much longer time – by comparison 2 weeks is very fast. There is a tradeoff between stranding fish (too fast) and keeping fish in habitat (use of water).
        - Sources for insight for ramp down guidance include:
            - 1. Larval fish sampling and isolated fish in pools (looking at rate of decline prior to that sampling) and
            - 2. Several years ago an IHA (Indicators of Hydrologic Alteration) was run as part of the TMC package for rise and fall rates for different magnitudes of historic events. This information can help to set bounds on this.
        - After discussion, and with the acknowledgment that there is a fair amount of work to analyze, there was general agreement to leave the ramp down period at 2 weeks for now.

4.0 2016 Operations

- Attendees discussed current forecasts and operation planning. Since originally available, the April forecast has decreased by 50,000 ac-ft. (which is about 5 days at peak). However, there are rumors of more precipitation due to El Nino influences.
- The 2016 AW calculations (based on the mid-March forecast) were presented:

- Minimum: 206,942 ac-ft; 14 possible days at peak, so no modeled peak
- Most probable: 412,416 ac-ft; 36 possible days at peak, 36 days modeled peak
- Maximum: 647,239 ac-ft; 62 possible days at peak, 60 days modeled peak.
- *Most Probable Calculations*
  - Most Probable forecast details: 0 days of 10,000 cfs; 4 days of 8,000 cfs; and up to 41 days of 5,000 cfs. (Please note that the recent decrease of 50,000 ac-ft means the 5,000 cfs is probably closer to 31 days.)
  - The most probable predictions indicate releases in mid-May with Animus peak projections for early June/late July.
  - If the 5,000 cfs cannot met the 21 day requirement, then the Decision Tree Run C indicates the water would be used to elevate baseflows.

- *Decision Tree Run C for 2016*
  - After the minimum 500 cfs baseflows, downstream uses, and minimum commitments are met there is a predicted 412,416 ac-ft remaining for 2016 (most probable prediction). This is greater than 292,000 ac-ft target volume. Decision Tree Run C thus calls for a 3-day ramp up and 2-week ramp down. Leaving 36 days at 5,000 cfs and ending the water year at 6,049.7 (6,050) ft.
  - This is an ever evolving situation and the forecasts can continue to change in response to weather. However, April 15th is really the first "decision date" based on "average" peaks in early June and the backtracking for ramp up periods and centering the peak.
  - Attendees discussed options related to EOWYST of 6,050 ft compared to 6,063 ft and if that needs to be considered in the 2016 decisions (i.e., does there need to be "buffer" storage for 2017?).
    - Under the current forecasts, there is little to no risk of shortage in the next 2 years.
    - Ending reservoir elevation of 6,063 ft provides about 4.75 years insurance and 6,050 ft is about 2.75 years (as based on 15 years of hydrology).
      - Any year with a spring release will basically always drive the reservoir elevation down to 6,050 ft. This could affect how big the spring peak could be in subsequent years.
      - This is why the Decision Tree is being modified so that there is opportunity to "bank" water (i.e., increase reservoir elevation by storing water) in years below 292,000 ac-ft to increase the frequency of getting larger peak flows every other year or so.
      - The concept is that if it has been a while without a good peak flow, we take the risk and drop the elevation down to 6,050 ft in order to achieve a high flow. But if the spring peak flow conditions can't be met, then we position ourselves to achieve the peak in the next year (maybe 2).
    - If the priority is to end 2016 at 6,063 ft in the reservoir, than a peak would not occur as it would not meet the 21-day requirement.
    - Attendees discussed the need to have a good peak flow this year since it has been so long since the last one. The real decision is determining whether to cap the peak flow at 21 days and put any remaining excess to elevated baseflow or put all the water this year toward the best peak flow possible.
      - Increasing baseflow would be for habitat purposes and increasing the number of flowing secondary channels.
      - The Biology Committee had previously prioritized high flow releases.

        - Some concern was expressed that the range between 6,063 ft and 6,050 ft was supposed to be "fair game" for the BC to determine use (spring peak or baseflow) but the Decision Tree forces a spring peak release every year that there is sufficient AW. It should be in the purview of the BC to make the decision on how to use the water. An example was shared of 3 consecutive years with a spring peak release – if available in the 4th year, the Decision Tree would force another spring peak release but the Committee should be able to "over rule" that and elevate baseflow.
    - It was pointed out that it would take releasing water to test elevated baseflow and responses. This, too, will lower the reservoir elevation.
- *Elevated Baseflow Water Use*
    - Realistically, a wet or dry summer can impact what can be done with baseflow.
    - The minimum AW calculations for 2016 could provide 90 days of 750 cfs (through July, August, and September).
    - There could be approximately 45 days at 1,000 cfs. If baseflow is to be elevated to 1,000 cfs for 90 days, then the reservoir ends below 6,063 ft (at ~ 6,058 ft).

- In a brief summary of discussion, it was reiterated that most attendees seem to favor releasing for spring peak flows at 5,000 cfs for as long as possible (provided the 21-day minimum can be met). However, attendees requested updated calculations based on the most current forecasts. The updated model results will be presented on Day 2.

5.0 Conclusions and Wrap-up

- Jim Brooks concluded Day 1 with a very brief summary of today's discussion:
    - In general, attendees continue to support forgoing Type 1 and Type 2 flows (as agreed to at Workshop #1) but would like to see data compilation, additional analyses (if/as appropriate), and formal adoption of the recommended Flow Recommendation changes.
    - There is ongoing discussion regarding Decision Tree changes and how to best address AW in any given year; particularly, how to balance spring peak flow releases, elevated baseflow, and when each should be prioritized (and how).
        - Several changes were requested to the Decision Tree Run C, including:
            - Potentially adding a "box" to the diagram that would allow the BC to "override" a spring peak release priority at their discretion (i.e., use AW for elevated baseflow in a year that the Decision Tree calls for a spring peak release);
            - Remove any/all references to the "60-day" maximum due to NEPA concerns; the maximum doesn't need to be specified.
    - There appeared to be general support for a 2016 spring peak release of 21-day at 5,000 cfs with a 3-day ramp up and 2-week ramp down period (provided the calculated AW volume is above 292,000 ac-ft.). There was not general agreement about whether to cap the spring peak flow at 21 days and use the rest of the water to elevate baseflow this year or to put all the available water toward the magnitude/duration of the spring peak flow.

- The floor was opened, but no public comment was given.

DAY TWO: April 6th, 2016

1.0 Opening and Re-Cap of Day One

- Jim Brooks welcomed everyone back for the second day of the San Juan River Environmental Flows Workshop #2.
- In a brief agenda review, Mr. Brooks highlighted the main discussion topics for today: 2016 Operations – continued discussion; the Spring Flow and Baseflow matrix; and monitoring.

2.0 Revised Flexible EOWYST Decision Tree Releasing Maximum Days at 5,000 cfs

- In response to discussions yesterday, the specific mentions of "up to 60 days" will be removed from the Revised Decision Tree to address concerns over the Period of Record. An additional "step" or box (or note) will be added clarifying that the Biology Committee can decide to lower the reservoir elevation target to bolster baseflows as they deem appropriate.
- It was requested the Program Office write up a narrative to accompany the Revised Decision Tree that contains explanations and justifications.
- With no objections voiced, there was general support for the Revised Decision Tree Run C - spring peak release of with a minimum of 21-day at 5,000 cfs with a 3-day ramp up and 2-week ramp down period.

3.0 Continued 2016 Operations Planning – Updated Model

- As requested, Susan Behery ran the model with the most current available forecasts (April). Initial operating decisions will be made off the "most probable" conditions.
- *April Forecast – Most Probable Conditions*
  - AW, predicted by the April 1 CBRFC forecast, is 401,000 ac-ft. This translates to a 21-day spring peak flow with 125,800 ac-ft remaining and ending with a reservoir elevation of 6,060 ft (on September 30th).
  - If the total AW of 401,000 ac-ft is applied to the SPR, flows could be elevated for 35 days at 5,000 cfs and leaving a remaining 5,900 ac-ft in excess.
  - The volume difference (between 21 days and 35 days) could be used to have:
    - 41 days > 2,425 cfs; 27 days > 4,850 cfs; 2 days > 7,760 cfs; or 0 days > 9,800 cfs.
  - AW used to elevate baseflow to 750 cfs and 1,000 cfs is 31,700 ac-ft and 62,800 ac-ft, respectively. However, if the season turns out to be dryer that predicted, even more water would be needed.
  - It has been a general priority to end a year with "better elevation" in order to position for the next year. All the modeled situations operate with the assumption of lowering the reservoir to the 6,050 ft this year.
    - The Animus statistics indicate 78% of normal (about April to June runoff of about 530,000 ac-ft). The longer the release, the more likely we are to hit those days. There is a good probability of getting above 10,000 cfs numbers this year. It has been a long time the system has experienced those types of flows. There is opportunity to test hypotheses on how important these large flows are and if they

"reset things." Habitat monitoring is in place but only for certain projects/sites to be able to collect the data.

- *Continued Discussion: Spring Peak Release and Baseflow Options*
  - One option that has been discussed is "capping" SPR at 21+ days (26 days, 30 days, etc.) and put the remainder to elevated baseflow.
    - This could provide 2 sets of hypotheses to be tested and monitored. However, one could interrupt or overshadow the other - rendering the data collected meaningless (i.e., confounding effects and issues with interpreting interacting variables).
    - It was pointed out that there haven't been high flows in a long time; one opinion is that it would be best to focus on that and the associated monitoring.
    - Some attendees expressed support in attempting to do both (SPR and elevate baseflow) – if there is opportunity, everything possible should be done in order to generate better recruitment of the native fish since we don't know when the opportunity will come again. This is conservation biology – put everything to recovering a species or system. Political deadlines and biological timeframes often mean there isn't luxury of testing "pieces."
    - Storms can and do affect the system and the biology independently of what management is attempting to accomplish. It might be prudent to frame the testable hypotheses with these 2 variables.
  - Attendees discussed biological considerations. The pike minnow produce later and might not be as affected by the spring peaks – although, there just isn't a lot of data. And the Razorback Sucker (sucker) numbers could drop mid-summer. The augmentation can confound the trends. This was pointed out just a caution/reminder of the negative relationship with estimated densities and the spring peak. There is a difference in the adult, spawning, and nursery habitat needs which are very important to the overall population.
    - The data used to suggest elevating baseflows is important for the endangered fish is "weak." The elevated baseflows have no real effect on the native fish and would just cost the frequency of high flows.
    - Attendees briefly discussed temperature concerns and the relative proportion related to the Animus and Navajo releases.
  - With the indications presented by Vince (that after a certain volume or number of days beyond which most of the habitat work was done – once past 1 million ac-ft, it flattens out until there is a big "jump" in water), some attendees reiterated their support for focusing on the peak this year and not attempting to elevated baseflows.
  - Others reiterated their support for attempting both SPR and elevated baseflow. Base funding is set through 2019. It will take several years to determine a biological response from these flow events. Maximizing the probability of having positive results in the next 3 years might direct how to approach this year. Aim for a better biological response in a shorter window to be able to take the information to Congress.
  - In response to the question asking if the "extra" 7 days of peak (extending 21 to 28 days) is more valuable than 21 days of peak *and* elevated baseflow, attendees were reminded that the "target" baseflow is what is provided out of the reservoir and baseflow is likely to be much higher downstream (natural flow and storms). The baseflow is often much higher than 500 cfs over the summer.
  - Some attendees expressed the opinion that the discussion about including elevated baseflow in high spring peak years violates the "spirit" of the new Decision Tree.

        - Others, however, disagreed. We don't know how long flow needs to be elevated to get certain levels of work done in the channel. We need to know the hypotheses and the tradeoffs.
        - Doing both allows for data collection now - instead of waiting for another year with the potential combination. The reality is that there is only a short time for the Program.
    - Focusing on the SPR this year provides the chance to test the biggest use of water for the fish. It also informs the long-term future of the Flow Recommendations by providing data on the value of 5,000 cfs flows.
        - Some attendees expressed the opinion that it would be best to answer one question really well this year instead of "dividing" the resources.
    - In the situation that the peak does not take as much water as forecasted, the options are to (1) consider an elevated baseflow – but would that somehow interfere with monitoring the peak or confound the responses? or (2) save the water for next year.
        - It would be difficult to "tease" out the fish response to any one particular management activity.

- *Monitoring*
    - Only existing (previously approved) projects are in place for the 2016 Workplan. Any new work, including monitoring, will need full Scopes of Work, approval (Biology Committee and then Coordination Committee [CC]), etc. before this summer.
        - Some ongoing monitoring projects might be able to be modified to accomplish some of the work but they do have fixed scopes.
        - It might be "attractive" to attempt both (SPR and elevated baseflow) but without the monitoring in place (fiscal and time constraints), it would be best to pursue days at peak.
    - It was suggested that a monitoring program be set up to accomplish the testing for the matrix as a guide to determine options for each year.
    - The Program could fund a post-peak "fly" for aerial photograph to help determine work done (by comparison to LIDAR data from fall 2013 and Google Earth 2015 photos).
        - A "whole river map" is needed to determine what (how many) secondary channels were opened, what was the increased in total wetted area and where, what types of habitat were provided, etc.
        - Certain information, like total wetted area and numbers of islands, can be post-processed. But other things, like what features are flowing, can be hard to determine due to vegetation overhang.
    - It was suggested that the transects done in the first 2 years of the Program be resampled (to add data on what is still flowing, what isn't, velocities, etc.).
    - In terms of a monitoring program, there should be a "suite" of monitoring activities that can be selected in any given year in response to the hydrology and management.
        - Monitoring should include cross-sections to help determine what is accomplished in 4 (or 5, or 6 days) and if the majority of the work is done early on. Then, the rest of the water can be moved to baseflow because there is supporting documentation.
        - It was suggested that there needs to be more thorough discussions on the hypotheses to be tested during elevated baseflow.
            - There could be benefits to attempting both SPR and elevated baseflow depending on the behavior of the Animus. But what would be measured? What questions are we trying to answer?

- *2016 Operations Discussion – Summary Conclusions*
    - A notification paper with the Programs Final Recommendations is needed by mid-April. The priority will be achieving a minimum 21-day SPR, and if the Animus drops suddenly releases will increase accordingly. The reservoir is not to end below 6,050 ft. Elevated baseflow will not be attempted this year – to allow for testing and monitoring of one action. The "shut off" will be indicated by the clear downward trend of the Animus (spent) – 7,000 cfs at the Four Corners for some number of days (to be discussed at the BC). If it is a wet spring, elevated baseflows can be expected, regardless of dam operations.
    - Depending on temperature and the Animus, releases could start in early May. To meet this potential schedule, the BC will formulate and provide the Draft 2016 Flow Releases to the Program Office by mid-April. The Program Office will provide those to the CC by mid-April. The approved operations will be provided back to Reclamation by mid- to late-April.

4.0 Monitoring to Evaluate the Flow Recommendations

- The purpose of this discussion is to determine what is/should be measured/monitored during the high flows and in response to high flows. While this pertains to the current year, this conversation can also provide guidance to future years.
- Discharge can influence a suite of different variables and we need to determine (1) which variable(s) to measure (as functionally linked to flow) and (2) are they then relevant to the endangered fish and how. There needs to be some consensus about what exactly is predicted to happen at each threshold.
- Once articulated, the assumed threshold "work" or "accomplishments" can be measured or tested. For example, if 10,000 cfs is predicted to move the channel, then there needs to be measuring of channel movement.
    - It was commented that some of this work was done during the research stages (3D surveys, transects) but the continued collection of that type of information hasn't been done.
    - The river conditions have changed over the years and the assumptions about what is being done (or which flows accomplish what) might no longer be true.
    - There hasn't been testing to determine more precisely what threshold-level provides the bankfull channel. Or provides the movement of the ponds. Site evolution – flow resistance, shade, vegetation encroachment, etc. – could potentially change some of the thresholds over time.

- *Flow Target Threshold History*
    - The history on the 2,500 cfs flow recommendation was to attempt frequent "cleaning." But has also been documented spawning in years without 2,500 cfs. It has since been realized that the clean cobble conditions can be found under flow most situations.
    - The 5,000 cfs flow target was recommended for the formation of early secondary channels. It has since been determined that the 5,000 cfs does not accomplish the cleaning of backwater without subsequently being raised (continuing up) to 8,000 cfs.
    - The 10,000 cfs flow was based on the "biggest" repeatable flow observed and the associated channel work/change.
    - These recommendations are "less exact calculations" and more "targets" to achieve significant overbanking.

        - Since migration won't happen equally in all part of the river (i.e., straight sections), it was suggested to focus monitoring and data collection on locations where the migration is more likely to happen (bends and habitat complexes most important for retention of juvenile fish).
        - The high flows (8,000 cfs and 10,000 cfs) scour and move cobbles – reworking miles of area. It takes high flows to rebuild bars and move sediment.
        - What makes the "mixer area" (Mixer) of River Mile (RM) 130 consistent in complexity? This area experiences a successful combination of geomorphic processes.

- *Monitoring Questions*
    - The Decision Tree is flexible and the habitat monitoring needs to be flexible as well.
    - The intent is to produce a "menu" of potential monitoring tools to be implemented depending on the targets (ex. monitoring of channel migration through aerial photos, mapping, etc. but on a local scale? Complex reaches? River wide?).
    - It would also be prudent to determine the suite of parameters to be measured *every year*, regardless of predicted flow, in order to determine the variability in the absence of flows - background information and measurement errors. For example, monitored cross sections to look at scour and fill, substrate, etc.
    - The specific "key" monitoring questions need to be identified, such as:
        1. Despite big flows, are we still losing channel complexity at these key habitat locations? If that's the "big" question, then combination of factors at the Mixer location should be examined (flow to: channel migration, scour, Russian Olive, incision, inundation); or
        2. Is there enough habitat (of the necessary diversity) in the river to support full recovery of the fish?; and
        3. What is the fish response to the habitat (i.e., separate the flow to habitat affects versus the flow to fish affects).
        - Other monitoring questions identified:
            a. How many fish can each habitat support?;
            b. How many fish, of each life stage, are need to reach adult-stage recruitment;
            c. How can the total wetted area be increase to previous levels (loss of 12-15% in the last 15 years)?;
            d. Can these flows suppress non-native vegetation? If yes, what volume and duration and what frequency?;
            e. Is the loss of islands (300 originally, now ~150) due to the loss of these high flows?;
            f. Are the fish spawning in the same places they did in the 1990s? in other areas as well? site preference? How is this related to the number of adults available?;
            g. What things are we *not doing* that we used to do for the fish?;
            h. In terms of site longevity – there needs to be focus on the "why" things are happening, not just the "what";
            i. What is the needed frequency of high flows? What is the inter-event period needed for maintenance?;
            j. Of the 158 secondary channels (not sand bars), 25% have always flowed and 25% are not flowing now – what is the difference between them?

        - In response to a question regarding high flow frequency, it was shared that there have only been 4 major events (1993, 1995, 2005, and 2008) and there hasn't been monitoring in place for all of them. Some hypotheses from the Flow Recommendations were rejected (see the Integration Report) and that lead to the conclusion that the Flow Recommendations needed to be changed because there is not enough water to do the intended accomplishments.

- *Creating versus Maintaining Habitat*
    - There is a difference between "creating habitat" and "maintaining habitat." What is the system or site response to these flows by themselves and how many will need mechanical intervention? It has already been acknowledged that the high flows can't be produced frequently enough to be successful without other action/intervention. We need to determine the combination of mechanical intervention and flow to optimize the work done and sustain the features for as long as possible. What is the interval before mechanical work will be needed again?
    - River wide, how many secondary channels are flowing? Are secondary channels gained or lost in the absence of mechanical intervention?

- *Monitoring Scale*
    - It was cautioned that there is a "scale" affect when looking at the magnitudes of flows. For example, the smaller flows impact areas of interest on the 5 to 20 ft range while the larger flows can rework areas that are miles in size.
        - Largest Scale: questions about trends and status of the system overall;
        - Intermediate Scale: habitat and associations between flow and response;
        - Small Scale: mechanisms, how things work, and why a specific response is achieved?
    - When investigating the invasive vegetation, there is the "big scale" (accomplished with aerial photography) and the "small scale." What is happening at the micro-level (seedlings, 1 or 2 years old) with the vegetation? What is the "window of opportunity" to rip out the invasive seedlings?

- *Data Compilation*
    - In response to some of the identified questions of interest, it was shared that in the 20-25 years of the Program, there has been much research and numerous studies. We know some things about the habitat the fish are using and how the habitat changes with flow (Critical Reach Study, 2008). Priority information is being collected on the River Ecosystem Restoration Initiative (RERI) sites.
    - Data integration has been an ongoing Program task. But reviewing and reworking the data needs to be a starting point to inform the monitoring program - what parts are applicable today? What are the changes?
    - The records contain the information that drove management changes. For example, the habitat and geomorphology monitoring programs were cancelled because of funding or lack of changes. Revisiting the records helps to avoid remaking decisions.

        - An easy way to disseminate the historical information would be to develop a table that identifies previous questions, what was measured, what was the answer, etc. But it will take someone to go through the reports, identify the main questions, hypotheses tested and resulting outcomes, confidences levels of each, identify what isn't known, analyze, and provide narratives/write ups, etc.
        - Not only would this task highlight where the Program has been, but helps to map out the future with actions rooted in the previous work and remaining questions. It could inform the revisions to the Flow Recommendations.
    - *Spawning versus Nursery Habitat*
        - The pike minnow and sucker are widely distributed in the river (from Reach 4 down to Reach 1). And there is decent surety that meso-larvae have been collected. If there were only a few spawning areas, it could be assumed the larvae would be "clumped" in a few areas. It may be indirect, but there is evidence that spawning is occurring widely in the river. Therefore, spawning habitat is not considered a limiting recruitment factor.
        - Instead, it is more likely that the limiting factor to recruitment is the nursery habitat – partially based on the changes in the river system since Navajo Dam came online. The biologic signal, in terms of eggs/larval/juvenile, should be detectable. The hypothesis would be that more nursery habitat is needed (compared to the amount now).
            - Others pointed out that determining which habitats are "good" or not and where they should be located would be hard to test given the river and hydrology conditions.
            - It was suggested that focus be placed on the reaches of river that appear to be resistant to the changes.
            - There needs to be fish monitoring to address the questions of population density and site utilization.
                - It was shared that there are some larval fish studies and PIT tag data for the RERI sites. But how many individuals can be supported by certain areas of habitat?
                - It was also suggested that detailed larval and juvenile sampling (density of eggs/fish) for habitat types could be extrapolated to the whole river to predict the number of fish. However, it was cautioned that any study would have to be "small scale" since the fish integrate a lot of the system at different life stages and the "big pictures" gets lost in that ultimately, recruitment occurs at the adult stage.
                    - How would the "intervening life stages" be targeted/captured? If they aren't captured, does it mean they are not present? If they are truly not present (instead of just not detected), is it due to missing habitat?
    - *2016 Monitoring Suggestions*
        - Given the potential high flows this year, it was suggested the Mixer Area and RERI sites be "monitored" or "observed" (as much as possible) to see the response and track or "monitor" (to the extent possible) the secondary channels to see they are affected by these flows. *It was acknowledged that*

contracting and funding could be limiting factors and any monitoring would have to be accomplished in within existing constraints.
        - The scale of the monitoring/data collection should be chosen to be comparable to the historic data.
        - Ideally, aerial photography will be taken for the entire river and would capture all the habitats (islands, embayments, backwaters, secondary channels, etc.).
        - Photo documenting the seedlings could be accomplished this summer for single points under the existing projects.

- *Monitoring Discussion Wrap Up*
    - There is general agreement that the larger flows (and related processes) are still important (if not critical) to the system. The lower flows are just not helpful (or as important) without the subsequent higher flows (as supported by information in 2006 Integration Report). The smaller flows might even be detrimental by (1) "irrigating" the young invasive vegetation and (2) depositing (building up) sediment at the mouths of the secondary channels.
    - A general hypothesis is that "maintaining these flows (5,000 cfs, 8,000 cfs, and 10,000 cfs) will create and maintain the habitat in the complexity needed to maintain and support the fish."
        - It was cautioned that site evolution itself can potentially impact (change) the thresholds over time (ex. flow resistance, vegetation shade, etc.).

5.0 Monitoring Scope of Work Overview

- Vincent Lamarra and Bill Miller presented on their monitoring project and projected a draft summary of the monitoring draft scope of work (under development). They will be developing a "menu" of potential monitoring tools that can be considered annually, depending on the targets and hydrology for that year. The overall objective can be framed as to "maintain and create habitat for the benefit of the native fish community (particularly the endangered species) in the San Juan River."

- *Conceptual Habitat And Water Temperature Monitoring Draft Scope Of Work*
    - The proposed approach would use some of the same techniques as current monitoring but with different implementation as well as new techniques for some tasks.
    - The implementation of the techniques would be based on water-year type, annual study needs, and timing of collection (specified each spring based on water year and hydrograph).
    - Individual Tasks Include:
        - Annual aerial photography
        - Periodic LIDAR flights – peel back vegetation for abandoned features
        - Habitat Mapping
            - Specific habitats – backwaters, islands, etc.
            - Multiple river miles or RERI sites – for focused and specific scale
            - Reach – complex versus simple to address migration and scour
            - Full river
    - Geomorphic Studies – could be at set interval/threshold triggers/large scale and small scale
        - Complex Channels/Simple Channels
            - Topography/bathymetry

            - Sediment transport
        - Secondary Channels
            - Flowing
            - Non-flowing – why?
        - Water Temperature
            - Annual summary of USGS data
            - Various types of data analysis
            - Water temperature modeling
                - Reservoir
                - River
        - Data Analysis And Reporting
            - Synthesis of existing geomorphic and habitat studies
            - Habitat-hydrology relationships
            - Water temperature impact/benefits
            - Restoration site analysis
            - Within these suggested options, there are ranges of opportunities that can be done in any given year. Things can also be refined as needed/necessary to cover the range of flows of interest and address hypotheses. The "menu" provides proposed things that can be done to answer the stated hypotheses.
- Intended Structure
    - The BC will suggest, based on the perceived water year, what they "want to see accomplished" and what question(s) to address. Then, activities will be selected from the "menu." Methods, proposed hypotheses, and estimated cost will need to be considered when selecting the doable/appropriate monitoring activities for that year.
    - There may be a set of tasks that are done on an annual basis or year round (ex. island count backwaters).
    - Temperature will be taken into account with limits on the depression for certain times of year – to avoid affecting certain life stages during identified times. *Mr. Miller has a paper on temperature that will be coming out soon.*

5.1 Questions, Comments, and Discussion

- Given the "matrix" approach discussed during this workshop, it was suggested that the questions/hypotheses associated with each "box" be identified and documented in advance. This is one way to "predetermine" the priorities or focus for any given water year.
- ***Question:*** It appears that suggestions on what to do for certain water-year types will be included [in the monitoring menu]. But what about guidance as to when these activities need to be repeated? How to keep the data set going? There is concern with potential data gaps.
    - ***Response:*** These are certainly issues that need to be considered. But many activities could be limited by budget and the costs could vary depending on the year. Realistically, there will be hard choices between "what we want to do" versus "what can we do?" versus "what do we have to do?"
- ***Question:*** The synthesis of existing studies is a really important task to get done right up front as it will inform what we should be concentrating on the most. Any feeling for how long that exercise will take?

        - ***Response:*** It all depends. Shorter documents in table form might not take as long as other potential formats. At least several months should be expected.

    - ***Question:*** There are some concerns about having so much flexibility (in terms of options and decisions) for each and every year. What are we going to compare those data against? What is the unit of replication and what needs to be measured to determine that? How are the effects of flows to be assessed?
        - ***Response:*** Any year could be limited by the physical constraints of the flows. And certain things just can't be done unless it is the right hydrologic year. But it might be possible to determine the number of times certain things need to be accomplished.

    - ***Comment:*** Concern was expressed that the idea was to renew the contract with a sense of adaptive management (AM). And to propose things, at a minimum, to be done every year.
        - ***Response:*** The planning is expected to take place every fall (fall meeting) to set up the following 9 months. Those plans should consider the type of year and what the BC wants to accomplish.
        - Activities that only occur at 10,000 cfs can only be compared to the next 10,000 cfs event. But the priority questions and hypotheses for each year can be determined and addressed.

    - ***Comment:*** It would be helpful to have the "core" monitoring program consisting of activities to be done every year (i.e., have a continual amount of data points). Then additional monitoring gets added based on flow/hydrology, feasibility, etc. It would be nice to have predetermined questions specific to flow level.

    - ***Question:*** Some activities (LIDAR and aerial photography) can be relatively pricy. Is there an estimate of cost that can be built into the budget (on some reoccurrence interval)?
        - ***Response:*** LIDAR is ~$58,000 and aerial photography is ~$20,000.
        - LIDAR looks at the outside channel topography which does not experience significant changes until after the largest flows. These "predictable" events could trigger a redo.

    - ***Comment:*** Shouldn't it be a collective Program effort to rethink the hypotheses and then match the monitoring activities specifically to those?
        - ***Response:*** The peer reviewers suggested a subcommittee do just that.
        - It has also been suggested that there be a "rapid process" to determine and mobilize on the pre-high flow data/monitoring that is needed. This is one way to examine the flow-habitat-fisheries links.
        - The Program Office was tasked with pulling out hypotheses from the Flow Recommendations and adding to them. The abiotic hypotheses will be presented next.

6.0 Review, Revise, and Develop Hypotheses for the Flow Recommendations

- Nathan Franssen opened discussion with projection of "*Hypotheses And Assumptions Behind Flow Recommendation Benchmarks Or How Do We Evaluate Flow Benchmarks?"* Attendees then reviewed and discussed the hypotheses and assumptions behind Flow Recommendation benchmarks.

- *In a working session, the Flow Recommendation Benchmarks (predictions and hypotheses) were projected. Attendees reviewed them one by one, added evidences and additional questions, and made suggested changes.*
- The predicted response at the 2,500 cfs and 5,000 cfs flows also occur at the high flows (8,000 cfs and 10,000). The "general phenomena" described for the smaller flows is applicable to the larger flows. Therefore, the hypotheses for these do not need to be reiterated at each subsequent threshold.
    - It was suggested the flows and associated hypotheses could be included in a table for simplification.
- The higher flows processes are still important. It has previously been acknowledged (see the 2006 Integration report) that the Type 1 and Type 2 flows are not helpful or as important without the higher flows. This lead to the decision to stop trying to force them so often and focus on the higher flows. Higher flows are also needed to remove the sediment that builds up at the mouth of the secondary channels.
- The assumed "work" done needs to be framed in a more conceptual manner in order to be effectively evaluated.

- 10,000 cfs Flow Metric (Type 4):
    - *Abiotic Hypothesized Effects:*
        1. Out Of Bank Flow
            - Attendees agreed that there was adequate evidence to support that bankfull is generally between 7,500 cfs and 8,500 cfs.
        2. Generates New Cobble Sources
            - Attendees agreed this does occur. Out-of-bank flows and moving the channel provides new cobble sources. Reworking existing bars also contributes to habitat.
            - There are questions related to the extent of vegetation and armoring diminishing the ability of the river to do this work. These could impact the duration of flows needed. Is non-native vegetation limiting new cobble sources?
            - Returning to the thought that spawning *habitat* is not a limiting factor to recruitment (as evidenced by spawning not being a current issue therefore it is occurring), what is the *high flow* relationship to spawning?
        3. Changes Channel Morphology And Maintains Channel Complexity
            - There have only been 4 years that the 10,000 cfs flow targets have been met. But there is general agreement that this is a correct hypothesis. However, there might be a scale-issue – system-wide? Stretches of the river, like the Mixer? At RERI sites?
                - Mechanical work can be very localized – such as the impact of the on the features and vegetation removal.
            - Attendees discussed how the term "maintains" alludes to "across multiple events." But between events, how does the vegetation encroachment behave over time and to what extent does it make it harder to accomplish the work with the same amount of water? Vegetation encroachment changes between events?
                - Unfortunately, the frequency and magnitude of these flows is not very manageable. Suggested hypothesis: if there is more than 3

years between 10,000 cfs events, the next one will not be as effective at maintaining the habitat.

- For the purposes of the Flow Recommendations, it is known that high flows change the channel morphology and channel complexity but does the frequency offset the net loss? This is one support for the decision to stop trying to force the low flows so often and focus on the higher flows.
    - The 1993-2003 Integration Report supports the observation that "maintenance" was not accomplished even when the frequency of higher flows was better. It is unknown if there is a new "set point" that can be maintained by these flows.
    - Can we "reset" the system so that available water is enough to sustain the system? Or is mechanical manipulation of the system going to be needed in perpetuity?
    - There is historical data on the occurrence of "resets" and when overall system decline has occurred (ex. after 1995).
- Some attendees recommended the rejection of the second half of the hypothesis: the system cannot maintain channel complexity within the river without mechanical assistance.

4. Increase Nutrient Loading And Productivity
    - High flows can be expected to flush terrestrial detritus into the system. Even though it can't be quantified, this is common sense and shouldn't need to be pursued.
5. Suppress Nonnative Vegetation In The Bank Full Channel
    - The Program Office just recently added this hypothesis; but it should be testable.
6. Promote Cottonwood Recruitment/Regeneration
    - Also recently added by the Program Office, this has not really been examined for this system.
    - Some attendees questioned why this was limited to 10,000 cfs flows? What about 8,000 cfs flows or smaller?

- *Additional Discussions*
    - Attendees then discussed "stream power" and what the system experiences (in terms of watts of power) for specific durations. Work accomplished is not linear to flow. The hydrology can be explained in terms of provided stream power in megawatts and not volume (cfs).
        - Suggested hypothesis: with greater flows of more duration of power, the system "reset" will be greater and more persistent over time.
        - Existing data on slope-by-reach, channel width, channel depth, etc. could be used to accomplish a stream power analysis and look at the total amount of work that is done over a time period and provide a weight to each. For example, a 10,000 cfs flow for 1 day will accomplish more work than a 5,000 cfs flow for 2 days.
    - Attendees also discussed inundation tolerance of Russian Olive and potential information in the literature. Russian Olive used to grow only 5 ft tall and now they are growing to 20 ft tall and creating an understory. From a

nonnative vegetation management standpoint, what are the effects of established Russian Olive and what are the treatment options?

- It was suggested the Program consider removal (cutting/burning) of Russian Olive from a selected site but it was cautioned that the treatment cost is high.

- *Summary of Changes*
  - The 3 main hypotheses to refine and focus on are:
    - #3, with definition of maintenance;
    - #5, with consideration of not just "in bank full" but removing seedlings outside the bank full and testing the effectiveness out of bank full channel;
    - and possibly #6.
    - Consider time questions related to inter-event periods and what happens in between those big flows.
  - It was suggested that several of these could also be applicable to 8,000 cfs flows.
  - Bill Miller and Vince Lamarra will generate methodologies for hypotheses #3 and #5 for the 10,000 cfs threshold flows.

- 8,000 cfs Flow Metric (Type 3):
  - *Abiotic Hypothesized Effects:*

    1. Maintenance Of Channel Cross Section
       - At 8,000 cfs, there will some places that will be out-of-bank. This marks the maximum amount of power within the channel itself, right before spreading out-of-bank.
       - Duration is important and as is maintaining wetted area. Cross sectional data and spatial data would be informative (especially for data on the entries and exits of the secondary channels). For some wetted area, if there are cobble and sand bars showing up at some flow – you are filling the channel. Getting at the vertical dimension is important - are we potentially going to incise the main channel if there is a series of several big water years?
         - The evolving cross sectional geometry and depth information at identified sites could be useful in understanding the response to vegetation and mechanical treatments. This can provide guidance on where to do more monitoring.
         - Returning to the importance of secondary channels, it was questioned why are some more maintained compared to others? Secondary channel control points could be critical for understanding these features. Anecdotally/observationally, they can be seen coming and going but the question is why? Geologically driven versus flow driven?
       - It was suggested Hypothesis #1 be change to: maintenance of channel cross section at secondary channel control points.

    2. Moves Cobble And Builds Cobble Bars
       - This is a known effect of the 8,000 cfs flows; but it is not particularly important to quantify it at this time because spawning habitat is believed to be adequate.

3. Create Larval Razorback Sucker Habitat During Peak And Receding Flows
    - This suggests habitat is better above 8,000 cfs for razorback sucker. But secondary channels would be flowing too fast. It is the receding flow that is better. The peak flow would create submerged vegetation and low velocity water sites for those fish as flows at or greater than 8,000 cfs start to go out of the channel.
    - Unfortunately, it is difficult to sample and map at high flows. There is observational evidence that this occurs and it is assumed the fish use the habitat created even though it can't be sampled effectively.
    - The lateral connectively during peak flows could be providing the refuge habitats for whatever native species are there.
4. Suppress Nonnative Vegetation In The Bank Full
    - Remember, 8,000 cfs is in the channel or just beginning to inundate.
    - It is hypothesized that the longer an 8,000 cfs flow lasts, the more effective it will be. The parameters for this and for the 10,000 cfs flows need to be consistently gathered in order to test/compare.
5. Promote Cottonwood Recruitment/Regeneration
    - It was suggested this be restated as: "to promote native growth."
    - There may be benefit to wetting the sides and edges, but by definition, these flows are not out of bank yet.
    - Additional questions to consider: (1) how long will this suppress the Russian Olive? Does that change as the plant matures?

- 5,000 cfs Flow Metric (Type 2):
    - *Abiotic Hypothesized Effects:*
        1. Clean Backwaters And Maintain Low Velocity Habitat In Reach 3
            - This hypothesis was removed in 2006 when it was determined that the 5,000 cfs flow only accomplish this when they increase to the higher flows. Thus, it occurs when the higher flows are achieved. With only 5,000 cfs, not enough sediment was transported down the channel so it would eddy out and fill back in.
            - With the decisions to revise the Flow Recommendations, the Type 1 and Type 1 flows are no longer being targeted.
            - Is there a threshold between 5,000 cfs and 8,000 cfs?
                - Potentially, but there is also a duration component. It's really a question of "big" water and the stream power calculation with the sediment transport question.
                - This is one of the supporting reasoning for waiting until the total flow has decreased to 6,000 or 7,000 cfs before shutting of the releases since the river is continuing to move water to/in the secondary channels.
            - It was suggested the 5,000 cfs flow target be kept in the documentation as it is an important component to the total and helps define the shape of the hydrograph.
            - It was recommended this be made a null hypothesis.
                - The hypothesis of cleaning backwater and low velocity habitats needs to be tested, but at flows greater than 5,000 cfs.

        - A suggested revision was: "clean backwaters and maintain low velocity habitat in Reach 3, above 5,000 cfs."
            - However, other attendees pointed out that it is difficult to regain the backwaters once lost in Reach 3 (and has been since 1995). There have been fundamental changes in the channel itself. If this is an important hypothesis, it might need to be generalized by not specifically referencing Reach 3.
                - 5,000 cfs will inundate some sites but it is not scouring vegetation off exposed sand bars or anything. The difference between 1,000 cfs and 5,000 cfs is more wetted, inundated areas.
                - However, it was offered that any secondary channel *that flows every year* will experience better vegetation suppression with 5,000 cfs flows compared to the secondary channels that only flow at higher flows.
                - Suggested hypothesis: 21 days at or above 5,000 cfs will provide some vegetation suppression in the secondary channels that flow regularly.

- 2,500 cfs Flow Metric (Type 1):
    - *Abiotic Hypothesized Effects:*
        1. Moves Cobble In High Gradient Areas
        2. Cleans Cobble For Spawning
            - This is a known affect and has been addressed earlier. Does 2,500 cfs do anything else for habitat? Support (or trigger) low-flow spawning?
                - There are multiple spawning triggers – temperature, day length, flow, etc.
                - There are more secondary channels flowing at 2,500 cfs compared to at 1,000 cfs. This is important habitat, especially during razorback sucker nursery and retention.
                - Short duration at elevated flow prepares seed beds and can actually assist Russian Olive encroachment and establishment. But this could be very channel-specific (compare channels that didn't flow below 2,500 cfs to the lower ones that inundated longer). Islands can be examined to see where suppression is occurring.
                - Suggested hypothesis: between 500 cfs and 2,500 cfs, anything that increases flow in the secondary channels will assist with the process of nonnative vegetation suppression.
                - It was cautioned that, depending on the timing, the larval pike minnow could be flushed out.

- Target Baseflow:
    - *Abiotic Hypothesized Effects:*
        1. Enhances Nursery Habitats
        2. 500 to 1,000 cfs Optimizes Backwater Habitats
        3. Target Baseflows Need To Be Higher To Achieve Desired Effects

        - It was cautioned that it could be difficult to tease out the effect of time versus the effect of flow. Over time, some secondary channels and backwaters have been lost for the same flow.
        - Secondary channels may be more important for the razorback suckers at the time of year we were running them. The wrong habitat may have been targeted when the Flow Recommendations were written.
        - If a higher baseflow is targeted (ex. 1,000 cfs) then more backwaters and secondary channels could be available earlier – providing benefit to the young-of-year stages. And the confluence with the main channel would stay open.
            - The evidence points to the range of 750 cfs to 1,000 cfs; but this has to be tested and the volume required traded against the peak flows.
        - It was suggested the minimum baseflow be left at 500 cfs but add a caveat of testing the higher range of 750 cfs to 1,000 cfs.
        - Suggested hypothesis: Increasing the baseflow from the minimum of 500 cfs will increase habitat in secondary channels and backwaters for endangered fish. Or "higher baseflow provides more nursery and small-bodied fish habitat than flow at 500 cfs."
        - It was suggested that monitoring of the main channel occur simultaneously with the monitoring of the secondary channels for comparison.

- Flood Control Releases (incorporated into operating rule)
    - *Abiotic Hypothesized Effects:*
        1. Improve Low Velocity Habitat Quality By Flushing Sediment
            - The effects of large pulses downstream have never been monitored.
            - Extra water is not to be "dumped" in the spring if at all possible. If there is extra water that puts the reservoir above 6,063 ft in September, then there will be a fall release. But the priority would be to increase baseflow toward the 1,000 cfs range instead of dumping it at end of season.
            - Any sediment work has some benefit, even if it doesn't fully counteract the effects of storms (which dump sediment back in). And main channel productively increases quicker.

- Wrap Up
    - The above discussions will provide hypotheses guidance for Mr. Miller and Mr. Larmarra to consider in their monitoring project.
    - The Program Office will take the suggestions and revisions and update the *Hypothesized Effects Of Flow Recommendation Benchmarks* document.
    - Retro-analysis of existing data could help address several questions and hypotheses that don't necessarily fit into discharge categories (i.e., independent of a particular discharge; ex., geomorphology).

7.0 Process to Finalize E-Flow Workshops

- The objective of this discussion is to determine the "path" forward or process steps to be followed up after meetings, workshops, and other efforts.
- One potential process was offered for group discussion:
    - Narrative Synthesis Of Workshops > Details Of Decision Tree To Implement > Identify Hypotheses To Evaluate > Develop Monitoring Needed To Test Hypotheses

- In this process, there is an assessment component that leads to revisions as needed/necessary (including reconvening the e-flow workshops).
- There was general agreement that the presented e-flow finalization process was acceptable at this point.

7.1 Questions, Comments, and Discussion

- ***Question:*** It seems that the focus is really on the geomorphology and habitat. But what about the link to the fish? We do all this work to see the effect on the habitat but we aren't we missing the biology link?
  - ***Response:*** There are biotic hypotheses listed under the flow metrics and the existing monitoring is looking at the biology component. We only reviewed the abiotic hypotheses today.
  - Is the monitoring able to show the cause and effect? Is it able to test the flow > habitat > fish links? (For example, test a hypothesis on the habitat or geomorphology that a peak flow results in a certain biologic response?)
  - Regarding temperature depressions, the effects of that depression on the fish can't be shown. But if it is hypothesized that temperature depression is potentially affecting the "doorway" they have to go through, does it warrant finding out?
    - The purpose of monitoring biologic response is to learn about long-term trends in abundance of the native and rare fish. It is not necessarily tied to a specific year type.
  - If the biology is missing from the e-flow workshop report, a large component will have been omitted. The linkage with the actual fish need to be done. It was requested that the write-up (summary document and narrative to be completed by the Program Office) include the biology components including which parts of the monitoring address the biology and identify where special studies might be needed.
  - One incentive to look at population estimates is that there are fish in the system resulting from the stocking program. Habitat-related things are based on the best available information at that time. The presence of an adult fish is a combination of many factors: habitat, predators, food, etc. Do we see an increase in the different age classes of fish as a result of effectively doing everything possible with the habitat? Is there retention of wild-produced fish?
    - Is the fall monitoring enough to determine response to habitat?
- ***Comment:*** The monitoring plans and activities need to be mindful of existing datasets and use those to verify or nullify what we are observing.
  - Program documents and studies and analyses indicate that habitat complexity is paramount and there is a strong relationship between complexity and native fish abundance. There is also literature with information on temperature depression(s), mortality, temperature shock, deformities, etc.
  - It was suggested that fish sampled in a high flow year could be preserved (and added to the existing specimens) for research into growth rates with low and high flow years. (Or complete a re-analysis on the existing specimens).

8.0 Workshop Adjournment and Wrap-Up

- Jim Brooks thanked everyone for their participation and support of this second Environmental Flows Workshop. The Program Office was thanked for their effort, coordination, and arranging of this meeting.
- The 2016 Operations recommendations will be finalized (following the process) in the next few days. Please expect conference calls to accomplish the approval process and provide Reclamation with everything they need in the appropriate timeframes.
- It was announcement that the 2016 Desert Fishes Council Annual Meeting is scheduled for November 15-19 in Albuquerque. www.desertfishes.org

San Juan River Environmental Flows Workshop 2: Attendees					
	Name	**Role**	**Affiliation**	**Date**	
				Tues 4/5	Wed 4/6
1	Bill Miller	BC	Miller Ecological Consultants/**B.C. Chair**	✓	✓
2	Jim Brooks		**Facilitator**	✓	✓
3	Martin Schluep		Alliant Environmental, LLC (contractor)	✓	
4	Marta Wood		Alliant Environmental, LLC (contractor/**note taker**)	✓	✓
5	Michael Farrington		American Southwest Icthyological Researchers (ASIR)	✓	
6	Henry Day		Arizona Public Service	✓	✓
7	Marian Wimsatt		BHP Billiton	✓	✓
8	Michelle Garrison	CC Alt	Colorado Water Conservation Board	✓	
9	Brian Bledsoe	Peer	Colorado State University/TNC	✓	✓
10	Harry Crockett	BC	Colorado Parks and Wildlife/State of CO	✓	✓
11	Tom Wesche	BC	Habitech, Inc. (Water Development Interests)	✓	✓
12	Ron Bliesner		Keller-Bliesner Engineering	✓	
13	Jacob Mazzone	BC	Jicarilla Apache Nation	✓	✓
14	Vincent Lamarra	BC	Navajo Nation (Ecosystem Research Institute)	✓	✓
15	Eliza Gilbert		New Mexico Department of Game and Fish (NMDGF)		✓
16	Mike Ruhl		New Mexico Department of Game and Fish (NMDGF)	✓	✓
17	Matthew Zeigler		New Mexico Department of Game and Fish (NMDGF)	✓	✓
18	Steve Ross	Peer	Peer Reviewer	✓	✓
19	Cathy Condon	CC	Southern Ute Indian Tribe	✓	✓
20	Carrie Lile		Southwestern Water Conservation Board	✓	✓
21	Dave Gori	BC	The Nature Conservancy (TNC)	✓	
22	Dale Lyons	BC Alt	The Nature Conservancy(TNC)	✓	✓
23	Ron Bliesener	BC Alt		✓	
24	Brent Uilenberg	CC	U.S. Bureau of Reclamation (BOR)	✓	✓
25	Susan Behery		U.S. Bureau of Reclamation (BOR)	✓	✓
26	Ryan Christianson		U.S. Bureau of Reclamation (BOR)	✓	✓
27	Ed Warner		U.S. Bureau of Reclamation (BOR)	✓	✓
28	David Campbell	PO	U.S. Fish and Wildlife Service, Region 2 (FWS)	✓	✓
29	Jason Davis	BC	U.S. Fish and Wildlife Service, Region 2 (FWS)	✓	✓
30	Scott Durst	PO	U.S. Fish and Wildlife Service, Region 2 (FWS)	✓	✓
31	Nathan Frannsen		U.S. Fish and Wildlife Service (FWS)	✓	✓
32	Melissa Mata		U.S. Fish and Wildlife Service (FWS)	✓	
33	Dale Ryden	CC	U.S. Fish and Wildlife Service (FWS)	✓	✓
34	Benjamin Schleicher	BC	U.S. Fish and Wildlife Service, Region 6 (FWS)	✓	✓
35	Tom Sinclair		U.S. Fish and Wildlife Service (FWS)	✓	
36	Leland Begay		Ute Mountain Ute	✓	
37	Kristin Green	CC		✓	✓

ATTACHMENTS

San Juan River Environmental Flows Workshop 2
April 5th and 5th, 2016

Action Items and Meeting Summary Document

Actions

- Susan Behery was asked to develop a table that contrasts the duration of time that goes by without a big flow versus how many times such a flow is "hit" during the same timeframe. (For example, for 2016 if Run C is the target, there can be more big events but there is a longer maximum period between those events.)
- A copy of all the workshop presentations will be emailed to meeting attendees (Program Office assignment?).
- The Program Office was asked to draft a narrative that will accompany the Revised Decision Tree (*Revised Flexible EWYST Decision Tree Releasing Maximum Days At 5,000 cfs)* with explanations and justifications. It was requested that a biology component be included in the narrative. (For example, how much water is needed in the river to keep larval habitat inundated for a desired amount of time? How does the timing of the shut down impact inundated nursery habitat? Etc.).
- The Program Office will draft a 2016 Operations memo for the Biology Committee to have as a read ahead for the decision call.
- Scott Durst will poll the Biology Committee to schedule a conference call to review Workshop #2 recommendations and make official 2016 Operating decisions.
- Nate Franssen will revise the threshold flow hypotheses with the revisions recommended during the group discussion.
- Bill Miller and Vince Lamarra will generate methodologies for hypotheses #3 and #5 for the 10,000 cfs threshold flows.

Suggestions

- Schedule a separate workshop to focus on and address monitoring.
- Schedule a separate workshop to compare and discuss the Gen 2 versus Gen 4 models. How to evaluate the model to make sure it is "ok?" And to make sure interpretations aren't against the hydrology used to generate the Flow Recommendations in the first place.

Upcoming Dates and Deadlines

- April 1 – Reclamation to provide Available Water calculations based on April 1 forecast; - *completed April 6*
- Now - A draft explanation paper, with Workshop #2 recommendations is basically needed now
    - Workshop Recommendation for approval: produce a 21 day minimum Spring Peak Flow, releasing 5,000 cfs; if available, maintain the peak for as long as possible (estimated to be ~35 days) with end-of-year reservoir elevation of 6,050. Baseflows will not be increased as part of the 2016 operations. Releases will be "shut off" when the Animus flow decreases to ~2,000 for several days.
- Soon – Biology Committee meeting to discuss/approval recommendations and elevate to CC

- Mid-April – Coordination Committee Review and Approval;
- Mid- to Late-April - Final Program recommendations are due to Reclamation

MEETING SUMMARY

DAY 1: Brief Summary and Highlights

- In the agenda review, some attendees pointed out that no final or official change has been made to the Flow Recommendations in response to the agreements from Workshop #1 and subsequent meetings. Some attendees expressed the concern that modifying the Decision Tree is in effect changing the Flow Recommendations. Others disagreed. Some concern was also expressed regarding the lack of sufficient documentation to support the revisions to the Flow Recommendations including more background and documentation on how we arrived at those suggestions.
    - The changes need to be well documented and supported scientifically in order to be robustly defensible.

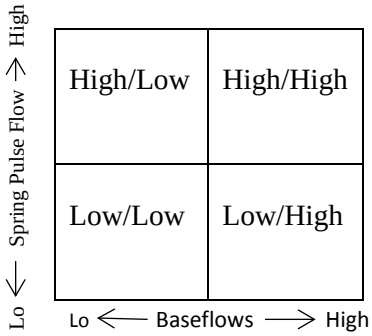
- Scott Durst then briefly shared a summary of environmental flow workshops to date and an overview of Workshop #2 goals and objectives.

- Susan Behery presented on several model runs (Navajo Operations Modeling) for 3 Decision Tree options and 3 summer baseflow options (500 cfs to 750 cfs; 750 cfs to 1000 cfs; 1000 cfs to 1200 cfs) – resulting in 9 total scenarios.
    1. Run A: 2015 Interim Operation Decision Tree, AWST 6,063 ft (for each of the 3 baseflow options)
    2. Run B: Type 3 And Type 4 Release Only (remove Type 1 & 2), AWST 6,050 ft; (for each of the 3 baseflow options) and
    3. Run C: Maximum Days at 5,000 cfs, AWST 6,050 ft. (for each of the 3 baseflow options)
        - Run C puts the most water toward a spring peak release and has the most volume attributed. (Run C mimics a Type 3 flow with a minimum of 21 days at 5,000 cfs.). There is almost no operational spill under Run C as all available water is going to the spring peak.
        - Runs A and B are similar to each other and lower in volume than Run C.
        - Potential shortage situations are driven by the potential baseflow changes.
    - Attendees briefly discussed the comparison of the "new" model with the Gen 2 model. Comparison of the models has not been completed. This is a functional model but it is unknown how to compare it to the basis for the Flow Recommendations.
    - In summary, Run C does not use the prescribed hydrograph like Runs A and B so Run C with target baseflow of 500 to 1000 cfs is the "best" in terms of meeting the most "beneficial" situations (available water, days above 5,000, etc.). But this run also has the lowest excess target baseflow available.
        - By comparison, Run A with baseflow of 1000 to 1200 cfs shows the more "worst" case scenarios.
    - It was pointed out that there is a NEPA consideration for several of the scenarios. Several runs could be accomplished within the existing Record of Decisions, but anything that exceeds 60s could be challenged.

- Attendees then discussed the "tradeoffs" between focusing on spring peak flow, baseflow, or a combination of both (suggested matrix). What are the "tradeoffs" in terms of accomplished work between maximizing days of peak (for nearly-bank full events for work in channel; rework

channel, rip out non-native vegetation, etc.) compared to elevated baseflows for maintenance and secondary channel (creating habitat) support.

- It was suggested that key hypotheses be identified and documented for each of the matrix options (i.e., fill out the matrix with identified appropriate hypotheses for each quadrant).



- In the afternoon session, attendees reviewed the proposed *Revised Flexible EWYST Decision Tree Releasing Maximum Days At 5,000 cfs.*
    - This "tree" or diagram incorporates all the flexibilities previously discussed.
    - This tree is flexible in that there is a range of target reservoir elevations for the available water calculations. A ballpark Type 3 hydrograph requires at least 229,000 ac-ft and is used to determine options for any given year. If above (or greater than) 229,000 ac-ft, there is a 3-day ramp up, minimum of 21 days at 5,000 cfs with attempt to match the Animus peak, and a 2-week ramp down.
        - Available Water less than 229,000 ac-ft is not sufficient to support a spring peak and can be used for elevated baseflows in that year.
    - Regarding the proposed, revised "Decision Tree", there was general support to attempt a 2-week ramp down period. There was also general agreement to recommend the chart's approval with (1) the removal of the specification of "up to 60 days" due to the concerns over the Period of Record; and (2) a note or clarification to be added that the Biology Committee can decide to lower the 6,063 ft ending reservoir elevation in years deemed necessary to bolster the baseflows for years with no spring peak flow.
    - Attendees discussed inspection schedules and potential impacts to flow decisions for 2016.

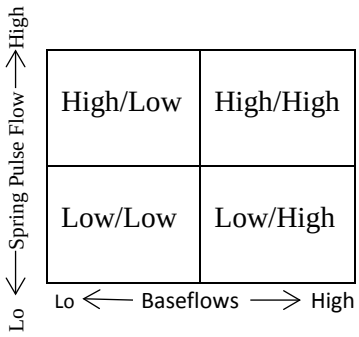
- Susan Behery presented 2016 calculations (based on the March forecast) and initiated discussion regarding 2016 operations.
    - 2016 Available Water calculations:
        - Minimum: 206,942 ac-ft for 14 possible days @ peak, so no modeled peak
        - Most Probable: 412,416 ac-ft for 36 possible days @ peak, 36 days modeled peak
        - Max: 647,239 ac-ft for 62 possible days @ peak, 60 days modeled peak.
        - Under the "most probable" forecast: 0 days of 10,000 cfs flow; 4 days of 8,000 cfs flow; *****41 days for 5,000 cfs flow.
            - ***** With the April decrease of 50,000 ac-ft, there will probably be closer to 31 days at 5,000 cfs.
        - Using Run C and the "most probable" calculations:
            - After meeting the minimum requires (500 cfs baseflow, downstream uses and minimum commitments) there is 412,416 ft left over. This is greater than 292,000 ac-ft so the Revised Decision Tree calls for a 3-day ramp up and 2-week ramp down with the reminder divided by 5,000 cfs per

day. This means a spring peak flow of ~36 days. End the year reservoir elevation is 6,049.7 (6050) ft.

- After discussion options to focus on an extended spring peak flow or combination of spring peak flow and elevated baseflow, many attendees supported utilizing all available water to extend the spring peak flow for as long as possible. One justification is that it has been so long since there was a "high" spring peak, the most benefit will be achieved by holding the peak for as long as possible (i.e., do as much work as possible). No additional water will be applied to elevating baseflow this year.

DAY 2: Brief Summary and Highlights

- Attendees began Day 2 with continued discussions on the 2016 Operations Planning.
- Susan Behery ran the model overnight using the April 1 forecast. It was agreed that decisions will be made off the "most probable" predictions.
    - The most probable Available Water, given the April 1 forecast, is 401,000 ac-ft. This translates into a 21-day Spring Peak Flow (of 5,000 cfs; Type 3 flow) leaving 125,800 of AW.
        - If all the AW were to be applied to a Spring Flow pulse, there could be a maximum of 35 days at 5,000 cfs and ending the year with 6,050 in the reservoir.
        - Attendees then discussed possible uses for "excess" water remaining after 21 days at 5,000 cfs. The two (2) options are: (1) sustain the 5,000 cfs flow for as many days possible; or (2) ramp down flow after 21 days and then elevate baseflow using the remaining water.
            - Regarding the option to increase baseflows for the entire summer, some attendees questioned the benefit of increasing baseflow to 750 cfs at the expense of ending the year with water in the reservoir to put toward a spring pulse next year.
                - The question is: "Is the extra ~7 days of peak flow more valuable compared to 21-days of peak flow along with elevated baseflow?
                - It was pointed out that baseflow if often above 500cfs (and approaching 1,000 cfs in the critical habitat areas) with regular spring/summer operations and storm events.
            - Attendees discussed the desire to utilize the high spring flow this year to accomplish monitoring and hypothesis testing. However, from a contracting position, it will be difficult (if not impossible) to modify existing contracts with enough time to mobilize this spring. Also, any hypotheses to be tested would need to be well-thought out, well defined, and agreed to.
            - Attendees briefly discussed the suggested "matrix" of pulse and baseflow options:



- Given the predictions for this year, there is the possibility of being able to achieve 8,000 cfs flows (maybe even 10,000 cfs flow if the weather contributes favorably). This could prove the opportunity to test the hypothesize "resetting" of the system – but would take monitoring and data collection prior to the high flows in order to determine changes.
- Attendees discussed the "pros and cons" to attempting both options this year. Main discussion points have been summarized in the table below:

	Pros	Cons
Maximum days Spring Pulse Flow	• Lack of high flows for several years translates into greatest need; • If the Animus and weather cooperate, could achieve very high flows	
Increased Targeted Baseflow	• Higher baseflows benefit native fishes; and don't benefit the non-natives; • Secondary channels come on-line, increasing diverse habitat availability;	• Based on estimates, if dry could require more water to achieve (possible "waste?") • Uses water that could be "banked" toward next year • Complication with interpretations due to interacting variables (compared to attempting just one treatment)

  - Attendees also discussed the need to identify when releases out of the reservoir are to be "shut off" (i.e., when ramping down should begin).
    - The suggestion is to "shut off" releases when the Animus flow declines to ~2,000 cfs for 2 or 3 days in a row (when *total* flow at the Four Corners declines to between 6,000 and 7,000 cfs for several days).

- Nathan Franssen then briefly presented "*Hypotheses And Assumptions Behind the Flow Recommendation Benchmarks – Or - How Do We Evaluate Flow Benchmarks?* and initiated discussion on reaching agreement on how high flows (and the response to high flows) will be monitored, including how to make the physical monitoring more effective and focused on the key questions.
  - It was cautioned that there is a "scale" affect when looking at the magnitudes of flows. For example, the smaller flows impact areas of interest on the 5 to 20 feet range while the larger flows can rework areas that are miles in size.
  - It was also cautioned that site evolution itself can potentially impact (change) the thresholds over time (ex. flow resistance, vegetation shade, etc.).
  - There was general agreement that the larger flows (and related processes) are still important to the system. The lower flows are just not helpful (or as important without the subsequent higher flows; as support by information in 2006 Integration Report) and might even be detrimental by (1) "irrigating" the young invasive vegetation and (2) depositing (building up) sediment at the mouths of the secondary channels.
  - Vincent Lamarra and Bill Miller will be producing a "menu" of potential monitoring tools that can be considered, depending on the targets. The overall objective can be framed as to "maintain and create habitat for the benefit of the native fish community (particularly the endangered species) in the San Juan River."

    - The general hypothesis is that "maintain these flows (5,000cfs, 8,000 cfs, and 10,000 cfs) will create and maintain the habitat in the complexity needed to maintain and support the fish.

- It was suggested that there should be a "suite of parameters" that are measured every year in order to determine the variability, even in poor water years with the absence of flows. This provides the background information and measurement errors.
    - There has to be some "base" monitoring that is maintained every year and builds the data sets.

- Additional questions and possible hypotheses (no particular order) captured during discussions included:
    1. Despite "big" flows, is channel complexity still being lost at key habitat locations? Do the "big flows" hold the system "steady?"
        a. If complexity is being lost, what is the causality between the flow and the location of concern (potentially including: channel migration, scour, Russian olive, incision, inundation, etc.).
    2. If the larger flows are maintained, will degradation be prevented over time?
    3. Do all the necessary/required habitat for the life-history stages exist within the river system? Is there enough habitat in the river system to support the full recovery the fish?
        a. How can sampling (capturing) of the intermediate and sub-adult life stages be accomplished/targeted? Are they not present? Are they missing habitat?
        b. Are there all the habitats needed for all the life stages for it to be a self-sustaining system?
    4. How many fish can each particular habitat site/type support?
    5. How many fish, of each life stage, are needed to reach adulthood and contribute to recruitment?
    6. How can the system recover from the "simplification" (loss of wetted area by 12 to 15%) that has occurred over the last 15 years?
    7. Can non-native vegetation be suppressed on restored sites to contribute to site longevity during certain/targeted flow?
    8. Can "new" habitat be created with just water?
    9. What is the species and habitat response to (a) flows and (b) flows plus mechanical intervention? How is that determined? Measured?
        a. What is the ideal flow and mechanical combination that optimizes site longevity before mechanical work is needed again?
    10. There is half the amount of islands (~150) as there were at the beginning of the Program. Why? Lack of "high enough" flows? If those flows are provided, will there be an increase in islands?
    11. Are the fish spawning in the same (or different) sites compared to the known locations of the 1990s? Are changes the result of the number of adults available? Do the fish have site/condition preferences for site selection?
        a. Can radio-telemetry be used to determine where the sizable fish going?
    12. What is not being done now (that used to be done) for the fish?
        a. Intensive Cross-Sections and Surveys – at the really complex, high priority sites to understand the response to flows; haven't been done for the past 12 years
    13. What is occurring on the "micro" scale in terms of vegetation and site armoring?

14. What is the “window of opportunity” to use flow/water to remove/rip out non-native seedlings?
15. How does created habitat respond to high flows?
16. How often are high flows needed (ideal frequency)? Is the system “maintained” given the inter-event period of the recent years? Does the assumed frequency need to be revised given the changes in the river system?
17. Given that the river is becoming more simplified and homogenous (as indicated by the loss of features, decreasing number of features, etc.), what is river-wide analysis aimed at answering?
    a. Will the river continue to lose channel complexity with time?
18. River-wide, how many secondary channels are flowing?
    a. Are secondary channels being lost in the absence of mechanical intervention? If so, at what rate?
    b. Of the 158 secondary channels (not sand bars), 25% have always flowed from day 1 while another 25% are not flowing now – what is the difference between those? Why does one work while another doesn’t? Can that inform the work necessary to get additional secondary channels flowing?
        i. Why do some secondary channels persist and others don’t? Junction angles? Bifurcate at a certain place? Certain channel invert relative to the main channel invert? Relationships to the apex of the bend? This insight can be used to prioritize which channels to work to keep open.
19. Spawning habitat is probably not limiting at this time, but nursery habitat is (based on the river situation prior to the dam and the resulting changes). There is a need for more nursery habitat that the system has now.
20. What types of habitat are needed for more recruitment? And where should that habitat be located?
    a. Focus on the reaches of river that appear to be most resistant to change(s) and use the information gathered there to inform potential work (needs) in other reaches.
    b. Fish monitoring for existing habitats is needed to better address the population density and site utilization questions.
    c. If there is recruitment, how many individuals can be supported by certain areas of habitat? Size? Type?
21. How does vegetation encroachment behave over time? And to what extent does it impact the ability to accomplish the same work with the same amount of water? (i.e., vegetation encroachment changes between events?)
        a. If there are more than 3 years between 10,000 cfs events, the next one will not be as effective at maintaining the habitat?
22. With greater flows of more duration and power, the “system reset” will be greater and more persistent over time.
23. What effect/extent if depression in temperature having on the fish?

- Additional activities/needs/considerations and potential projects (in no particular order) also discussed include, but are not limited to:
    - There is 1 dataset of described vegetation on both sides for the entire river as part of the original vegetation work. Vegetation could be remapped along the corridor to indicate detailed vegetation changes. There is also no data on vegetation at the “microscale.”

- Use GIS layers to compare to track cobble bar movement (spatial) within the river to determine if they are armoring; and postulate what would be needed to keep them dynamic.
- Photo documentation of site vegetation seedlings could be accomplished this summer as single data points under existing projects; quadrant counts could be considered as well.
- Monitoring of Channel Migration and Geometry – accomplished with mapping; aerial photography. Related decisions: river wide? Focus on complex reach(es) only?; Photography – cameras; Scour chains; Cross-sections;
- Monitoring Sediment Transport (Load) -
- Backwater Island Count – gets to the complexity of habitat issue/concerns.
- Monitoring of Backwater/Secondary Channel Scour – was done years ago but storm events resulted in immediate fill back. Abandoned because it wasn't providing useable data. Could be reexamined if completed in summer (not fall).
- Simultaneous habitat mapping and fish sampling is needed to speak to the population density and site utilization questions. After a site restoration, how do the fish respond?
    - Intensive monitoring of potential nursery habitat (with detailed larval and juvenile sampling to determine densities), could density be extrapolated or predicted for other sites? The entire river?
- Complete a stream-power analysis - recalculate based on existing data (slope by reach, channel width, depth) to look at the total amount of work that is done over a time period integrating all the flows. Flows can then be weighted for comparisons (ex. a 5,000 cfs flow for 2 days versus a 10,000 cfs flow for 1 day).

- Acknowledged challenges included:
    1. previous work (research and studies) justified/supported the decisions to cease certain monitoring activities – that work needs to be cited/referenced and
        a. has the system undergone enough changes since those studies that would warrant reexamining needs?
    2. funding and budget constraints; and the associated resulting priorities
        a. the Program needs to have an idea if/what restoration will work before a lot of money is spent
    3. separating the effects of flow on habitat versus the effects of flow on fish versus how habitat availability/quality effects the fish response?
    4. determining "life stage" densities and utilization at different sites; study size and scale would have to be appropriate for the targeted life-stage (intensity, short- versus long-term, etc.).

- Several attendees suggested a first step be to synthesize the existing data and analyses.
    - There is 20 to 25 years of work and research that has been accomplished but there is no summary document or table that neatly outlines the questions addressed, what was measured, and the resulting answer.

- Identified and referenced reports/studies/documents/data included (please note these are not full citations nor complete titles):
    - 2008 Implementing Critical Reach Study
    - RERI site and associated a priori information
    - Cross sections for the RERI Phase I and II (recently within the last 2 to 3 years)
    - Original vegetation research with mapped vegetation for both sides of the river
    - Original (2006?) Integration Report
    - Habitat Report

- Bill Miller then projected a draft outline summarizing the monitoring draft scope of work that is currently under development, titled "*Conceptual Habitat And Water Temperature Monitoring Draft Scope Of Work.*"
    - The proposed approach uses some of the same techniques as current monitoring but different implementation in certain cases. New techniques are being proposed for other tasks.
    - The implementation of the techniques would be based on water-year type (and hydrograph) and annual study needs.
    - The Biology Committee will be able, based on the previous water year, determine what work and monitoring is to be accomplished. They will be able to select from the options and drive the proposed hypotheses and approaches.
        - It was suggested that key hypotheses be identified and documented for each of the matrix options (i.e., fill out the matrix with identified appropriate hypotheses for each quadrant).
        - Attendees discussed determining what needs to be done annually (i.e., core monitoring), data gaps, guidance needs for repeated work/monitoring, and how funding could limit options in any given year.
- Attendees reviewed the threshold flow hypotheses and providing suggested revisions.
- Scott Durst then presented a suggested process to finalize the e-flow workshops. There was general agreement among attendees that the suggest process was sufficient for the time and could be modified as needed in the future.