United States Department of the Interior

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2-22-91-F-292 and 2-22-98-F-402

Memorandum

To: Area Manager, Bureau of Reclamation, Western Colorado Area Office, Grand Junction, Colorado (Attn: Carol DeAngelis)

From: Acting Field Supervisor, U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, New Mexico

Subject: Final Biological Opinion for Navajo Reservoir Operations, Colorado River Storage Project, Colorado-New Mexico-Utah

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion (BO) on the effects of actions associated with the Bureau of Reclamation's (Reclamation) "Biological Assessment (BA) of the Navajo Reservoir Operations, Colorado River Storage Project, Colorado, New Mexico, and Utah." The duration of this action will be from the acceptance of the BO to whatever time that reinitation may be necessary. This BO concerns the effects of the action on the federally endangered Colorado pikeminnow (*Ptychocheilus lucius*) (pikeminnow) and its designated critical habitat, the federally endangered razorback sucker (*Xyrauchen texanus*) and its designated critical habitat, the endangered southwestern willow flycatcher *(Empidonax traillii extimus)* (flycatcher), and the threatened bald eagle (*Haliaeetus leucocephalus)*. Reclamation determined that the proposed action "may affect, not likely to adversely affect" the pikeminnow and its critical habitat, the razorback sucker and its critical habitat, the flycatcher, and the bald eagle.

We concur with Reclamation's determination for the bald eagle and the flycatcher. We reviewed our previous determination of "may effect, likely to adversely effect" for the flycatcher and based on information provided by Reclamation, Reclamation's conservation measures, and the Bureau of Land Management's planned activities and concur that the proper determination for the flycatcher is "may affect, not likely to adversely affect." We commend Reclamation's planned conservation measures for the flycatcher, which include development and implementation of a flycatcher management plan on Reclamation's Navajo Unit project lands, and a Conservation Partnership with the Farmington Office of the Bureau of Land Management to develop and improve habitat for flycatchers along the San Juan River. These measures were described in your memorandum received by the Service on October 12, 2004, and they include the assurance that any enhancement or restoration efforts will be designed to provide conservation benefit to the

flycatcher. We are available for technical assistance with these conservation measures and would appreciate periodic updates on your progress and the success of these important projects.

After a comprehensive analysis of the information provided, the Service has determined that the correct effects determination for the pikeminnow and its critical habitat and the razorback sucker and its critical habitat is "may affect, likely to adversely affect." We make this determination based on the adverse effects continued into the future (see page 45 for explanation) and not the implementation of a natural hydrograph. The Service takes this opportunity to acknowledge that a major component of the proposed action, Reclamation's mimicking of the natural hydrograph should prove beneficial for the aquatic species. This BO does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 C.F.R. 402.02. Instead, we have relied upon the statutory provisions of the Endangered Species Act (Act) of 1973 to complete the following analysis with respect to critical habitat.

In accordance with section 7 of the Act, as amended (16 U.S.C. 1531 et seq.), and the Interagency Cooperation Regulations (50 CFR 402), this document transmits the Service's BO for impacts to federally listed threatened and endangered species as a result of the Reclamation's proposed action. A complete administrative record of this consultation is on file at the Service's New Mexico Ecological Services Field Office (NMESFO).

Consultation History

On December 28, 1979, the Service issued a BO for the proposed Animas-La Plata Project (2-22-80-F-13). It concluded that the project was not likely to jeopardize the bald eagle, pikeminnow, or peregrine falcon. One of the conservation recommendations from the 1979 BO requested thorough surveys of the native fish community in the San Juan River. Surveys between May 1987 and October 1989 found 10 adult and 18 young-of-the-year (YOY) pikeminnow and the presence of adult razorback sucker in the San Juan River (Platania et al. 1991).

On February 6, 1990, Reclamation reinitiated the Animas-La Plata consultation. On May 7, 1990, the Service issued a draft BO concluding that the project would jeopardize the continued existence of the pikeminnow, but offered no reasonable and prudent alternative to the project in the draft opinion. Reclamation and the Service cooperatively developed a reasonable and prudent alternative. The Service issued a final BO on October 25, 1991 (ES/GJ-6-90-CO-004), which concluded that the project as proposed would likely jeopardize the continued existence of the pikeminnow and razorback sucker. The elements of the reasonable and prudent alternative provided in that BO were that Reclamation would: 1) Limit initial depletions to 57,100 acre feet (af); 2) implement 7 years of research to determine endangered fish habitat needs; 3) operate Navajo Dam to provide 300,000 af/year and a wide range of flow conditions for the endangered fish; 4) guarantee that, based on the results of the research program and dependent upon the prevailing hydrology, Navajo Reservoir would be operated for the life of the Animas-La Plata Project to mimic a natural hydrograph; 5) provide legal protection for the reservoir releases instream to and through the endangered fish habitat to Lake Powell, and a commitment to develop and implement a Recovery Implementation Program for the San Juan River. The San

Juan River Basin Recovery Implementation Program (SJRRIP) for endangered fish species was initiated on November 1, 1992. The SJRRIP was intended to conserve populations of pikeminnow and razorback sucker in the San Juan River Basin consistent with the Act, and proceed with water development in the basin in compliance with federal and state laws, interstate compacts, Supreme Court decrees, and Federal trust responsibilities to the Southern Ute Indian Tribe, Ute Mountain Ute Tribe, the Jicarilla Apache Nation, and the Navajo Nation (SJRRIP 1995).

Reclamation requested initiation of section 7 consultation on Navajo Dam operations on June 30, 1991. The Service responded on August 19, 1991, and agreed that the timeframe for the consultation would continue through the research period established in the Animas-La Plata Project BO, enabling Reclamation to gather data on the endangered fish. This consultation completes the 1991 section 7 consultation on Navajo Unit operations.

In 1996, the Service issued a BO based on Reclamation's BA for full development of the Animas-La Plata Project (GJ-6-CO-95-033). Full development consisted of a 191,230 af annual diversion and a 149,220 af annual depletion. The BO found the proposed project would likely jeopardize the continued existence of pikeminnow and razorback sucker. The elements of the reasonable and prudent alternative included: 1) only those project features that result in a maximum depletion of 57,100 af (Phase I, stage A) would be constructed, until all elements of the reasonable and prudent alternative were completed. However, if Reclamation could provide a minimum winter flow out of Navajo Dam of approximately 300 cfs on a recurring basis and mimic a natural hydrograph, then Stage A could be operated with 57,100 af as an average annual depletion. After the end of the research period in 1998 and development of flow recommendations, Navajo Dam operations would be based on those recommendations; 2) Reclamation would provide operational and funding support to complete the 7-year research program; 3) Reclamation would continue to operate Navajo Dam under study guidelines developed under element 2 for the research period; 4) Reclamation would develop procedures to implement flow recommendations requested for the research period; 5) Reclamation would cooperate with the Biology Committee and Navajo Dam Operating Committee to determine the release hydrograph for spring flows and would follow the agreed upon hydrograph without deviation, except under emergency conditions or where deviation was required to stay within the U.S. Army Corps of Engineers' (Corps) flood operating rules; 6) at the termination of the biological studies undertaken during the 7-year research period, year-round flow recommendations based on the best scientific and commercial data available would determine the manner and extent to which Navajo Dam would be operated to mimic the natural hydrograph for the life of the Animas-La Plata Project; and 7) the binding agreements to legally protect the reservoir releases to and through the endangered fish habitat to Lake Powell that were executed in support of the 1991 BO would continue. Reclamation would continue funding and participating in the SJRRIP.

In 2000, after the issuance of the San Juan River Flow Recommendations produced by the SJRRIP Biology Committee (Flow Recommendations) (Holden 1999), and a revised project proposal, the Service issued a BO on a scaled-back Animas-La Plata Project (ES/GJ-6-CO-00-F-

016) that limited the annual average depletions to 57,100 af (Service 2000). The Service found that the project, with implementation of the proposed conservation measures, was not likely to jeopardize the razorback sucker or pikeminnow or adversely modify critical habitat. The conservation measures that were part of the proposed action included: 1) Operation of Navajo Dam to mimic the natural hydrograph of the San Juan River to benefit endangered fishes and their critical habitat by following the Flow Recommendations and subject to the completion of the Navajo Reservoir Operations Environmental Impact Statement and Record of Decision; 2) Reclamation would be responsible for maintenance and use of the Riverware model used to model the Flow Recommendations that were developed by the SJRRIP Biology Committee; 3) Reclamation would keep in effect the Memorandum of Understanding and Supplemental Agreement to protect the releases for endangered fishes to and through the endangered fish habitat; 4) the Durango Pumping Plant would be operated in a manner that would not interfere with meeting the Flow Recommendations; 5) Reclamation would implement all actions necessary to prevent non-native fish escapement from Ridges Basin Reservoir; 6) Reclamation would develop and implement a monitoring program for potential adverse bioaccumulation of trace elements in bald eagle food items in Ridges Basin Reservoir; and 7) Reclamation would incorporate bypass flows to promote natural recruitment of cottonwood trees along the Animas River.

The Service received the first copy of the Navajo Reservoir Operations BA in August of 2002, after Reclamation had selected a preferred alternative for their Navajo Reservoir Operations Environmental Impact Statement. Updated BAs were received in November 2002, May 2003, and July 2003. On September 17, 2003, the Service was notified that the July 2003 project description was final. On October 10, 2003, Reclamation requested initiation of formal consultation. The Service's October 28, 2003, response recognized September 17, 2003, as the beginning of the formal consultation period. The Service received language describing the trigger for "extreme conditions," further refining the proposed action, on December 23, 2003.

The Service released a preliminary draft BO for public review on January 26, 2004. On May 19, 2004, the Service received a memorandum from Reclamation that amended their proposed action to not include evaporative loss. The Service and Reclamation have been working since that date to fully analyze the effects of the project and clarify issues raised during the public review.

Description of the proposed action

Action Area

The action area considered in this BO for the proposed action consists of the entire San Juan River Basin, to the full pool of Lake Powell (Figure 1). This action area differs from what was presented in the BA due to the interrelated and interdependent effects of the projects listed in Table 1.

Proposed action

Reclamation proposes to operate Navajo Dam and Reservoir in accordance with the Flow Recommendations. As described in the Consultation History, the Flow Recommendations were

developed after seven years of research (1991-1997), and were finalized in 1999. Reclamation has been operating Navajo Dam according to the Flow Recommendations since 1999. The minimum releases (250 cfs) from Navajo Dam have not been implemented. If the Record of Decision (ROD) for the Navajo Operations EIS recommends implementation of the proposed action, these minimum releases will occur after the ROD is completed. Consultation for the proposed action began in 1991 and the BA with an analysis of the effects of the action was provided to the Service in the summer of 2002.

The two-fold purpose of the proposed action (referred to as the 250/5000 alternative in the Draft Environmental Impact Statement (Reclamation 2002) is to: 1) Develop operating criteria for Navajo Dam and Reservoir in order to assist in creating and maintaining habitat in the San Juan River to help conserve and recover populations and designated critical habitat of the pikeminnow and razorback sucker, and 2) maintain the authorized purposes of the Navajo Unit, including future water development. The proposed change in reservoir operation, along with other elements of the SJRRIP, would conserve the endangered fish and enable water development to proceed in the San Juan River Basin in compliance with applicable laws, compacts, court decrees, and American Indian trust responsibilities.

The intent of the proposed reservoir operations is to mimic the San Juan River's natural hydrograph downstream from its confluence with the Animas River to Lake Powell. Although the pre-dam hydrograph cannot be precisely replicated, releasing between 250 and 5,000 cubic feet per second (cfs) will provide a hydrograph that is similar to the pre-dam conditions (Figure 2). The peak releases (5,000 cfs) would be planned to meet the statistical requirements of the spring Flow Recommendations. A decision tree (Figure 3) would be used to determine spring releases, which would occur in approximately 70 percent of the years. The summer, fall, and winter base flow releases are intended to meet the Flow Recommendations in the river downstream of Farmington of 500 to 1,000 cfs. The operation criteria are also designed and intended to consistently meet endangered fish minimum base flows downstream from Farmington (500 cfs). Maximum recommended base flows (1,000 cfs) downstream from Farmington would occasionally be exceeded because of high inflows from the Animas River and other natural flood events.

The Flow Recommendations call for using a moving weekly average of 2 of the 4 downstream gauges to monitor whether flows are kept between 500 and 1,000 cfs. There can be significant variability in these gauge readings and the selective use of any two gauges could give results above or below the intent of the Flow Recommendations (SJRRIP 2002a). Because of this, in 2002 the SJRRIP Biology Committee of the SJRRIP suggested that flows be monitored by following the "Three Gauge Rule:"

> "Use the lesser of the average of Bluff, Four Corners and Shiprock (gauges) and the average of Farmington, Shiprock, and Four Corners (gauges)" (SJRRIP 2002a).

Extreme conditions (low or high flows) identified by Reclamation will be handled on a case-by-case basis with recommendations of the Biology Committee" (SJRRIP 2003a). Reclamation will use the "Three Gauge Rule" until an improved system is developed.

Reclamation will use information from existing Tri-annual Navajo Unit Operations meetings, held in January, April and August, to discuss the upcoming period's operations. At these meetings Reclamation will solicit comments, ideas, and information from members of the public, government (local, state, Federal) agencies, Tribes, and others regarding the affected resources on the San Juan River. This information will be used in decisions on how to regulate water releases from Navajo Reservoir. Reclamation will use existing water inflow forecasts, reservoir level, and historic averages to predict the water supply available to meet Flow Recommendations and authorized purposes. This information, along with the decision tree for peak flows, will be analyzed and considered by Reclamation in the development of an operation plan. The operations will provide releases between 250 and 5,000 cfs. Reclamation will be responsible for implementing the operation plan following completion of a Record of Decision under the National Environmental Policy Act (NEPA) process.

The proposed action was modified by Reclamation from what was presented in the July 2003 BA by inclusion of "extreme conditions" language. The extreme conditions language was modified by Reclamation from the language contained in the Recommendations for San Juan River Operations and Administration developed in response to the 2002 water year and provided to the Service via electronic mail. The 2003 agreement and associated documents can be found at http://southwest.fws.gov/SJRRIP/progdocs.html. Prior to 2003, the hydrologic scenario used to model water availability in the San Juan River Basin met the Flow Recommendations and water users received their full allocation. In 2003, Reclamation faced the possibility that they would be unable to meet the water demands of all the users and adhere to the Flow Recommendations. In response to the potential water shortage in the San Juan River Basin, Reclamation worked with all the water users and the Service to develop an agreement to share shortages proportionally. This shortage sharing process has been included in the project description to illustrate the mechanism by which Reclamation shall define "extreme conditions," and describe San Juan River management under those conditions. Extreme drought conditions are addressed in more detail later in this section.

Operational Flexibility

Inherent in the operation of Navajo Dam are variables that influence dam operations, including changes or errors associated with inflow forecasts, fluctuations in the Animas River, unusual or unexpected precipitation events, gauge errors and discrepancies, and unexpected maintenance needs at Navajo Dam. Reclamation will take these variables into account when making operating plans to meet the Flow Recommendations.

Water committed for future development but not currently used will offer short term flexibility in reservoir releases. This may be a significant amount (up to 102,100 af) of water in many, but not all years. When possible, the release of this water will be incorporated into operations to augment the 250 cfs minimum release during the irrigation season; the goal will be to maintain

irrigation season releases between 350 and 500 cfs, while assuring a spring release and recommended minimum flows as described in the Flow Recommendations. Water forecasted to be available will be identified, quantified, and scheduled for release to the extent possible at the annual spring Navajo Reservoir Operations meeting. The SJRRIP Biology Committee indicated that during the irrigation season (March through October) "it may not be effective or necessary to lower releases below 500 cfs until water use in the basin increases to the point that the water is needed to meet runoff period recommendations. This flexibility is extended only to the irrigation season as defined . . . and only until water development reaches the level that additional water is needed for Spring releases" (February 21, 2002, memorandum from Biology Committee to Reclamation).

As full water development occurs, minimum releases would be no lower than 250 cfs. In the long-term, flexibility will diminish. In drought years, there may be no flexibility. Existing flexibility within the Flow Recommendations could occasionally allow minimum summer releases to be above 250 cfs. During the Navajo Unit Operations meetings and in discussions with the Service, an operation plan to meet the Flow Recommendations, authorized project purposes, and water development needs will be prepared. Unutilized water, resulting from the aforementioned variables, could be identified and used to increase irrigation season releases or for other uses.

Part of the SJRRIP is to implement a process of "adaptive management," where the effects of dam operations on endangered fish and their habitat and downstream resources would be monitored and the results of that monitoring would form the basis for possible future tests or modifications of dam operations and/or the Flow Recommendations. Through this process there might be water identified in the system or operations that could be available at different times or for different uses. This adaptive management is already considered within the Flow Recommendations, in that they may be adjusted as new information is gained through monitoring and research. Navajo Unit Operation meetings will also provide a forum for adaptive management and an opportunity for the public and SJRRIP stakeholders to learn about monitoring results and to express their views about Reclamation's operation plans for the Navajo Unit.

Maintaining Authorized Navajo Unit Purposes

As indicated previously, in addition to meeting Flow Recommendations, the proposed plan is intended to maintain the authorized purposes of the Navajo Unit. The Unit, along with other major storage units, was authorized by the Colorado River Storage Project (Act of April 11, 1956, ch. 203, 70 Stat. 105). The storage units were authorized to:

- Regulate the flow of the Colorado River,
- Store water for beneficial consumptive use, making it possible for the States of the Upper basin to utilize the apportionments made to and among them in the Colorado River compacts,
- Provide for irrigation,
- Provide for flood control,

- Provide for the generation of hydroelectric power, and
- Provide for recreation and facilities to mitigate or enhance fish and wildlife.

Reclamation has determined that both the Flow Recommendations and the Unit's authorized purposes can be met under the proposed action.

Flow Recommendations

The basis of the Flow Recommendations for the San Juan River is to mimic the natural hydrograph. The recommendations provide flow variability considered necessary to create and maintain habitat for pikeminnow and razorback sucker. The recommendations integrate hydrology, geomorphology, habitat, and biology to define flow magnitude, duration, and frequency for the spring runoff period and base flows for the non-runoff periods.

The proposed action follows the recommended operating rules (Holden 1999) and meets or exceeds flow criteria according to model results (Reclamation 2003). This model uses long-term historic flow data, which encompasses a variety of wet and dry conditions; however, there is always a level of uncertainty in future climatic conditions which could have a positive or negative effect on the amount of water available to meet the Flow Recommendations.

Following are the current Flow Recommendations:

A. Category: Flows > 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 percent of the years on average for the period of record 1929 to 1993. Maximum number of consecutive years without meeting at least a flow of 9,700 cfs (97 percent 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 endangered fishes. The frequency and duration are based on mimicry of the natural hydrograph, which is important for 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 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 percent of the years on average for the period of record 1929 to 1993. Maximum number of consecutive years without meeting at least a flow of 7,760 cfs (97 percent 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 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 pikeminnow reproductive success.

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 percent of the years on average for the period of record 1929 to 1993. Maximum number of consecutive years without meeting at least a flow of 4,850 cfs (97 percent 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 about 50 percent 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 pikeminnow spawning area (RM 132) and its backwater habitat abundance.

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 percent of the years on average for the period of record 1929 to 1993. Maximum number of consecutive years without meeting at least a flow of 2,425 cfs (97 percent 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 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.

E. Category: Timing of the peak flows noted in conditions 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 (RM 180 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 is 14 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.

F. Category: Target Base Flow (mean weekly nonspring 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 increased flows due to storms and still maintain optimum backwater area. This level

of flow balances the 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 pikeminnow reproductive success.

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 the creation and maintenance of nursery habitat. Periodic clean water spike flows improve low velocity habitat quality by flushing sediment and may suppress red shiner and fathead minnow abundance.

The ability of Reclamation to meet a flow in any given year is partially dependent on the flows in the Animas River. The Animas River is tributary to the San Juan River, is unregulated, and can contribute a substantial amount of water to the San Juan River. Navajo Dam can release up to 5,000 cfs to augment peak flows in the Animas River. Reclamation has met the Flow Recommendations through critical habitat since 1999.

Depletions

The depletions shown in Table 2 are for existing private and public projects that affect San Juan River flows. Some of these projects have undergone section 7 consultation and others have not. Reclamation projects in Table 2 that will require section 7 consultation in the future include the Hammond Project, the Florida Project, the Pine River Project, and the Mancos Project. Table 2 also includes future projects that have undergone consultation and NEPA analysis; these projects include the Animas-La Plata Project, completion of the Navajo Indian Irrigation Project, and the Jicarilla Apache Nation water sale to the Public Service Company of New Mexico. The depletions, other than evaporative loss, that are portrayed in Table 2 are either analyzed as part of this document's Environmental Baseline, Cumulative Effects, or as Interrelated or Interdependent Effects of the action.

The majority of the depletions shown in Table 2 are independent of the Navajo Unit; however, there are both direct and interrelated effects from Navajo Unit depletions. Depletions that have completed section 7 consultation are included in the Environmental Baseline. Some of these

depletions are also interrelated and interdependent to the operation of Navajo Dam (such as the Navajo Indian Irrigation Project (280,600 af), San Juan Power Plant (16,200 af), and minor depletions (small contracts less than 100 af)) and are actions that cannot be analyzed twice. The analysis of the effects of these actions is properly set out in the Environmental Baseline. Navajo Reservoir evaporation (27,428 af) is not part of Reclamation's proposed action, but it is an effect of Navajo Dam operations. Future evaporation from the reservoir is considered in the Effects of the Action section of this document. Historical losses from evaporation are considered in the Environmental Baseline section.

Not all of the State compact water or Indian trust water is included in the depletion table (Table 2) that was used to determine that the proposed action could meet the Flow Recommendations. Only existing public and private projects, existing uses with no Federal nexus, future uses without a Federal nexus that are reasonably likely to be developed in the foreseeable future, and future projects that have undergone section 7 consultation and NEPA analysis at the time of this consultation, are included in the table of depletions.

Most depletions to the San Juan River that have completed section 7 consultation, including certain depletions that would occur upon the completion of the Navajo Indian Irrigation Project and the Animas-La Plata Project, and depletions that depend on the reoperation of Navajo Reservoir to mimic the natural hydrograph as part of their commitment from prior section 7 consultations. Table 1 shows those projects that are dependent upon the reoperation of Navajo Reservoir to mimic the natural hydrograph as part of their compliance with the Endangered Species Act.

The proposed action does not preclude future depletions; however, NEPA analysis and section 7 consultations are necessary for any depletion with a Federal nexus. The SJRRIP and Service have developed principles that explain and outline the process under which additional water projects and depletions will be evaluated.

Extreme Conditions

The following extreme conditions language was developed by Reclamation as a result of the Recommendations for San Juan River Operations and Administration process in 2003 and 2004. The language was modified into extreme conditions language by Reclamation for potential use in future years with either exceptionally high or low water availability. The Recommendations for San Juan River Operations and Administration, and associated documents developed for 2003 are available at http://southwest.fws.gov/SJRRIP/. Extreme conditions could represent either extremely wet or dry years. Shortage sharing could occur during periods of extreme drought conditions, or the year(s) following an extreme drought.

During periods of abnormally high inflow and high reservoir levels, Navajo Reservoir may need to be operated to allow releases higher than 5,000 cfs. This would result in flows that exceed the Corps safe channel capacity (5,000 cfs) between Navajo Dam and Farmington, and may exceed the San Juan River channel capacity below the confluence with the Animas River of 16,000 cfs.

If reservoir releases need to be increased in the late summer or fall due to heavy rainfall upstream from the reservoir, the unusually high inflows will be released as a fall spike.

In periods of extreme drought conditions, when water shortages are anticipated to Navajo Reservoir water supply contractors diverting above, at, or below Navajo Reservoir (such as occurred in 2003), shortage sharing plans would be developed based upon the available water, with input from the Service, New Mexico State Engineer, and reservoir water users. The available water, taking into account both the prospective runoff originating above Navajo Reservoir and the available water in storage in Navajo Reservoir will be apportioned between the contractors as directed in Section 11 of Public Law 87-483. Reclamation will assess available water for the water year and determine whether shortages are anticipated. Reclamation will hold discussions with the Service and the SJRRIP to determine flow targets and minimum base flows for endangered fish. The shortage sharing plans could include modifications to reservoir releases and target base flows. While Section 11 of P.L. 87-483 provides the framework for apportioning water to Navajo Reservoir water users between those diverting above and those diverting at or below the reservoir, in years where shortages are anticipated, it is understood that this does not preclude water users from developing cooperative water sharing agreements, such as those that were developed in 2003 through 2005, so long as such agreements would not cause Reclamation to undertake any change in its operations from how they would operate under Section 11.

To determine if sufficient water will be available in any given year to meet the authorized purposes of the Navajo Unit, as well as meet the Flow Recommendations, Reclamation compares prospective runoff and available water in Navajo Reservoir against the annual diversion requirements of the various uses in the basin. Determination of an extreme dry year, which could result in a shortage situation, can be triggered by lack of snowpack or a lack of available water in storage, or a combination of both.

Seasonal water supply forecasts are generated monthly from January through July for the San Juan River Basin. Reclamation develops an annual operating plan for Navajo Reservoir based on the Most Probable Forecast. This forecast is the best estimate of stream flow volume that can be produced given current conditions and based on the outcome of similar past situations. There is a 50 percent chance that the stream flow volume will exceed the forecast value and a 50 percent chance that the stream flow volume will be less than the forecast value. Uncertainties are inherent in water supply forecasts due to imperfection in the techniques in developing the forecasts and the unpredictability of weather. The first water supply forecast is developed in early January and provides a very preliminary prediction of what the reservoir inflow volume. Each subsequent month's forecast refines that prediction. As the year progresses, there is more certainty about the information affecting stream flow.

The SJRRIP Hydrology Committee found that a minimum carryover storage level of 900,000 af (lake elevation of 6,018.8 feet) on July 31 was needed to prevent shortages to water users in future years and meet the Flow Recommendations for the San Juan River downstream of Farmington. This was a calibrated value for 1999 depletion levels in the basin using the 1929-1993 period of record, a minimum Navajo Dam release of 250 cfs, and a maximum release of

5,000 cfs. This minimum carryover value will be updated as water use increases in the basin. The SJRRIP Hydrology Committee used this modeling method to make the determination that 2003 was an "extreme year" since the Most Probable Forecast placed the July 31 level below 6,018.8 feet. The Hydrology Committee is continuing to develop the method for determining extreme years, but the basis will be similar to what was used in 2003.

As an example of how shortage sharing could be implemented, in 2003, Reclamation developed a computer model to calculate anticipated shortages using the most recent Minimum Probable Forecast, the available water supply in Navajo Reservoir, and the anticipated demands from the various users and uses. This model is updated twice a month as new forecasts became available. Using the Minimum Probable Forecast and the anticipated demands for water, the computer model created a Navajo Reservoir operational scenario for that year. If the model forecast that the reservoir level would drop below elevation 5,990 feet (bottom of active storage, delineated by the intake structure for the Navajo Indian Irrigation Project) anytime during the irrigation season (March through early November), a shortage would occur. The model then proportionally allocated that shortage to all users, including the endangered fish, and uses based upon their respective demands for that year. As a result of decreasing (or shorting) the demands of all users and uses, the reservoir level did not drop below elevation 5,990 feet. As the inflow forecasts and actual water levels in Navajo Reservoir changed, so did the anticipated shortage amount. To address potential impacts to the pikeminnow and razorback sucker, the SJRRIP Biology Committee made the following recommendations in a September 28, 2003, memo to SJRRIP Coordination Committee (SJRRIP 2003a), quoted below:

> "For the 2003 and 2004 irrigation seasons, a shortage sharing agreement was signed by Navajo Reservoir contractors and the major run-of-river diverters in the San Juan River whereby all shared shortages equally, including flows for the endangered species. The Biology Committee reviewed historical flows, habitat and biological data and recommended that a limit be set on the shortage to the endangered species such that flows in the critical habitat area not fall below 250 cfs during April – October using the 3-gauge rule. Shortage sharing was to be calculated based on a 500 cfs normal demand wherein the volume of water released to support this use would be shorted equally with other water users.
>
> For 2004, recognizing the need to conserve water and provide sufficient water for a spring peak release at the earliest possible time, the Biology Committee recommends that the non-shorted minimum target flow for April through October be set to 400 cfs for 2004 only. Any shortage would be computed based upon 400 cfs rather than 500 cfs. To protect the fish from possible harm, we further recommend that the flows be allowed to fall below 350 cfs for no more than 50 cumulative days and below 300 cfs for no more than 40 cumulative days for this period under implementation of the shortage sharing rules. As determined last spring, the 7-day average flow in the habitat should not fall below 250 cfs. All compliance calculations are to be made using the three-gauge rule.

> We [Biology Committee] recommend that the drought conservation measures, specified above, be implemented only as long the low decile inflow forecast projects an end-of-July Navajo Reservoir content of less than 1,000,000 af and only for the remainder of 2003 and the 2004 irrigation season. Any time the low decile forecast (minimum probable) shows a reservoir level above 1,000,000 af at the end of July, the normal habitat flow would revert to 500 cfs. According to the flow recommendation report, Table 8.4, this reservoir level will protect water users, including the fish, from shortages up through the depletion base level, which is somewhat greater than present depletion. Today's depletion levels are higher than those described as "current" in the flow recommendation report due to the continued expansion of Navajo Indian Irrigation Project and the delay of Navajo Indian Irrigation Project return flow. Using the recommended minimum carry-over storage for the depletion base in Table 8.4 will sufficiently protect all users from shortage and provide some margin to assist in conserving water for a future spring release."

The SJRRIP Biology Committee's recommendations contemplated the delivery of water from the Navajo Reservoir Supply under subcontracts between the Jicarilla Apache Nation and the Public Service Company of New Mexico, the Arizona Public Service Company, and BHP Billiton, provided that the subcontracts are limited to the delivery in the aggregate of 16,000 af of water during 2004 to the San Juan Generating Station, the Four Corners Power Plant and the related mines (collectively, the power plants), and that actual delivery of water under the subcontracts shall be made only to provide supplemental water to the power plants in the event of shortages determined pursuant to the Shortage Sharing Recommendations. The 2004 Shortage Sharing Recommendations further contemplated the delivery of up to 4,000 af from the Navajo Reservoir Supply under subcontracts between the Jicarilla Apache Nation and the San Juan Water Commission under specified conditions. These subcontracts provide a backup water supply, in the event of a shortage determination, to the power generating companies and the municipal water users represented by the San Juan Water Commission that have existing contracts or direct flow uses below Navajo Dam. Because the water supplied under these subcontracts is within the existing depletions addressed in the BO for the Animas-La Plata Project and included in Table 2 of this BO, these subcontracts do not increase net depletions. They provide a mechanism that helps prevent significant regional economic impacts due to extended drought.

Given that shortages reduce the level of operational flexibility as discussed on Page 6, the utilization of subcontracting from the Navajo Reservoir Supply contractors for a variety of purposes is an appropriate method for maintaining some level of flexibility in managing the system during extreme conditions. Leasing arrangements approved by Reclamation between Navajo Reservoir Supply contractors and willing lessees for the purposes of meeting short-term needs as a result of water shortages will be considered to be part of the proposed action, and covered by this consultation provided that they do not increase net depletions or measurably reduce flows through the critical habitat reach. Reclamation will annually review and report to the Service and the SJRRIP on the effects of such subcontracts on net depletions and flows through the critical habitat reach. In future years, should extreme conditions exist and shortage

sharing agreements be considered, Reclamation will solicit the opinion of the Biology Committee to determine suitable base flow.

Shortage sharing agreements can cause a single-year deviation from the Flow Recommendations by reducing the target base flows through critical habitat. These reductions in target base flows may delay recovery of the razorback sucker and pikeminnow (SJRRIP 2003a). The Service believes that shortage sharing would only occur during extreme drought conditions and would not affect Reclamation's ability to meet the Flow Recommendations with the exception of the target base flows during the extreme drought conditions, or the following year. While shortage sharing arrangements could result in a short-term delay in recovery, such arrangements are designed to protect the water level of Navajo Reservoir which will be a long-term benefit to razorback sucker, pikeminnow, and primary constituent elements of their designated critical habitat, by reducing the possibility of catastrophic water shortages in the basin which could result in significant dewatering.

Status of the species and critical habitat

Colorado Pikeminnow

The pikeminnow is the largest cyprinid (member of the minnow family, Cyprinidae) native to North America and it evolved as the top predator in the Colorado River system. It is an elongated pike-like fish that once grew as large as 1.8 meters (m) (6 feet) in length and weighed nearly 45 kilograms (100 pounds) (Behnke and Benson 1983); such fish were estimated to be 45-55 years old (Osmundson et al. 1997). Today, fish rarely exceed 1 m (approximately 3 feet) in length or weigh more than 8 kilograms (18 pounds). The mouth of this species is large and nearly horizontal with long slender pharyngeal teeth (located in the throat), adapted for grasping and holding prey. The diet of pikeminnow longer than 80 to 100 millimeters (mm) (3 or 4 inches [in]) consists almost entirely of other fishes (Vanicek and Kramer 1969). Adults are strongly counter-shaded with a dark, olive back, and a white belly. Young are silvery and usually have a dark, wedge-shaped spot at the base of the caudal fin.

Based on early fish collection records, archaeological finds, and other observations, the pikeminnow was once found throughout warm water reaches of the entire Colorado River Basin down to the Gulf of California, including reaches of the upper Colorado River and its major tributaries, the Green River and its major tributaries, the San Juan River and some of its tributaries, and the Gila River system in Arizona (Seethaler 1978, Platania 1990). Pikeminnow apparently were never found in colder, headwater areas. Seethaler (1978) indicates that the species was abundant in suitable habitat throughout the entire Colorado River Basin prior to the 1850s. By the 1970s they were extirpated from the entire lower basin (downstream of Glen Canyon Dam) and from portions of the upper basin as a result of major alterations to the riverine environment. Having lost approximately 75-80 percent of its former range, the pikeminnow was federally listed as an endangered species in 1967 (Service 1967, Miller 1961, Moyle 1976, Tyus 1991, Osmundson and Burnham 1998).

Critical habitat is defined as the areas that provide physical or biological features that are essential for the recovery of the species. Critical habitat was designated for the pikeminnow in 1994, within the 100-year floodplain of the species' historical range in the following section of the San Juan River Basin (59 FR 13374) (Maddux et al. 1993, Service 1994).

> New Mexico, San Juan County; and Utah, San Juan County. The San Juan River from the State Route 371 Bridge in T. 29 N., R. 13 W., section 17 to the full pool elevation at the mouth of Neskahai Canyon on the San Juan arm of Lake Powell in T. 41 S., R. 11 E., section 26.

The Service identified water, physical habitat, and the biological environment as primary constituent elements of critical habitat. This includes a quantity of water of sufficient quality that is delivered to specific habitats in accordance with a hydrologic regime that is required for the particular life stage for the species. The physical habitat includes areas of the Colorado River system that are inhabited or potentially habitable for use in spawning and feeding, as a nursery, or serve as corridors between these areas. In addition, oxbows, backwaters, and other areas in the 100-year floodplain, which when inundated provide access to spawning, nursery, feeding, and rearing habitats, are included. Food supply, predation, and competition are important elements of the biological environment.

Life History

The life history phases that appear to be most limiting for pikeminnow populations include spawning, egg hatching, development of larvae, and the first year of life. These phases of pikeminnow development are tied closely to specific habitat requirements. Natural spawning of pikeminnow is initiated on the descending limb of the annual hydrograph as water temperatures approach the range of 16°C (60.8°F) to 20°C (68°F) (Vanicek and Kramer 1969, Hamman 1981, Haynes et al. 1984, Tyus 1990, McAda and Kaeding 1991). Temperature at initiation of spawning varies by river. In the Green River, spawning begins as temperatures exceed 20-23°C (68-73°F); in the Yampa River, 16-23°C (61-68°F) (Bestgen et al. 1998); in the Colorado River, 18-22°C (64-72°F) (McAda and Kaeding 1991); in the San Juan River temperatures were estimated to be 16-22°C (61-72°F). Spawning, both in the hatchery and under natural riverine conditions, generally occurs in a 2-month period between late June and late August. However, sustained high flows during wet years may suppress river temperatures and extend spawning into September (McAda and Kaeding 1991). Conversely, during low flow years, when the water warms earlier, spawning may commence in mid-June.

Temperature also has an effect on egg development and hatching success. In the laboratory, egg development was tested at five temperatures and hatching success was found to be highest at 20°C (68°F), and lower at 25°C (77°F). Mortality was 100 percent at 5, 10, 15, and 30°C (41, 50, 59, and 86°F). In addition, larval abnormalities were twice as high at 25°C (77°F) than at 20°C (68°F) (Marsh 1985). Experimental tests of temperature preference of yearling (Black and Bulkley 1985a) and adult (Bulkley et al. 1981) pikeminnow indicated that 25°C (77°F) was the most preferred temperature for both life phases. Additional experiments indicated that optimum

growth of yearlings also occurs at temperatures near 25°C (77°F) (Black and Bulkley 1985b). Although no such tests were conducted using adults, the tests with yearlings supported the conclusions of Jobling (1981) that the final thermal preference of 25°C (77°F) provides a good indication of optimum growth temperature for all life phases.

Males become sexually mature earlier and at a smaller size than do females, though all are mature by about age 7 and 500 mm (20 in) in length (Vanicek and Kramer 1969, Seethaler 1978, Hamman 1981). Hatchery-reared males became sexually mature at 4 years of age and females at 5 years. Average fecundity of 24, 9-year old females was 77,400 (range, 57,766–113,341) or 55,533 eggs/kg, and average fecundity of 9 ten-year old females was 66,185 (range, 11,977–91,040) or 45,451 eggs/kg (Hamman 1986).

Most information on pikeminnow reproduction has been gathered from spawning sites on the lower 20 miles (12.2 kilometers) of the Yampa River and in Gray Canyon on the Green River (Tyus and McAda 1984, Tyus 1985, Wick et al. 1985, Tyus 1990). Pikeminnow spawn after peak runoff subsides. Spawning is probably triggered by several interacting variables such as day length, temperature, flow level, and perhaps substrate characteristics. Known spawning sites in the Yampa River are characterized by riffles or shallow runs with well-washed coarse substrate (cobble containing relatively deep interstitial voids (for egg deposition)) in association with deep pools or areas of slow non-turbulent flow used as staging areas by adults (Lamarra et al. 1985, Tyus 1990). Recent investigations at a spawning site in the San Juan River by Bliesner and Lamarra (1995) and at one site in the upper Colorado River (Service unpubl. data) indicate a similar association of habitats. The most unique feature at the sites used for spawning, in comparison with otherwise similar sites nearby, is the lack of embeddedness of the cobble substrate and the depth to which the rocks are devoid of fine sediments; this appears consistent at the sites in all three rivers (Lamarra et al. 1985, Bliesner and Lamarra 1995).

Collections of larvae and young-of-year (YOY) downstream of known spawning sites in the Green, Yampa, and San Juan Rivers demonstrate that downstream drift of larval pikeminnow occurs following hatching (Haynes et al. 1984, Nesler et al. 1988, Tyus 1990, Tyus and Haines 1991, Platania 1990, Ryden 2003a). Studies on the Green and Colorado Rivers found that YOY used backwaters almost exclusively (Holden 2000). During their first year of life, pikeminnow prefer warm, turbid, relatively deep (averaging 0.4 m [1.3 feet]) backwater areas of zero velocity (Tyus and Haines 1991). After about 1 year, young are rarely found in such habitats, although juveniles and subadults are often located in large deep backwaters during spring runoff (Service, unpublished data; Osmundson and Burnham 1998).

Pikeminnow often migrate considerable distances to spawn in the Green and Yampa Rivers (Miller et al. 1982, Archer et al. 1986, Tyus and McAda 1984, Tyus 1985, Tyus 1990), and similar movement has been noted in the main stem San Juan River. A fish captured and tagged in the San Juan arm of Lake Powell in April 1987, was recaptured in the San Juan River approximately 80 miles upstream in September 1987 (Platania 1990). Ryden and Ahlm (1996) report that a pikeminnow captured at river mile (RM) 74.8 (between Bluff and Mexican Hat)

made a 50-60 mile migration during the spawning season in 1994, before returning to within 0.4 river miles of its original capture location.

Although migratory behavior has been documented for pikeminnow in the San Juan River (Platania 1990, Ryden and Ahlm 1996), of 13 radio-tagged fish tracked from 1991 to 1994, 12 were classified as sedentary and only one as migratory (Ryden and Ahlm 1996). Miller and Ptacek (2000) followed 7 radio-tagged wild pikeminnow in the San Juan River and found these fish to also use a localized area of the river (RM 120 to RM 142). In contrast to pikeminnow in the Green and Yampa rivers, the majority of pikeminnow in the San Juan River reside near the area in which they spawn (Ryden and Ahlm 1996, Miller and Ptacek 2000). During their study, Ryden and Ahlm (1996) found that pikeminnow in the San Juan River aggregated at the mouth of the Mancos River prior to spawning, a behavior not documented in other rivers in the upper Colorado River Basin. Miller and Ptacek (2000) also recorded 2 pikeminnow in both 1993 and 1994 at the mouth of the Mancos River prior to the spawning period.

Historical spawning areas for the pikeminnow in the San Juan River are unknown; however, Platania (1990) speculated that spawning likely occurred upstream at least to Rosa, New Mexico. Two locations in the San Juan River have been identified as potential spawning areas based on radio telemetry and visual observations (Ryden and Pfeifer 1994, Miller and Ptacek 2000). Both locations occur within the "Mixer" (RM 133.4 to 129.8), a distinct geomorphic reach of the San Juan River. The upper spawning location is located at RM 132 and the lower spawning location at approximately RM 131.1. Both locations consist of complex habitat associated with cobble bar and island complexes. Habitat at these locations is similar to spawning habitats described for the Yampa River and is composed of side channels, chutes, riffles, slow runs, backwaters, and slackwater areas near bars and islands. Substrate in the riffle areas is clean cobbles, primarily 7.6 to 10.2 centimeters (3 to 4 in) in diameter (Miller and Ptacek 2000). Habitat characteristics at the lower spawning area, based on radio telemetry and visual observations, include a fast narrow chute adjacent to a small eddy.

During 1993, radio-tagged pikeminnow were observed moving to potential spawning locations in the Mixer beginning around July 1. Fish were in the spawning areas from approximately July 12 to July 25. During this period flows in the San Juan River were on the descending limb of the spring runoff. Temperatures increased from approximately 20 to 25°C (68 to 77°F) during the same time period. Observations in other years show a similar pattern. However, specific spawning times and duration of the spawning period appear to vary from year to year. Information on radio-tagged adult pikeminnow during the fall suggests that pikeminnow seek out deep water areas in the Colorado River (Miller et al. 1982, Osmundson and Kaeding 1989), as do many other riverine species. Pools, runs, and other deep water areas, especially in upstream reaches, are important winter habitats for pikeminnow (Osmundson et al. 1995).

On the Green River, tributaries are an important habitat component for pikeminnow (Holden 2000). Both the Yampa River and White River were heavily used by pikeminnow subadults and adults, apparently as foraging areas (Tyus 1991). The tributaries were the primary area of residence to which the adults returned after spawning. Tributaries to the San Juan River no

longer provide habitat for adults because they are dewatered or access is restricted (Holden 2000). Pikeminnow utilized the Animas River in the late 1800s. This river could still provide suitable habitat; however, the present pikeminnow population is downstream from the mouth of the Animas River about 50 miles (Holden 2000). Pikeminnow aggregated at the mouth of the Mancos River prior to spawning in the early 1990s (Ryden and Ahlm 1996, Miller and Ptacek 2000).

Very little information is available on the influence of turbidity on the endangered Colorado River fishes. Osmundson and Kaeding (1989) found that turbidity allows use of relatively shallow habitats ostensibly by providing adults with cover; this allows foraging and resting in areas otherwise exposed to avian or terrestrial predators. Tyus and Haines (1991) found that young pikeminnow in the Green River preferred backwaters that were turbid. Clear conditions in these shallow waters might expose young fish to predation from wading birds or exotic, sight-feeding, piscivorous fish. It is unknown whether the river was as turbid historically as it is today. For now, it is assumed that these endemic fishes evolved under conditions of high turbidity. Therefore, the retention of these highly turbid conditions is probably an important factor in maintaining the ability of these fish to compete with non-natives that may not have evolved under similar conditions.

Population Dynamics

Due to the low numbers of pikeminnow collected in the San Juan River, it is not possible to quantify population size or trends. Estimates during a seven-year research period between 1991 and 1997 suggest that there were fewer than 50 adults in a given year (Ryden 2000a). The ability of the pikeminnow to withstand adverse impacts to its populations and its habitat is difficult to discern given the longevity of individuals and their scarcity within the San Juan River Basin. At this stage of investigations on the San Juan River, the younger life stages are considered the most vulnerable to predation, competition, toxic chemicals, and habitat degradation. The ability of a population to rebound from these impacts may take several years or more.

Between 1991 and 1995, 19 (17 adult and 2 juvenile) wild pikeminnow were collected in the San Juan River by electrofishing (Ryden 2000a). Wild adult pikeminnow were most abundant between RM 142 (the former Cudei Diversion) and Four Corners at RM 119 (Ryden and Ahlm 1996) and they primarily use the San Juan River between these points (Ryden and Pfeifer 1993, 1994, 1995a, 1996). The multi-threaded channel, habitat complexity, and mixture of substrate types in this area of the river appear to provide a diversity of habitats favorable to pikeminnow on a year-round basis (Holden and Masslich 1997).

Successful reproduction was documented in the San Juan River in 1987, 1988, and 1992 through 1996, by the collection of larval and/or YOY pikeminnow. The majority of the YOY pikeminnow were collected in the San Juan River inflow to Lake Powell (Archer et al. 1995, Buntjer et al. 1994, Lashmett 1994, Platania 1990). Some YOY pikeminnow have been collected near the Mancos River confluence, New Mexico and in the vicinity of the Montezuma Creek confluence near Bluff, Utah, and at a drift station near Mexican Hat, Utah (Buntjer et al. 1994,

Snyder and Platania 1995). The collection of larval fish (only a few days old) at Mexican Hat in two different years suggests that perhaps another spawning area for pikeminnow exists somewhere below the Mixer (Platania 1996). Capture of a larval pikeminnow at RM 128 during August 1996 was the first larva collected immediately below the suspected spawning site in the Mixer (Holden and Masslich 1997).

Platania (1990) noted that, during 3 years of studies on the San Juan River (1987 - 1989), spring flows and pikeminnow reproduction were highest in 1987. He further noted catch rates for channel catfish were lowest in 1987. Subsequent studies (Brooks et al. 1994) found declines in channel catfish in 1993; these declines have been attributed to a successive series of higher than normal spring runoffs from 1991 through 1993. Recent studies also found catch rates for YOY pikeminnow to be highest in high water years, such as 1993 (Buntjer et al. 1994, Lashmett 1994).

Tissue samples from pikeminnow caught during research conducted under the SJRRIP have been analyzed as part of a basin-wide analysis of endangered fish genetics. The results of that analysis indicate that the San Juan River fish exhibit less genetic variability than the Green River and Colorado River populations, likely due to the small population size, but were very similar to pikeminnow from the Green, Colorado, and Yampa Rivers (Morizot in litt. 1996). These data suggest that the San Juan population is probably not a separate stock (Holden and Masslich 1997).

Competition and Predation

Pikeminnow in the upper Colorado River Basin live with about 20 species of warm-water non-native fishes (Tyus et al. 1982, Lentsch et al. 1996) that are potential predators, competitors, and vectors for parasites and disease. Backwaters and other low-velocity habitats in the San Juan River are important nursery areas for larval and juvenile pikeminnow (Holden 1999) and researchers believe that non-native fish species limit the success of pikeminnow recruitment (Bestgen 1997, Bestgen et al. 1997, McAda and Ryel 1999). Osmundson (1987) documented predation by black bullhead (*Ameiurus melas*), green sunfish (*Lepomis cyanellus*), largemouth bass (*Micropterus salmoides*), and black crappie (*Pomoxis nigromaculatus*) as a significant mortality factor for YOY and yearling pikeminnow stocked in riverside ponds along the upper Colorado River. Adult red shiners (*Cyprinella lutrensis*) are known predators of larval native fish in backwaters of the upper basin (Ruppert et al. 1993). High spatial overlap in habitat use has been documented among young pikeminnow, red shiner, sand shiner (*Notropis stramineus*), and fathead minnow (*Pimephales promelas*). In laboratory experiments on behavioral interactions, Karp and Tyus (1990) observed that red shiner, fathead minnow, and green sunfish shared activity schedules and space with young pikeminnow and exhibited antagonistic behaviors to smaller pikeminnow. They hypothesized that pikeminnow may be at a competitive disadvantage in an environment that is resource limited.

Channel catfish (*Ictalurus punctatus*) has been identified as a threat to juvenile, subadult, and adult pikeminnow in the San Juan River. Channel catfish were first introduced in the upper Colorado River Basin in 1892 (Tyus and Nikirk 1990) and are now considered common to

abundant throughout much of the upper basin (Tyus et al. 1982, Nelson et al. 1995). The species is one of the most prolific predators in the upper basin and, among the non-native fishes, is thought to have the greatest adverse effect on endangered fishes due to predation on juveniles and resource overlap with subadults and adults (Hawkins and Nesler 1991, Lentsch et al. 1996, Tyus and Saunders 1996). Stocked juvenile and adult pikeminnow that have preyed on channel catfish have died from choking on the pectoral spines (McAda 1983, Pimental et al. 1985). Although mechanical removal (electrofishing, seining) of channel catfish began in 1995, intensive efforts (10 trips/year) did not begin until 2001. Mechanical removal has not yet led to a positive population response in pikeminnow (Davis 2003); however, because the pikeminnow population is so low, documenting a population response would be extremely difficult.

Status and Distribution

The pikeminnow was designated as endangered prior to the Act; therefore, a formal listing package identifying threats was not prepared. Construction and operation of main stem dams, non-native fish, and local eradication of native minnow and suckers in the early 1960s were recognized as early threats (Miller 1961, Holden 1991). The pikeminnow recovery goals (Service 2002a) summarize threats to the species as follows: stream regulation, habitat modification, competition with and predation by non-native fish, and pesticides and pollutants.

Major declines in pikeminnow populations occurred in the lower Colorado River Basin during the dam-building era of the 1930s through the 1960s. Behnke and Benson (1983) summarized the decline of the natural ecosystem, pointing out that dams, impoundments, and water use practices drastically modified the river's natural hydrology and channel characteristics throughout the Colorado River Basin. Dams on the main stem fragmented the river ecosystem into a series of disjunct segments, blocked native fish migrations, reduced water temperatures downstream of dams, created lake habitat, and provided conditions that allow competitive and predatory non-native fishes to thrive both within the impounded reservoirs and in the modified river segments that connect them. The highly modified flow regime in the lower basin coupled with the introduction of non-native fishes decimated populations of native fish.

In the upper Colorado River Basin, declines in pikeminnow populations occurred primarily after the 1960s, when the following dams were constructed: Glen Canyon Dam on the main stem Colorado River, Flaming Gorge Dam on the Green River, Navajo Dam on the San Juan River, and the Aspinall Unit dams on the Gunnison River (Table 3). Some native fish populations in the upper basin have managed to persist, while others are nearly extirpated. River reaches where native fish have declined more slowly, more closely resemble pre-dam hydrologic regimes, where adequate habitat for all life phases still exists, and where migration corridors allow connectivity among habitats used during the various life phases.

A factor not considered when the pikeminnow was listed was water quality. Surface and ground water quality in the Animas, La Plata, Mancos, and San Juan River drainages have become concerns in recent years (Abell 1994). Changes in water quality and contamination of associated biota are known to occur in Reclamation projects in the San Juan drainage (i.e., irrigated lands on

the Pine and Mancos Rivers) where return flows from irrigation make up a portion of the river flow (Sylvester et al. 1988). Increased loading of the San Juan River and its tributaries with heavy metals; elemental contaminants such as selenium, salts, polycyclic aromatic hydrocarbons (PAHs); and pesticides has degraded water quality of the San Juan River in critical habitat (Abell 1994, Wilson et. al. 1995, Holden 1999).

Razorback Sucker

Like all suckers (family Catastomidae, meaning "down mouth"), the razorback sucker has a ventral mouth with thick lips covered with papillae and no scales on its head. In general, suckers are bottom browsers, sucking up or scraping off small invertebrates, algae, and organic matter with their fleshy, protrusible lips (Moyle 1976). The razorback sucker is the only sucker with an abrupt sharp-edged dorsal keel behind its head. The keel becomes more massive with age. The head and keel are dark, the back is olive-colored, the sides are brownish or reddish, and the abdomen is yellowish white (Sublette et al. 1990). Adults often exceed 3 kg (6 lbs) in weight and 600 mm (2 ft) in length. Like pikeminnow, razorback suckers may live 40-plus years.

Historically, razorback suckers were found in the main stem Colorado River and major tributaries in Arizona, California, Colorado, Nevada, New Mexico, Utah, Wyoming, and in Mexico (Ellis 1914; Minckley 1983). Bestgen (1990) reported that this species was once so numerous that it was commonly used as food by early settlers and that a commercially marketable quantity was caught in Arizona as recently as 1949. In the upper Colorado River Basin, razorback suckers were reported to be very abundant in the Green River near Green River, Utah, in the late 1800s (Jordan 1891). An account in Osmundson and Kaeding (1989) reported that residents living along the Colorado River near Clifton, Colorado, observed several thousand razorback suckers during spring runoff in the 1930s and early 1940s. In the San Juan River drainage, the first documented razorback sucker from the river was documented in 1988 (Platania 1990); however, two adults were also collected from an irrigation pond attached to the river by a canal in 1976 (Platania 1990) and it is very likely that razorback sucker once occurred in the main stem as far upstream as Rosa, New Mexico (Ryden 1997).

A marked decline in populations of razorback suckers can be attributed to construction of dams and reservoirs, introduction of non-native fishes, and removal of large quantities of water from the Colorado River system. Dams on the main stem Colorado River and its major tributaries have fragmented populations and blocked migration routes. Dams also have drastically altered flows, water temperatures, and channel geomorphology. These changes have modified habitats in many areas so that they are no longer suitable for breeding, feeding, or sheltering. Major changes in species composition have occurred due to the introduction of non-native fishes, many of which have thrived due to man-induced changes to the natural riverine system. Habitat has been significantly degraded to a point where it impairs the essential life history functions of razorback sucker, such as reproduction and recruitment into the adult population.

On March 14, 1989, the Service was petitioned to conduct a status review of the razorback sucker. Subsequently, the razorback sucker was designated as endangered under a final rule published on October 23, 1991 (Service 1991). The final rule stated that "Little evidence of

natural recruitment has been found in the past 30 years, and numbers of adult fish captured in the last 10 years demonstrate a downward trend relative to historic abundance. Significant changes have occurred in razorback sucker habitat through diversion and depletion of water, introduction of non-native fishes, and construction and operation of dams" (Service 1994). Recruitment of larval razorback suckers to juveniles and adults continues to be a problem.

Critical habitat was designated in 1994, within the 100-year flood plain of the razorback sucker's historical range in the following area of the upper Colorado River (Service 1994).

> New Mexico, San Juan County; and Utah, San Juan County. The San Juan River from the Hogback Diversion in T. 29 N., R. 16 W., section 9 to the full pool elevation at the mouth of Neskahai Canyon on the San Juan arm of Lake Powell in T. 41 S., R. 11 E., section 26.

The primary constituent elements of critical habitat are the same as those described earlier for pikeminnow.

Life History

McAda and Wydoski (1980) and Tyus (1987) reported springtime aggregations of razorback suckers in off-channel habitats and tributaries; such aggregations are believed to be associated with reproductive activities. Tyus and Karp (1990) and Osmundson and Kaeding (1991) reported off-channel habitats to be much warmer than the main stem river and that razorback suckers presumably moved to these areas for feeding, resting, sexual maturation, spawning, and other activities associated with their reproductive cycle.

While razorback suckers have never been directly observed spawning in turbid riverine environments within the upper Colorado River Basin, captures of ripe specimens, both males and females, have been recorded in the Yampa, Green, Colorado, and San Juan Rivers (Valdez et al. 1982, McAda and Wydoski 1980, Tyus 1987, Osmundson and Kaeding 1989, Tyus and Karp 1989, Tyus and Karp 1990, Osmundson and Kaeding 1991, Platania 1990, Ryden 2000b). Because of the relatively steep gradient in the San Juan River and lack of a wide flood plain, razorback sucker are likely spawning in low velocity, turbid, main channel habitats. Aggregations of ripe adults have been documented in two locations. The capture of larval razorback sucker approximately 48 km (30 mi) upstream from the other sites suggests a third spawning location (Ryden, Service, in litt. 2004).

Sexually mature razorback suckers are generally collected on the ascending limb of the hydrograph from mid-April through June and are associated with coarse gravel substrates. Both sexes mature as early as age four (McAda and Wydoski 1980). Fecundity, based on ovarian egg counts, ranges from 75,000-144,000 eggs (Minckley 1983). McAda and Wydoski (1980) reported an average fecundity (N=10) of 46,740 eggs/fish (27,614–76,576). Several males attend each female; no nest is built. The adhesive eggs drift to the bottom and hatch there (Sublette et al. 1990). Marsh (1985) reported that, in laboratory experiments, the percentage of egg hatch

was greatest at 20°C (68°F) and all embryos died at incubation temperatures of 5, 10, and 30°C (41, 50, and 86°F).

Because young and juvenile razorback suckers are rarely encountered, their habitat requirements in the wild are not well known, particularly in native riverine environments. However, it is assumed that low-velocity backwaters and side channels are important for YOY and juveniles, as it is to the early life stages of most riverine fish. Prior to construction of large main stem dams and the suppression of spring peak flows, low velocity, off-channel habitats (seasonally flooded bottomlands and shorelines) were commonly available throughout the upper Colorado River Basin (Tyus and Karp 1989, Osmundson and Kaeding 1991). Modde (1996) found that on the Green River, larval razorback suckers entered flooded bottomlands that are connected to the main channel during high flow. However, as mentioned earlier, because of the relatively steep gradient of the San Juan River and the lack of a wide flood plain, flooded bottomlands are probably much less important in this system than are other low velocity habitats such as backwaters and secondary channels (Ryden, Service, in litt. 2004).

Reduction in spring peak flows eliminates or reduces the frequency of inundation of off-channel and bottomland habitats. The absence of these seasonally flooded riverine habitats is believed to be a limiting factor in the successful recruitment of razorback suckers in other upper Colorado River streams (Tyus and Karp 1989, Osmundson and Kaeding 1991). Wydoski and Wick (1998) identified starvation of larval razorback suckers due to low zooplankton densities in the main channel and loss of floodplain habitats that provide adequate zooplankton densities for larval food as one of the most important factors limiting recruitment. Maintaining low velocity habitats is important for the survival of larval razorback suckers.

Outside of the spawning season, adult razorback suckers occupy a variety of shoreline and main channel habitats including slow runs, shallow to deep pools, backwaters, eddies, and other relatively slow velocity areas associated with sand substrates (Tyus 1987, Tyus and Karp 1989, Osmundson and Kaeding 1989, Valdez and Masslich 1989, Osmundson and Kaeding 1991, Tyus and Karp 1990). The diet consists primarily of algae, plant debris, and aquatic insect larvae (Sublette et al. 1990).

Population Dynamics

Because wild razorback sucker are rarely encountered and they are a long-lived fish, it is difficult to determine natural fluctuations in the population. The existing scientific literature and historic accounts by local residents strongly suggest that razorback suckers were once a viable, reproducing member of the native fish community in the San Juan River drainage. Currently, razorback sucker is rare throughout its historic range and extremely rare in the main stem San Juan River. Until 2003, there was very limited evidence indicating natural recruitment to any population of razorback sucker in the Colorado River system (Bestgen 1990, Platania 1990, Platania et al. 1991, Tyus 1987, McCarthy and Minckley 1987, Osmundson and Kaeding 1989, Modde et al. 1996). In 2003, two juvenile (age-2) razorback sucker, 249 and 270 mm (9.8 and

10.6 in), thought to be wild-produced from stocked fish were collected in the lower San Juan River (RM 35.7 and 4.8) (Ryden, Service, in litt., 2004).

Competition and predation

Many species of non-native fishes occur in occupied habitat of the razorback sucker. These non-native fishes are predators, competitors, and vectors of parasites and diseases (Tyus et al. 1982, Lentsch et al. 1996, Pacey and Marsh 1999, Marsh et al. 2001). Many researchers believe that non-native species are a major cause for the lack of recruitment and that non-native fish are the most important biological threat to the razorback sucker (e.g., McAda and Wydoski 1980, Minckley 1983, Tyus 1987, Service 1998, Muth et al. 2000). There are reports of predation of razorback sucker eggs and larvae by common carp (*Cyprinus carpio*), channel catfish, smallmouth bass (*Micropterus dolomieui*), largemouth bass, bluegill (*Lepomis macrochirus*), green sunfish, and red-ear sunfish (*Lepomis microlophus*) (Jonez and Sumner 1954, Marsh and Langhorst 1988, Langhorst 1989). Marsh and Langhorst (1988) found higher growth rates in larval razorback sucker in the absence of predators in Lake Mohave, and Marsh and Brooks (1989) reported that channel catfish and flathead catfish were major predators of stocked razorback sucker in the Gila River. Juvenile razorback sucker (average total length 171 mm [6.7 in]) stocked in isolated coves along the Colorado River in California, suffered extensive predation by channel catfish and largemouth bass (Langhorst 1989). Aggressive behavior between channel catfish and adult razorback sucker has been inferred from the presence of distinct bite marks on the dorsal keels of four razorback suckers that match the bite characteristics of channel catfish (Ryden, Service, in litt. 2004).

Lentsch et al. (1996) identified six species of non-native fishes in the upper Colorado River Basin as threats to razorback sucker: red shiner, common carp, sand shiner, fathead minnow, channel catfish, and green sunfish. Smaller fish, such as adult red shiner, are known predators of larval native fish (Ruppert et al. 1993). Large predators, such as walleye (*Stizostedion vitreum*), northern pike, and striped bass (*Morone saxatilis*), also pose a threat to subadult and adult razorback sucker (Tyus and Beard 1990).

Status and Distribution

Currently, the largest concentration of razorback sucker remaining in the Colorado River Basin is in Lake Mohave. Estimates of the wild stock in Lake Mohave have fallen precipitously in recent years from 60,000 as late as 1991, to 25,000 in 1993 (Marsh 1993, Holden 1994), to about 9,000 in 2000 (Service 2002b). Until recently, efforts to introduce young razorback sucker into Lake Mohave have failed because of predation by non-native species (Minckley et al. 1991, Clarkson et al. 1993, Burke 1994). While limited numbers of razorback suckers persist in other locations in the Lower Colorado River, they are considered rare or incidental and may be continuing to decline.

In the upper Colorado River Basin, above Glen Canyon Dam, razorback suckers are found in limited numbers in both lentic (lake-like) and riverine environments (Table 3). The largest

populations of razorback suckers in the upper basin are found in the upper Green and lower Yampa Rivers (Tyus 1987). Lanigan and Tyus (1989) estimated a population of 948 adults (95 percent confidence interval: 758 to 1,138) in the upper Green River. Eight years later, the population was estimated at 524 adults (95 percent confidence interval: 351-696) and the population was characterized as stable or declining slowly with some evidence of recruitment (Modde et al. 1996). They attributed this suspected recruitment to unusually high spring flows during 1983–1986 that inundated portions of the floodplain used as nurseries by young. In the Colorado River, most razorback suckers occur in the Grand Valley area near Grand Junction, Colorado; however, they are increasingly rare. Osmundson and Kaeding (1991) reported that the number of razorback sucker captures in the Grand Junction area has declined dramatically since 1974. Between 1984 and 1990, intensive collecting effort captured only 12 individuals in the Grand Valley (Osmundson and Kaeding 1991). The wild population of razorback sucker is considered extirpated from the Gunnison River (Burdick and Bonar 1997).

Scientifically documented records of wild razorback sucker adults in the San Juan River are limited to two fish captured in a riverside pond near Bluff, Utah in 1976, and one fish captured in the river in 1988, also near Bluff (Platania 1990). Large numbers were anecdotally reported from a drained pond near Bluff in 1976, but no specimens were preserved to verify the species. No wild razorback sucker were found during the 7-year research period (1991-1997) of the SJRRIP (Holden 1999). Hatchery-reared razorback sucker, especially fish greater than 350 mm (13.8 in), introduced into the San Juan River in the 1990s have survived and reproduced, as evidenced by recapture data and collection of larval fish (Ryden 2000b).

Razorback suckers are in imminent danger of extirpation in the wild. The razorback sucker was listed as endangered October 23, 1991 (Service 1991). As Bestgen (1990) pointed out:

> Reasons for decline of most native fishes in the Colorado River Basin have been attributed to habitat loss due to construction of mainstream dams and subsequent interruption or alteration of natural flow and physio-chemical regimes, inundation of river reaches by reservoirs, channelization, water quality degradation, introduction of non-native fish species and resulting competitive interactions or predation, and other man-induced disturbances (Miller 1961, Joseph et al. 1977, Behnke and Benson 1983, Carlson and Muth 1989, Tyus and Karp 1989). These factors are almost certainly not mutually exclusive, therefore it is often difficult to determine exact cause and effect relationships.

The razorback sucker recovery goals identified streamflow regulation, habitat modification, predation by non-native fish species, and pesticides and pollutants as the primary threats to the species (Service 2002b). Within the upper Colorado River Basin, recovery efforts include the capture and removal of razorback suckers from all known locations for genetic analyses and development of brood stocks. In the short term, augmentation (stocking) may be the only means to prevent the extirpation of razorback sucker in the upper Colorado River Basin. However, in the long term it is expected that natural reproduction and recruitment will occur. A genetics management plan and augmentation plan have been written for the razorback sucker (Crist and Ryden 2003).

Summary of status and distribution for both razorback sucker and pikeminnow

Pikeminnow and razorback sucker remain in danger of extinction in the wild. Both fish species evolved in large, unregulated river systems that have been modified by human activities. Dams have inundated habitat, blocked movements, changed water temperature and river morphology, altered flow regimes, trapped sediment, and enabled non-native species to flourish (Service 1998). Despite concerted efforts to recover populations, the long-term prognosis for both pikeminnow and razorback sucker remains unknown. Rangewide, progress toward pikeminnow recovery has occurred in the Yampa and Green Rivers. On the San Juan, spawning by razorback sucker has been recorded every year since 1998 (Ryden 2003c, Brandenburg and Farrington 2005). Capture of two juvenile razorback suckers in 2003, and one in 2004, was the first indication of recruitment to the population in the San Juan River (Ryden and McAda 2005b). Recruitment to reproductive age remains limited for all populations. On the San Juan River both species have been stocked, individuals have persisted, and in 2004, catch per unit effort for both species was the highest recorded (Ryden and McAda 2005a, 2005b). Larval pikeminnow have been documented in the San Juan River, indicating that spawning is occurring.

Environmental baseline

The Environmental Baseline includes the past and present impacts of all Federal, State, and private actions and other human activities in the action area; the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal section 7 consultation; and the impact of State or private actions contemporaneous with the consultation process. All projects previously built or consulted on, and those State or private projects presently being built or considered that deplete water from the San Juan River Basin are in the Environmental Baseline for this proposed action. The baseline does not include the effects of the action under review, only actions that have occurred previously. (See page 46 for further explanation of future effect.)

Although the San Juan River was once a relatively small portion of the overall range of these species, the importance of this river to the species' populations has increased with the extensive loss of habitat from the lower Colorado River Basin. In this section we discuss the status of the species in the action area and factors affecting these species and their critical habitat. This includes dams and their effects on the riverine habitat, water quality, propagation programs for the species, water depletions, diversion structures, and non-native species.

The Environmental Baseline consists of discrete hydrological periods of time; pre-dam (pre 1962), post-dam but pre-Flow Recommendations (1962-1991), 7-year research period (1991-1997), and post-Flow Recommendations (1999-date of this BO). The pre-dam era includes all years prior to the closure of Navajo Dam in 1962. The pre-Flow Recommendations era extends from the closure of Navajo Dam until 1991, when experimental flows were initiated. The 1991 to 1997 period is the 7-year research period, when physical habitat changes were investigated with implemented experimental flows. During the 7-year research period, the hydrologic regime

was analogous to the flows recommended as the final 1999 Flow Recommendations. From 1999 to the date of this BO is considered the post-Flow Recommendations period. During this period, Reclamation met the flow criteria through critical habitat and only deviated from the proposed action by not reducing Navajo Dam releases to 250 cfs when conditions would have allowed. Table 4 shows these time lines with respect to some of the factors affecting the razorback and pikeminnow.

Status of the species within the action area

Colorado pikeminnow

Platania and Young (1989) summarized historic fish collections in the San Juan River drainage that indicate that pikeminnow once inhabited reaches above what is now the Navajo Dam and Reservoir near Rosa, New Mexico. Lake Powell and Navajo Reservoir resulted in the direct loss of approximately 161 km (100 mi) of San Juan River habitat for the two endangered fishes (Holden 2000). Since closure of Navajo Dam in 1963, the accompanying fish eradication program, physical changes associated with the dam, and barriers to movement, wild pikeminnow have been eliminated from the upper San Juan River upstream of Navajo Dam. The 10 km (6.2 mi) below the dam are essentially sediment free, resulting in the clearest water of any reach (Miller and Ptacek 2000). The cool, clear water has allowed development of an intensively managed blue-ribbon trout fishery to the exclusion of the native species (Miller and Ptacek 2000).

Between 1987 and 1996, no wild pikeminnow adults were caught above Shiprock (approximately RM 150). Radio telemetry studies conducted from 1991 to 1995 indicated that pikeminnow remained within a relatively small area of the river, between RM 110 to RM 142 (Holden 2000). The removal of the diversion at Cudei (RM 142), construction of non-selective fish passage at the Hogback diversion (158.6) and the completion of the PNM (RM 166.1) selective fish passage ladder in 2003 has restored fish access to about 36 miles of critical habitat on the San Juan River for pikeminnow. In 2004, 5 pikeminnow (226-250 total length [8.9-9.8 in]) were caught in the lower few miles of the Animas River (Ryden and McAda 2005). These fish were all age-2 that had been stocked in June 2004 about 0.3 RMs downstream of the Animas River confluence (Ryden and McAda 2005). During the seven-year research period (1991 to 1997) it was estimated that there were fewer than 50 adults in the San Juan River in any given year (Ryden 2000a).

Razorback sucker

From 1991 to 1997, no wild adult razorback suckers were collected in the San Juan River and only one was caught during studies conducted in the late 1980s (Holden 2000). Beginning in May 1987, and continuing through October 1989, complementary investigations of fishes in the San Juan River were conducted in Colorado, New Mexico, and Utah (Platania 1990, Platania et al. 1991). In 1987, a total of 18 adult razorbacks were collected (six were recaptured once) on the south shore of the San Juan arm of Lake Powell (Platania 1990, Platania et al. 1991). These fish were captured near a concrete boat ramp at Piute Farms Marina and were believed to be either a spawning aggregation or possibly a staging area used in preparation for migration to a

spawning site. Of the 12 razorback suckers handled in 1987, 8 were ripe (expressing milt) males while the other 4 specimens were females that appeared gravid.

In 1988, a total of 10 razorback suckers were handled at the same general location, 5 of which were in reproductive condition (Platania et al. 1991). Six of the 10 individual specimens in the 1988 samples were recaptures from 1987. Also in 1988, a single adult tuberculate male razorback sucker was captured in the San Juan River near Bluff, Utah (RM 80) (Platania 1990, Platania et al. 1991). This was the first confirmed record of this species from the main stem San Juan River. The presence of this reproductively mature specimen suggested that razorback suckers were attempting to spawn within the riverine portion of the San Juan drainage. However, no wild razorback suckers have been collected on the San Juan River since 1988 (Ryden, Service, pers. comm. 2002). A Schnabel multiple-census population model estimated that there were 268 razorback suckers in the San Juan River from RM 158.6 to 2.9 in October 2000 (Ryden 2001). This population estimate refers to stocked razorback sucker.

Factors Affecting Species Environment within the Action Area

The San Juan River is a tributary to the Colorado River and drains a basin of approximately 25,000 mi^2 (65,000 km^2) located in Colorado, New Mexico, Utah, and Arizona (Reclamation 2003). From its origins in the San Juan Mountains of southwestern Colorado (at an elevation exceeding 13,943 ft) (4,250 m), the river flows westward through New Mexico, Colorado, and into Lake Powell, Utah. The majority of water that feeds the 345 mi (570 km) of river is from the mountains of Colorado. From a water resources perspective, the area of influence for the proposed project begins at the inflow areas of Navajo Reservoir, and extends west from Navajo Dam approximately 224 mi (359 km) along the San Juan River to Lake Powell. The dam is operated and maintained by Reclamation (Reclamation 2003). The major perennial tributaries in the project area are the Los Pinos, Piedra, Navajo, Animas, La Plata, and Mancos Rivers, and McElmo Creek. There are also numerous ephemeral arroyos and washes that contribute little flow to the San Juan River, but large sediment loads.

As recognized in the Draft Environmental Impact Statement for Navajo Reservoir Operations (Reclamation 2002) (DEIS), changes in biodiversity associated with the historical San Juan River occurred when Navajo Dam was placed into operation. The reservoir physically altered the San Juan River and surrounding terrain and modified the pattern of flows downstream. Similar to rivers downstream of other dam operations in the southwestern United States, the San Juan River downstream of the dam became clearer due to sediment retained in the reservoir, and the water became colder, because it is released from a deep pool of water. The DEIS states that all species of plants and animals that existed along the river channel were affected to varying degrees. The disruption of natural patterns of flow caused changes to the vegetation along the river banks by altering the previously established conditions under which the plants reproduced and survived.

Navajo Dam regulates river flows, provides flood control and contributes to recreational and fishery activities (Reclamation 2002). In addition to the changes caused to the river by dam operations, the DEIS (Reclamation 2002) recognized that there were changes to how the lands in

the area were used. Irrigation water provided by Navajo Dam contributed to agriculture being practiced on a large scale. The reservoir stores water for the Navajo Indian Irrigation Project (Consultations #2-22-91-F-241, #2-22-92-F-080, and #2-22-99-F-381), the Hammond Irrigation Project, and various municipal and industrial uses making it possible to nearly double the amount of irrigation in the basin. At the present time, the Navajo Indian Irrigation Project diverts an annual average of approximately 160,000 af from the reservoir for irrigation south of Farmington (Reclamation 2002). In the future, this use is expected to approximately double (Reclamation 2002). This will further affect the river and the native species dependent on the river both directly, through flow diversions, and indirectly, through changes in water quality, as a result of the water acquiring salts, pesticides, and fertilizers from the irrigated lands' return flows to the river (Reclamation 2002).

In addition to the effects of operating Navajo Dam, over the last century, the San Juan River has experienced diversions for municipal use, resulting in a variety of return flows to the river, including industrial waste, stormwater runoff, and discharges from sewage treatment plants. Compounding these changes has been the appearance of non-native species of fish and plants, creating competition with native species (Reclamation 2002).

Although there are impacts to the river ecosystem from dam construction itself, dams have many impacts that continue after the structure is complete. Dams affect the physical, chemical, and biological components of a stream ecosystem (Williams and Wolman 1984, Collier et al. 1996, Service 1998, Mueller and Marsh 2002). Some of these effects include a change in water temperature, a reduction in lateral channel migration, channel scouring, blockage of fish passage, transformation of riverine habitat into lake habitat, channel narrowing, changes in the riparian community, diminished peak flows, changes in the timing of high and low flows, and a loss of connectivity between the river and its flood plain (e.g., Sherrard and Erskine 1991, Power et al. 1996, Kondolf 1997, Polzin and Rood 2000, Collier et al. 2000, Shields et al. 2000). Of these, change in water temperature, blockage of fish passage, transformation of riverine habitat into lake habitat, changes in the timing and magnitude of high and low flows, and changes in channel morphology are discussed later in the document in greater detail.

Water temperature

The cold water below Navajo Dam limits the potential spawning habitat of the endangered fishes in the San Juan River. Prior to dam construction water temperatures at Archuleta (approximately 10 km [6.1 mi] below the dam) were above the threshold spawning temperature of 20° C (68° F) for approximately 2 months (Holden 1999). Since dam construction, water temperature is rarely over 15° C (59° F) and is too cold for successful pikeminnow spawning (Holden 1999, Miller, SJRRIP Biology Committee, pers. comm. 2004). The threshold temperatures for spawning at Shiprock (approximately 125 km [78 mi] below the dam) occur about 2 weeks later on average than pre-dam (Holden 1999). Consequently, spawning is unlikely to occur from Navajo Dam to the confluence of the Animas River (approximately 72 km [45 mi] below the dam) and would be delayed for two weeks or more from the confluence with the Animas River down to Shiprock.

Water temperatures at Shiprock before the construction of Navajo Dam were above 20° C (68° F) from approximately mid-June until mid-September (three months) (Holden 1999). Projected temperatures at Shiprock from 1993-1996, during a portion of the 7-year research period, were above 20° C (68° F) for more than one month (August) (Holden 1999). Because fish are cold-blooded, their metabolism and growth depend on water temperature. The amount of food eaten, assimilation efficiency, and time to sexual maturity are affected by temperature (Lagler et al. 1977). Cold water typically decreases food consumption, decreases assimilation efficiency, decreases growth rate, and increases the time to sexual maturity (Lagler et al. 1977). Development time of pikeminnow and razorback sucker embryos is inversely related to temperature and survival is reduced at temperatures that depart from 20° C (68° F) (Bulkley et al. 1981, Hamman 1982). Marsh (1985) found that for razorback suckers, time to peak hatch was 216 hours (9 days) at 15° C (59° F) and 84 hours (3.5 days) at 25° C (77° F) and that the percent of eggs hatched was highest at 20° C (68° F). All the pikeminnow eggs tested died at incubation temperatures of 15° C (59° F) or lower (Marsh 1985). Marsh (1985) concluded that his results indicated that survival and hatching success were maximized near 20° C (68° F). Reducing the number of days water temperature is near 20°C (68°F) is expected to have a negative impact on the hatching success and growth of razorback sucker and pikeminnow.

Because the combination of a suitable spawning bar (an area of sediment-free cobbles) and suitable temperatures occur downstream on the San Juan (at the Mixer [RM 133.4 to RM 129.8]), there is a greater chance that larval fish will drift into Lake Powell and be lost from the population. Dudley and Platania (2000) found, based on a neutral buoyancy bead study, that drifting larval pikeminnow would be transported from the Mixer to Lake Powell in as little as three days. For those larval fish not carried into Lake Powell, a delay in spawning (which reduces the amount of time YOY have to grow before winter) and overall colder water temperatures (resulting in slower growth) could lead to smaller, less fit YOY, and reduce survival. While this reasoning is biologically sound, because there are so few pikeminnow in the San Juan River, the consequences of lower water temperatures on survival and recruitment of pikeminnow have not been tested for this river. There is speculation that the large volume of cold water in the upper Green River may be a major reason why larval pikeminnow drift so far downstream (Holden 2000). The same pattern may also occur on the San Juan River.

In conclusion, cold water released from Navajo Dam has the following effects on razorback sucker and pikeminnow; water temperatures that were once suitable for spawning for pikeminnow near Archuleta are no longer suitable; and, if spawning were to occur near Shiprock, it would be delayed by approximately 2 weeks compared to pre-dam. A delay in spawning reduces the amount of time that larval fish have to grow before winter.

Blockage of fish passage

Like other major dams on the Colorado River and its tributaries, Navajo Dam blocked all fish passage. While native fish once could move unimpeded from the San Juan River into the Colorado River and its tributaries, they are now confined to a relatively short reach of 362 km (225 mi) between Lake Powell and Navajo Dam. If adverse conditions occur (extreme low flow, extreme high flow, unfavorable temperatures or water quality) the fish can not escape or seek

refuge in the Colorado River as they once could. Razorback sucker and pikeminnow that may have been trapped above the reservoir have all died or were killed during treatment with rotenone (Olson 1962, Holden 1999). In addition to the major dams, diversion structures constructed in the San Juan River have also created barriers to fish passage.

Ryden and Pfeifer (1993) identified five diversion structures between Farmington, New Mexico, and the Utah state line that potentially acted as barriers to fish passage at certain flows (Cudei, Hogback, Four Corners Power Plant, San Juan Generating Station (PNM weir), and Fruitland Irrigation Canal diversions). When radio telemetry studies were initiated on the San Juan River in 1991, only one radio-tagged pikeminnow was recorded moving upstream past one of the diversions. In 1995, an adult pikeminnow moved above the Cudei Diversion and then returned back downstream (Miller and Ptacek 2000). Other native fish had been found to move either upstream or downstream over all five of the weirs (Buntjer and Brooks 1997, Ryden 2000a). In 2001, Cudei Diversion (RM 142) was removed from the river and Hogback Diversion (previously an earth and gravel berm structure), which had to be rebuilt every year, was made into a permanent structure with non-selective fish passage. Channel catfish that were tagged downstream of the Hogback Diversion in spring and summer 2002 were recaptured upstream of the structure in summer and fall, 2002 (Davis, Service, pers.comm., 2002). It is highly likely that pikeminnow, razorback sucker, and other native fishes can negotiate the ladder. The removal of Cudei Diversion and installation of the fish ladder at Hogback Diversion improved access for native fishes over a 24.5 mile reach of river.

Until 2003, the PNM weir (RM 166) was also a barrier to fish passage. Thanks to funding and technical assistance from the SJRRIP and operation and maintenance by the Navajo Nation, the PNM selective fish ladder was completed and has been operational since 2003. This has allowed passage past that structure by pikeminnow and razorback suckers. Between June and December 2003, 17,394 native fish used the passage including 9 pikeminnow and 4 razorback suckers (LaPahie, 2003). However, the Four Corners Power Plant (Arizona Public Service) Diversion at RM 163.3 can act as a fish barrier when the control gate for the structure is closed (Masslich and Holden 1996). Above the PNM weir, the Fruitland Irrigation Canal Diversion (RM 178.5) may block pikeminnow access during flows less than 2,000 cfs (typical for July-September). Fish may pass through a sluiceway during higher flows and during the winter at low flows when the sluice gates are left open (Masslich and Holden 1996).

Dams have fragmented razorback sucker and pikeminnow habitat throughout the Colorado River system. Within the San Juan River, fish passage was once impeded by five instream structures. One of these structures has been removed, two have been equipped with fish passage structures, and two remain as impediments to fish passage for part of the year depending on flow. However, no remaining structures are complete barriers within critical habitat. Pikeminnow and razorback sucker can potentially navigate from Lake Powell, past the Animas River, up to the Hammond Diversion Dam, a total of approximately 338 km (210 mi).

Transformation of riverine into lake habitat

Lake Powell inundated the lower 87 km (54 mi) of the San Juan River and Navajo Reservoir inundated another 43 km (27 mi). The two reservoirs reduced the potential range and habitat for the two endangered fishes from about 523 km (325 mi) to 362 km (225 mi) and inundated potential pikeminnow spawning areas in the upper San Juan River (Holden 2000). Although the loss of habitat is substantial, several other problems for native fishes resulted from the creation of lakes. The larvae of razorback sucker and pikeminnow drift downstream until they find suitable nursery habitat (backwaters or other low velocity areas) (Holden 2000). Because the river has been truncated 87 km (54 mi) on the lower end, there are many fewer stream miles available for nursery habitat. Some pikeminnow in the Green and Colorado River systems drift up to 322 km (200 mi) from spawning areas before finding nursery habitat, while others use nursery areas only a few miles below the spawning areas (Trammell and Chart 1999). The majority of YOY pikeminnow that have been collected in the San Juan River have been at the inflow to Lake Powell (Buntjer et al. 1994, Lashmett 1994, Archer et al. 1995, Platania 1996). Because of the many predators present and lack of suitable habitat, it is unlikely that larvae survive in Lake Powell.

In 1961, prior to the filling of Navajo Dam, New Mexico Department of Game and Fish used rotenone "to eliminate trash fish species" from the Pine River (24 km [15 mi]), the Navajo River (9.6 km [6 mi]), and the San Juan River (120 km [75 mi]) (Olson 1962). Fourteen species of fish were eliminated in the treated section of river (Olson 1962). There were three drip stations on the San Juan River that effectively killed the majority of the fish from the Colorado state line, near Rosa, New Mexico, down to Fruitland, approximately 64 km (40 mi) below Navajo Dam (Olson 1962). Included in the list of fish eliminated was pikeminnow (Olson 1962). The number of fish killed was not recorded because of the large scale of the project (Olson 1962). The intent of the project was to reduce (eliminate) competition and predation between native fish and the non-native trout fishery that was to be established.

Lake Powell is populated by several fish species not native to the Colorado River that are predators on native fish. As mentioned earlier, larval native fish that drift into Lake Powell are almost certainly lost to predation by largemouth bass, smallmouth bass, striped bass, walleye, or crappie (*Pomoxis* sp.). Striped bass migrates up the San Juan River as far upstream as the PNM weir (RM 166) in some years (Davis 2003). Adult striped bass are piscivorous (Moyle 1976). In 2000, 432 striped bass were captured during monitoring trips for pikeminnow and during trips to remove non-native fishes (Davis 2003). The contents of 38 stomachs were analyzed and native suckers were found in 41 percent (Davis 2003). This migratory predator is a threat to both YOY and juvenile native fish.

In conclusion, the transformation of riverine habitat into lake habitat had the following impacts on razorback sucker and pikeminnow:

1) Approximately 128 km (80 mi) of river was inundated and no longer provide suitable habitat for both fish with the exception of adult razorback sucker, which can use portions of Lake Powell (Platania et al. 1991).

2) Nursery habitat for both species was inundated when Lake Powell was created (and filled).
3) The emphasis of fisheries management shifted to game fish production. Consequently riverine habitat that supported native fish, including razorback sucker and pikeminnow, was treated with rotenone (after Navajo Dam was constructed) so that game fish production in the reservoirs could be promoted (Olson 1962, Holden 1991, Quartarone and Young 1995).
4) Non-native game fish were stocked in Lake Powell and Navajo Reservoir. Non-native fish are believed to limit the success of pikeminnow and razorback sucker recruitment and are considered biological threats to the species (McAda and Wydoski 1980, Minckley 1983, Osmundson 1987, Tyus 1987, Ruppert et al. 1993, Bestgen 1997, Bestgen et al. 1997, Service 1998, McAda and Ryel 1999, Muth et al. 2000).

Changes in the timing and magnitude of flows

Typical of rivers in the Southwest, the San Juan was originally characterized by large spring snowmelt peak flows, low summer and winter base flows, and high-magnitude, short-duration summer and fall storm events (Holden 1999) (Figure 2). Historically, flows in the San Juan River were highly variable and ranged from a low of 44 cfs in September 1956, to a high of 19,790 cfs in May 1941 (mean monthly values) at the U.S. Geological Survey (USGS) Station gauge near Shiprock, New Mexico. The flows for this period of time do not necessarily represent a "natural" condition because water development began in the basin near the turn of the century and many irrigation projects that diverted and depleted water from the San Juan River were already in place. For the 49 years of record prior to Navajo Dam a peak spring flow greater than 15,200 cfs occurred 13 times (25 percent of the time). The highest spring peak flow recorded (daily mean) was 52,000 cfs (June 30, 1927).

The completion of Navajo Dam in 1962, and subsequent dam operations through 1991, altered the natural hydrograph of the San Juan River substantially (Holden 1999). There was an appreciable reduction in the magnitude, and a change in timing of the annual spring peak. In wet years, dam releases began early to create space in the reservoir to store runoff (Holden 1999). The peak discharge averaged 54 percent of the spring peak of pre-dam years. The highest mean monthly flow was 9,508 cfs (June 1979), a decrease of more than 10,000 cfs compared to pre-dam years. Base flows were substantially elevated in comparison to pre-dam years. The median monthly flow for the base flow months (August-February) averaged 168 percent of the pre-dam period (Holden 1999). Minimum flows were elevated and periods of near-zero flow were eliminated with a minimum monthly flow during base-flow periods of 250 cfs compared to 65 cfs for the pre-dam period (Holden 1999). The hydrograph was flatter during this time period (Figure 2).

During the 1991 to 1997 research period, flows were manipulated by Reclamation in coordination with the SJRRIP to determine fish population and habitat responses when Navajo Dam was operated to mimic a natural hydrograph (Holden 1999). Thanks to Reclamation's flexibility in managing flows and the technical input from the SJRRIP this period of

experimental flow manipulations allowed researchers an opportunity to develop flow recommendations. A more natural hydrograph was maintained during this period (1991 to 1997) of experimental flows. The research flow period was more similar to the years that followed (1998 to present) than they were prior to 1991. For this reason, the years from 1991 to present were used to analyze the effects of the Flow Recommendations on physical habitat and endangered fish populations.

Since the Flow Recommendations were published (Holden 1999), Navajo Dam has been operated to meet them. A natural hydrograph has been mimicked, although the pre-Navajo Dam peak magnitudes are no longer possible because of outlet restrictions at the dam (Figure 2). Although higher peak flows could be beneficial in maintenance of desirable channel morphology, it is also possible that because the river is truncated by Lake Powell, higher peak spring flows would carry more larval fish into Lake Powell. The more natural hydrograph created by the Flow Recommendations is an improvement over the pre-1991 hydrograph in that native fish receive the proper cues at the proper times to trigger spawning, more suitable habitat is available at the proper times for young fish, and over time, it is expected that suitable physical habitat characteristics for native fishes will be maintained. Although the magnitude of flows that once existed on the San Juan cannot be duplicated because of the existence of Navajo Dam, the timing of natural peak flows can be closely approximated. The implementation of the Flow Recommendations is an important improvement over the dam operations that were in effect from 1962-1991.

Changes in channel morphology

The quantity and timing of flows influence how the channel and various habitats are formed and maintained. It is hypothesized that the channel width during the 1930s was much wider than the historical condition as large amounts of sediment entered the river in response to upland habitat degradation and erosion caused by overgrazing (Holden 1999). Channel narrowing is a problem because as the channel width decreases, water velocity increases, and the amount of low velocity habitats, important to the early life stages of the fish, decreases (Service 1998). Between the 1930s and 1950s the channel narrowed by an average of 29 percent between the present day site of Navajo Dam (RM 224) and River Mile 67 (Holden 1999). From 1930 to 1942, suspended sediment load was approximately 47,200,000 tons/year (Holden 1999). Between 1943 and 1973, suspended load dropped by half to 20,100,000 tons/year (Holden 1999). The 1930s aerial photography shows a sand-loaded system, and where the channel was not confined, the river was broad during high flows and braided during low flows (Holden 1999). Channel narrowing before 1962 was most likely due primarily to the reduction in sediment load. Channel narrowing in later years (after 1962) corresponds to the modification of flows by Navajo Dam and the introduction and encroachment of Russian olive (Holden 1999). Indications are that the trend towards a narrower channel flattened or stopped by 1988 (Bliesner 2004).

Reduced peak flows after Navajo Dam was completed (1962 to 1991) exacerbated the growth of exotic riparian vegetation (primarily salt cedar and Russian olive). These non-native trees armored the channel banks and contributed to the creation of a narrower channel (Bliesner and

Lamarra 1994). Modification of flows and non-native vegetation led to more stabilized channel banks, a deeper, narrower main channel, and fewer active secondary channels (Holden 1999).

Since 1992, when a natural hydrograph was mimicked, peak flows have been higher than in the pre-experimental research flow period (prior to 1991) (Figure 2). During this period of time, the amount of backwater habitat has decreased in 4 of 6 reaches (Bliesner 2004). However, the base year used to track backwater habitat (1962-1991) may have had an unusually large amount of backwater habitat as a result of several above average wet years (Bliesner 2004). Other low velocity habitat (i.e., pools, eddies), slackwater, and shoal areas have not changed significantly since 1992 (Bliesner 2004). Because backwaters are an important habitat for young native fishes (e.g., young stocked pikeminnow were found in backwaters 60 percent of the time and in other low-velocity habitats nearly 40 percent of the time (Holden 1999)), loss of backwaters remains a concern. The drought and lack of high flows may also be contributing to the short-term loss of backwater habitat that is currently being observed.

Channel complexity is another important component of razorback sucker and pikeminnow habitat. One measure of channel complexity is the number and area of islands present. Between 1950 and 1960 there was a large decrease in island area (Bliesner 2004). Vegetation encroached on the channel and long secondary channels were cut off as the floodplain stabilized. The increase in vegetation during this period coincided with a long-term drought, which contributed to channel simplification (Bliesner 2004). Between 1960 and 1988, island area increased to the historic levels that were present in 1934 (Bliesner 2004). The 10 years prior to 1988 were the wettest on record, so although vegetation continued to increase in the floodplain, the large flows opened secondary channels, creating large islands. During this period, Russian olive invaded the system and spread rapidly (Bliesner 2004). Since 1992, the trend in island area and island number have shown slight (but statistically insignificant) increases in all reaches except for one (Bliesner 2004). At this point, the data indicate that there has been no loss of bank full channel complexity since 1992. The period of monitoring has been short; confirmation of these trends is tentative until there is another hydrologic wet period (Bliesner 2004).

Large flows (bank full and above) are most effective at moving sediment through the system and long duration of high flows appears to maintain backwater and low velocity habitats and assist in maintaining channel complexity. Flows above 8,000 cfs are effective in maintaining backwater habitat, while flows in the range of 5,000 cfs are not (Bliesner 2004). While manipulation of the hydrograph through dam releases can maximize the utilization of available water for habitat maintenance, some periodic swings in the availability of particular habitats are likely to occur in response to natural hydrologic cycles. At current population levels, habitat does not appear to be a limiting factor for either the razorback sucker or pikeminnow adults (Holden 2000). However, the habitat needs of larval fish have not been thoroughly explored and further research may find specific habitat needs that are not being met or that are limiting (Holden 2000).

In conclusion, the trend towards a narrower channel appears to have stopped and although the amount of backwater habitat has decreased, other important low velocity habitats and channel complexity have not changed significantly (Bliesner 2004). Channel morphology has been monitored for a relatively short time and the recent drought and lack of high flows may have an

over-riding influence on channel-forming processes. Monitoring over a longer period with the inclusion of wet years and high flows will give a better picture of how the Flow Recommendations are maintaining favorable channel characteristics for the pikeminnow and razorback sucker. However, it appears that suitable channel morphology is being maintained and improved.

Water Quality

In addition to the physical changes from dams and water diversions, and biological changes from introduction of non-native fish, chemical changes have occurred as a result of widespread irrigation and drainwater disposal in the Colorado River Basin (Finger et al. 1995, Thomas et al. 1997, Engberg et al. 1998, Hamilton 1998). Quartarone and Young (1995) interviewed 111 people who recounted numerous experiences from the 1920s to the early 1950s and noted that in the late 1940s and early 1950s, Colorado "whitefish" (as pikeminnow were called at the time) were becoming rare in the upper Colorado River Basin. They believed that this rarity was the result of pollution in the rivers from dumping of raw sewage, railroad oil, and wastewaters.

Surface and groundwater quality in the Animas, La Plata, Mancos, and San Juan River drainages have become significant concerns (Abell 1994). Changes in water quality and contamination of associated biota are known to occur in Reclamation projects in the San Juan drainage (specifically associated with irrigated lands on the Pine and Mancos Rivers) where return flows from irrigation make up a portion of the river flow (Sylvester et al. 1988). Increased loading of the San Juan River and its tributaries with heavy metals; elemental contaminants such as selenium, salts, polycyclic aromatic hydrocarbons (PAHs); and pesticides has degraded water quality of the San Juan River in critical habitat (Abell 1994, Wilson et al. 1995, Simpson and Lusk 1999).

Information on existing water quality in the San Juan River has been derived from data gathered by the U.S. Department of the Interior (DOI) as part of its National Irrigation Water Quality Program investigation of the San Juan River area in Colorado, New Mexico, and Utah; results from Reclamation's water quality data for the Animas-La Plata Project; and ongoing contaminant monitoring and research conducted as part of the SJRRIP. Some of this information has been presented in Blanchard et al. (1993), Abell (1994), Wilson et al. (1995), Thomas et al. (1998), and other references cited in Simpson and Lusk (1999). Thomas et al. (1998) found that concentrations of most potentially toxic elements analyzed from the San Juan River drainage in their study, other than selenium, were generally not high enough to be of concern to fish, wildlife, or humans.

PAHs are compounds that may reach aquatic environments in domestic and industrial sewage effluents, in surface runoff from land, from deposition of airborne particulates, and particularly from spillage of petroleum and petroleum products into water bodies (Eisler 1989). Wilson et al. (1995) reported that concentrations of PAHs were elevated in the Animas River, but no identification of source location or activity has been made. The San Juan River below Montezuma Creek also had elevated levels of PAHs; and seasonal increases in PAH

concentrations were detected in the Mixer area of the river (a potential spawning site for pikeminnow). PAH levels in the bile of common carp and channel catfish sampled were high in one fish and moderate in several other fish from the San Juan River. The presence of PAH metabolites in bile of every fish sampled suggested some level of exposure to hydrocarbons (Wilson et al. 1995). Service analyses of PAH contamination of aquatic biota of the San Juan River, and liver tissue examinations of fish in the river, raised concerns regarding the exposure of these organisms to contaminants introduced into the basin. However, PAHs do not appear to be a limiting factor to native fishes in the San Juan at this time (Holden 2000).

Selenium (a trace element) occurs naturally in many soil types, and is abundant in the drier soils of the West. Selenium enters surface waters through erosion, leaching and runoff. Sources of selenium, both anthropogenic and natural, in the San Juan River, have been reported by O'Brien (1987), Blanchard et al. (1993), and Thomas et al. (1998). Selenium, although required in the diet of fish at very low concentrations (less than 0.5 micrograms per gram on a dry weight basis (μg/g), is toxic at higher levels (> 3 μg/g), and may be adversely affecting endangered fish in the upper Colorado River Basin (Hamilton 1999, Hamilton et al. 2000, Hamilton et al. 2002). Excess dietary selenium causes elevated concentrations of selenium to be deposited into developing eggs, particularly the yolk (Buhl and Hamilton 2000). If concentrations in the egg are sufficiently high, developing proteins and enzymes become dysfunctional and lead to deformed embryos that may be at higher risk for mortality.

Selenium concentrations in the San Juan River Basin are of concern because of its documented effects on fish and wildlife reproduction and survival and high levels detected in some locations within the basin (Blanchard et al. 1993, Wilson et al. 1995, Thomas et al. 1998). Selenium concentrations can be elevated in areas where irrigation occurs on soils which are derived from or which overlie Upper Cretaceous marine sediments. Thomas et al. (1998) found that water samples from DOI project irrigation-drainage sites developed on Cretaceous soils contained a mean selenium concentration about 10 times greater than those in samples from DOI project sites developed on non-Cretaceous soils. Percolation of irrigation water through these soils and sediments leaches selenium into receiving waters. Other sources of selenium include power plant fly ash and oil refineries. Water depletions, by reducing dilution effects, can increase the concentrations of selenium and other contaminants in water, sediments, and biota (Osmundson et al. 2000).

Tributaries to the San Juan River carry higher concentrations of selenium than found in the main stem river immediately upstream from their confluence with the San Juan River. Increased selenium concentrations may also result from the introduction of ground water to the main stem of the river along its course. Although these levels are diluted by the flow of the San Juan River, the net effect is a gradual accumulation of the element in the river as it travels downstream. For example, concentrations of selenium in water samples collected from the main stem of the San Juan River exhibited a general increase in maximum recorded values with distance downstream from Archuleta, New Mexico, to Bluff, Utah, (less than 1 μg/L [micrograms per liter] to 4 μg/L) (Wilson et al. 1995). The safe levels of selenium concentrations for protection of fish and wildlife in water are considered to be less than 2 μg/L and toxic levels are considered to be

greater than 2.7 µg/L (Lemly 1993, Maier and Knight 1994, Wilson et al. 1995). However, dietary selenium is the primary source for selenium in fish (Lemly 1993, Buhl and Hamilton 2000). Thus, sediment and biotic analyses are necessary to understand the risk of selenium to fish and wildlife.

The SJRRIP arranged for toxicity tests to be conducted in order to determine the effects of environmental contaminants in water (Hamilton and Buhl 1997), and in diet and tissues (Buhl and Hamilton 2000) of the razorback sucker and pikeminnow in the San Juan River. The waterborne toxicity tests showed a potential threat to endangered fishes from waterborne concentrations of copper and contaminant mixtures created to simulate the water quality conditions of two irrigation drains (Hamilton and Buhl 1995, 1997). However, the results of the dietary toxicity tests showed that dietary selenium (as opposed to water borne selenium) was the primary source of selenium accumulation in pikeminow, accumulated selenium left the tissues slowly after exposure ended, and the selenium concentrations in eggs were significantly greater than concentrations in the parent (Buhl and Hamilton 2000). However, the concentrations in the eggs (9.8-11.6 µg/gram) were lower than those in eggs linked with reproductive impairment in fish (Buhl and Hamilton 2000). Unfortunately, due to small sample size, the reproductive metrics (number of eggs expressed, egg weight, hatchability, time to hatch, and survival, growth, and deformities of the larvae) could not be statistically evaluated in this study (Buhl and Hamilton 2000).

Seethaler et al. (1979) and Quartarone and Young (1995) suggested that irrigation and pollution were contributing factors to razorback sucker and pikeminnow population declines, and Hamilton (1999) hypothesized that historic selenium contamination of the upper and lower Colorado River Basins contributed to the decline of these endangered fish by affecting their overall reproductive success. However, because riverine systems are open systems where concentrations can vary considerably over time in relation to flow (as opposed to a closed system like a lake where concentrations tend to remain steady or increase), and because results from the 7-year research period were inconclusive, selenium concentrations are not currently seen as a limiting factor to native fishes in the San Juan River (Holden 2000). However, as recovery of the pikeminnow and razorback sucker proceeds, research should continue on this issue. These fish can live over 40 years (Behnke and Benson 1983), increasing their susceptibility to bioaccumulation of selenium. In addition, they often stage at tributary mouths such as the Mancos River before spawning, increasing their exposure to elevated levels of dietary selenium (Wilson et al. 1995). Therefore, the impact of selenium on reproductive success may become more important in coming years as adults survive and age in the river.

Propagation and stocking

Colorado pikeminnow

Because of the extremely low numbers of wild pikeminnow and poor recruitment into the population, a stocking program was initiated to augment pikeminnow numbers. Experimental stocking of 100,000 YOY pikeminnow was conducted in November 1996, to test habitat suitability and quality for young life stages (Lentsch et al. 1996). Monitoring in late 1996 and

1997, found these fish scattered in suitable habitats from just below the upstream stocking site at Shiprock, New Mexico, to Lake Powell. During the fall of 1997, the fish stocked in 1996 were caught in relatively high numbers and exhibited good growth and survival rates (Holden and Masslich 1997). In August 1997, an additional 100,000 YOY pikeminnow were stocked in the river. In October 1997, the YOY stocked two months previously were found distributed below stocking sites and in relatively large numbers nearly 10 miles above the Shiprock stocking location. The 1997 stocked fish were smaller in size than those stocked in 1996, but apparently could move about the river to find suitable habitats (Holden and Masslich 1997).

In July 1998, 10,571 YOY pikeminnow were stocked at Shiprock but only one was found through March 1999, in the lower San Juan River (Archer et al. 2000). In July 1999, 500,000 larval pikeminnow were stocked just below Hogback Diversion (RM 158.6). The larvae were found 157 miles below the stocking site 62 hours later and were never recaptured again. High flows in 1999, likely washed them into Lake Powell (Jackson 2001). In June 2000, 105,000 larvae were stocked just below Cudei Diversion (RM 142). Despite more normal flows in 2000, only four larvae were found and three had floated 64 miles downstream two days after stocking (Jackson 2001). No larvae stocked in 2000 were found during a sampling trip four weeks later, but a pikeminnow fitting the size class of the 1999 stocking was found. During an October 2000, sampling trip three pikeminnow that were likely stocked in 1999, were captured but, again, no larvae stocked in 2000 were found (Jackson 2001). In October 2002, approximately 210,418 age-0 pikeminnow were stocked, half at RM 180.2 and half at RM 158.6. In November 2003, another 176,933 age-0 and age-1 were stocked at numerous sites between RM 188 and RM 148 (Ryden, Service, in litt. 2004). In 2004, 280,000 age-0 pikeminnow were stocked in numerous low-velocity habitats from RM 188 to RM 148 (Ryden and McAda 2005a).

Forty-nine pikeminnow adults were stocked at the Highway 371 bridge (RM 180.2) in 1997; however, these fish did not remain in the stretch of river above the PNM weir (RM 166.6) for more than a few months (Miller and Ptacek 2000). In 2001, 148 adult pikeminnow were stocked at RM 180.2. These fish went below PNM weir shortly thereafter but 7 of these adults used the PNM fish ladder in 2003 (Ryden, Service, in litt. 2004). Another stocking of adults at RM 180.2 occurred in 2002 but the movement and distribution of these fish are not yet known (Ryden, Service, pers. comm. 2002). In 2002, 39 pikeminnow were collected during adult monitoring; 36 of the 39 were stocked as adults in April 2001 (Ryden 2003b). In 2003, 32 juvenile pikeminnow were collected during adult monitoring; these fish had been stocked as juveniles in October 2002 (Ryden, Service, in litt. 2004). In 2004, 1,219 age-2 pikeminnow were stocked at RM 180.2 (Ryden and McAda 2005). In total, over 1,000,000 pikeminnow have been stocked from 1996 to 2002 (Ryden 2003b).

Because of human impacts to the Colorado and San Juan Rivers, pikeminnow was thought to be extirpated from the San Juan River (Tyus et al. 1982). Surveys conducted from 1987-1989 revealed that pikeminnow was still present in the San Juan River, but in very low numbers (Platania et al. 1991). When the SJRRIP was established in 1992, one of the program elements was the protection of genetic integrity, management, and augmentation of populations of the endangered fish. While the annual stocking target of 300,000 pikeminnow (Ryden 2003a) has

not yet been met, the minimum target of 200,000 fish was met in 1999, 2002, and 2004, and pikeminnow have been stocked every year since 1996 (Ryden 2003a). Pikeminnow from a wide range of size-classes were captured in the San Juan in 2004, indicating that there has been survival from numerous years' stockings (Ryden and McAda 2005a). In addition, the catch per unit effort for pikeminow in 2004 was the highest recorded since river-wide sampling began in 1996 (Ryden and McAda 2005c). The SJRRIPs augmentation program has been successful in increasing the number of pikeminnow in the San Juan River in a relatively short time, increasing the number of fish much faster than if augmentation had not taken place.

Razorback sucker

Although evidence indicates that razorback suckers were once abundant in the San Juan River at least up to the confluence with the Animas River (Platania and Young 1989), wild razorback suckers, if they still exist, are extremely rare in the river. Because of the limited number of razorback sucker and the lack of recruitment, a stocking program was begun to supplement the population. Between 1994 and 2004, a total of 10,852 hatchery raised razorback suckers were stocked into the San Juan River (Ryden and McAda 2005). Some fish that were stocked as early as 1994, are still being collected during annual sampling (Ryden 2001). Larval razorback suckers have been collected each year since 1998, indicating that the stocked fish are successfully spawning in the San Juan River (Brandenburg et al. 2003, Brandenburg and Farrington 2005).

In March 1994, 15 radio-tagged razorback suckers were stocked in the San Juan River at Bluff, Utah (RM 79.6); near Four Corners Bridge (RM 117.5); and above the Mixer in New Mexico (RM 136.6). In October 1994, an additional 16 radio-tagged adults and 656 PIT-tagged fish were stocked in the same locations and at an additional site just below the Hogback Diversion in New Mexico (RM 158.5). Monitoring found that these razorback suckers used slow or slackwater habitats such as eddies, pools, backwaters, and shoals in March and April, and fast water 92.2 percent of the time in June and August (Ryden and Pfeifer 1995b). During 1995, both radio-tagged fish and PIT-tagged fish were contacted or captured. Razorback suckers were found in small numbers from the Hogback Diversion (RM 158.6) to 38.1 river miles above Lake Powell (Ryden, Service, pers. comm. 2002). In September 1995 and October 1996, 16 and 237 razorback suckers were stocked, respectively. Results of the monitoring efforts indicated that the San Juan River provides suitable habitat to support subadult and adult razorback sucker on a year-round basis (Ryden and Pfeifer 1996). This led the SJRRIP to initiate a 5-year augmentation program for the razorback sucker in 1997 (Ryden 1997). Between September 1997, and November 2001, 5,896 subadult razorback sucker were stocked below Hogback Diversion Dam. An additional 25 subadults were stocked in 2002 (Service, unpubl. data). As of 2001, about 2 percent of the fish stocked from 1994 to 2001 were recaptured and 40 adult or subadult razorback suckers were recaptured in 2002 (Service, unpubl. data). In 2002, 62 razorback suckers were collected, all were stocked fish (Ryden 2003b).

Four ripe male razorback suckers collected at RM 100.2 in spring 1997, appeared to be part of a spawning aggregation. Three other razorback suckers were positively identified within the aggregation of fish but could not be captured. Several of the collected fish had moved up or down the river to the general location of the aggregation, suggesting some focus, such as

spawning, for the aggregation (Ryden 2000b). In 1998, two larval razorback suckers were collected between Montezuma Creek and Bluff, Utah, downstream of the 1997 aggregation site (Ryden 2000c). In April of 1999, two ripe male razorback suckers and one gravid female were collected within a few feet of the 1997 aggregation. All three fish were from the November 1994 stocking. All of the adult razorback suckers suspected to be spawning were part of the 939 fish stocked between 1994 and 1996. Between May 4 and June 14, 1999, 7 larval razorback suckers were collected below the suspected spawning site (Ryden 2000c). In spring 2000, 129 larval razorback suckers were collected, in spring 2001, 50 were collected, and in 2002, 812 were collected (Brandenburg et al. 2003). Larval razorback suckers were collected in the San Juan River between RM 8.1 and 124.8 (University of New Mexico, unpubl. data). Larvae collected at RM 124.8 demonstrate that stocked razorback sucker are spawning upstream and correlates with Ryden's 2004 report documenting spawning at RM 154.4. This information indicates that the stocked fish are spawning and producing larval fish.

Although evidence indicates that razorback suckers were once abundant in the San Juan River at least up to the Animas River (Platania and Young 1989), by the 1980s they were rare (Platania et al. 1991). Even with intensive sampling only one adult was captured in the river from 1987-1989, and 292 collections of larval fish during that same time recovered no razorback sucker (Platania et al. 1991). Because of the limited number of razorback sucker and the lack of recruitment, the SJRRIP initiated a stocking program to supplement the population. Between 1994 and 2004, a total of 10,852 hatchery-raised razorback suckers were stocked into the San Juan River (Ryden and McAda 2005b). Despite the small number of stocked fish, many stocked razorback sucker recruited to adulthood and successful spawning by these fish has been recorded every year since 1998 (Ryden 2003c, Brandenburg and Farrington 2005). In addition, the catch per unit effort for razorback sucker in 2004 was higher than in any previous year (Ryden and McAda 2005c). The augmentation program has been successful in increasing the number of razorback sucker in the San Juan River in a relatively short time, increasing the number of fish much faster than if augmentation had not taken place.

Water depletions

Significant depletions and redistribution of flows of the San Juan River have occurred as a result of other major water development projects, including the Navajo Indian Irrigation Project and the San Juan-Chama Project. At the current level of development, average annual flows at Bluff, Utah, already have been depleted by 30 percent (Holden 1999). By comparison, the Green and Colorado Rivers have been depleted approximately 20 percent (at Green River) and 32 percent (at Cisco), respectively (Holden 1999). These depletions have likely contributed to the decline in pikeminnow and razorback sucker populations (Service 1998). Depletions are expected to increase as full development of water rights and water projects occurs. To the extent that water is exported out of the basin (San Juan-Chama Project) or consumptively used (e.g., evaporation from fields, irrigation canals, reservoir surface) it is not available to maintain flows within the river. Maintenance of streamflow is essential to the ecological integrity of large western rivers (Service 1998).

Water depletion projects that were in existence prior to November 1, 1992, are considered to be historic depletions because they occurred before the initiation of the SJRRIP. Projects that began after this date are considered new projects. On May 21, 1999, the Service issued a BO (R2/ES-TE CL 04-054) determining that new depletions of 100 af or less, up to a cumulative total of 3,000 af, would not: 1) Limit the provision of flows identified for the recovery of the pikeminnow and razorback sucker, 2) be likely to jeopardize the endangered fish species, or 3) result in the destruction or adverse modification of their critical habitat. Consequently, any new depletions under 100 af, up to a cumulative total of 3,000 af, may be incorporated under the May 21, 1999, BO, but still require consultation.

Several consultations contributing to the baseline conditions used reoperation of Navajo Reservoir in accordance with the Flow Recommendations as part of their section 7 compliance (Table 1). Some of these projects have been completed (e.g., PNM Water Contract with Jicarilla Apache Nation), some are partially complete (e.g., Navajo Indian Irrigation Project), and some have not been fully implemented (e.g., Animas-La Plata Project). Those that have not been completed yet (approximately 125,000 af/y depletion) provide water for the operational flexibility discussed under the "Proposed Action" section. As these projects are fully implemented, the amount of water available for operational flexibility will decrease. The projects in Table 1 have undergone section 7 analysis for the effects of their depletions on the razorback sucker, pikeminnow, and their critical habitat. Table 1 also includes the minor depletions covered in the May 21, 1999, BO (R2/ES-TE CL 04-054).

Diversion structures

There are numerous points of diversion on the San Juan River for irrigation and energy production. In addition to acting as fish passage impediments (as discussed earlier), most of these structures do not have screens or other devices to prevent fish from entering (Holden 2000). Although anecdotal, Quartarone and Young (1995) present many stories from senior citizens that recalled seeing or catching razorback suckers from irrigation ditches, sometimes in very large numbers. Trammell (2000) reported that after stocking 500,000 larval pikeminnow below Hogback diversion structure, 63 larvae were collected from the Cudei diversion canal. This number represented 0.013 percent of the total stocked. Catch rate was 4.39 pikeminnow/100 m^3 of water sampled.

In December 2004, 140 pikeminnow in three size classes were caught in the Hogback Diversion Canal (Platania and Renfro 2005). Most of the individuals (92 percent) were between 33-65 mm standard length (SL) (1.3-2.5 in) that had been stocked in October 2004. Seven were between 130-187 mm (SL) (5.1-7.4 in) and 4 were 210-264 mm (SL) (8.3-10.4 in) (Platania and Renfro 2005). Pikeminnow were caught from 0.5 to 17.8 canal miles from the diversion structure (Platania and Renfro 2005).

Pikeminnow that enter diversion structures face an uncertain fate, though fish may find their way back to the river. Because entrainment is unknown the SJRRIP is analyzing entrainment at all

diversion structures and addressing entrainment issues as they are determined. Razorback suckers are not currently found high enough in the system to enter the diversion structures.

Non-native fish

Nearly 70 non-native fish species have been introduced into the Colorado River system over the last 100 years (Service 1998). Non-native fish in the San Juan River include rainbow trout (*Oncorhynchus gairdneri*), brown trout (*Salmo trutta*), striped bass, walleye, channel catfish, black bullhead, yellow bullhead, largemouth bass, smallmouth bass, green sunfish, long-ear sunfish (*Lepomis megalotis*), bluegill, white crappie, fathead minnow, red shiner, and common carp (Buntjer 2003). Channel catfish was first introduced in the upper Colorado River Basin in 1892 (Tyus and Nikirk 1990) and is thought to have the greatest adverse effect on endangered fishes due to predation on juveniles and resource overlap with subadults and adults (Hawkins and Nesler 1991, Lentsch et al. 1996, Tyus and Saunders 1996). Adult and juvenile pikeminnow that have preyed on channel catfish have died from choking on the pectoral spines (McAda 1983, Pimental et al. 1985, Quartarone and Young 1995, SJRRIP 2003b). Mechanical removal of non-native fish (seining and electrofishing) from the San Juan River began in 1995, but was not instituted as a management tool until 1998 (Smith and Brooks 2000). Removal efforts have focused on channel catfish and common carp because they are the most abundant large-bodied non-native fishes and are known predators on native fish and eggs (Davis 2003).

From 1999-2001, 18,260 channel catfish and 9,547 common carp were removed from the river (Davis 2003). Over this period of time, catch rates did not decrease for either species but the mean length of channel catfish caught decreased (Davis 2003). The advantages of reducing the mean size of channel catfish is that they are not thought to be piscivorous until they reach a length of about 450 mm (17.7 in), and fecundity (number of eggs) is much greater in larger fish (Davis 2003). An increase in the number of smaller fish could potentially lead to an increase in competitive or aggressive interactions with native fish. However, it is expected that continued removal efforts will eventually reduce the numbers of smaller channel catfish as well (Davis 2003).

The primary method used to capture large-bodied non-native species is electrofishing. In 1999, one, three-day trip was made and non-natives were removed from Hogback diversion structure to the PNM weir. In 2000, two trips were made and in 2001 and 2002, 10 trips were made each year to this same section. In 2003, non-natives were removed from a second reach, RM 166.6 down to Shiprock (RM 148). During non-native fish removal, razorback sucker and pikeminnow are also shocked and captured. Electrofishing has been shown to have negative effects on trout (Kocovsky et al. 1997, Nielsen 1998). While no direct mortality has been documented, there could be adverse effects to the fish from repeated shocking and handling.

For more than 50 years, researchers have been concerned that non-native fishes have contributed to the decline of native fishes in the Colorado River Basin (Service 1989). Non-native species are potential predators, competitors and vectors for parasites and disease (Tyus et al. 1982, Lentsch et al. 1996, Pacey and Marsh 1999, Marsh et al. 2001). The non-native channel catfish is

one of the most prolific predators in the upper basin and, among the non-native fishes, is thought to have the greatest adverse effect on endangered fishes due to predation on juveniles and resource overlap with subadults and adults (Hawkins and Nesler 1991, Lentsch et al. 1996, Tyus and Saunders 1996). Because non-native fish are considered to be an important biological threat to pikeminnow and razorback sucker, control of non-native fishes through removal has become part of the SJRRIP. It is too early in the SJRRIPs removal program to determine what effect removal of non-native fishes is having on populations of pikeminnow and razorback sucker.

Effects of the action

Operation of Navajo Reservoir and Dam since 1999 has been experimentally consistent with Reclamation's proposed action to mimic the natural hydrograph. During the period from 1991 to 1997 when experimental flows were tested, a natural hydrograph was also maintained. The effects of Navajo Dam operations since 1991 have been discussed in the Environmental Baseline section of this document, and those effects that will continue into the future are analyzed here as ongoing effects of the action on the two listed fish species. In consultations, the Service typically evaluates projects that have not been constructed or implemented. However, in this consultation, the Service is evaluating the effects of a project that has already been constructed and operated for years. Therefore, the effects of the proposed action (operation of Navajo Dam) are those effects that result from the continued operation of Navajo Dam and the implementation of the Flow Recommendations. Thus, the Service must first establish the environmental baseline using the current status and conditions of the listed species and their habitats; the Service does not go back in time and establish the baseline of the species' condition prior to construction and operation of the reservoir and dam. (See section "Environmental Baseline.") The environmental conditions that would result from project implementation (i.e., continued operations) is then projected and evaluated against the environmental conditions that would result if operations were not continued. The difference between those environmental conditions is the effect of continued operations on the system. Continued operations of the river under the current operations represent a "future with the project" environmental condition. The continued effects from the operation of Navajo Reservoir are (1) depletions; (2) cold water releases; and (3) changes in channel morphology.

Effects of the action on pikeminnow and razorback sucker

Reductions in razorback sucker and pikeminnow populations and habitat, due to dams, competition and predation from non-native fishes, changes in flow and temperature regimes, and changes in river channel morphology warranted listing these species as endangered. In response to listing, the Service and other Federal agencies have implemented actions to conserve the species and encourage recovery. One such action is the operation of Navajo Dam to mimic the natural hydrograph by following the Flow Recommendations of the SJRRIP (Holden 1999). Since 1999, Reclamation has followed the Flow Recommendations, with the exception of meeting the lower base flows. However, fish and habitat responses have been monitored since 1991, when a more natural hydrograph first began to be mimicked (Bliesner 2004). These data provide insights on the effects we anticipate will occur under the proposed action.

The proposed action to operate Navajo Dam and Reservoir in accordance with the Flow Recommendations is presented in the BA as a beneficial effect, with the intent that these operations will reduce the ongoing adverse effects of Navajo Dam to both the fish and their critical habitat. The intent of the proposed action is also to improve pikeminnow and razorback sucker populations and the quantity and quality of their habitat when compared to the pre-Flow Recommendations era. The SJRRIP could recommend modified flow targets in any given year to respond to identified issues. In addition, we expect that if the SJRRIP identifies that changes need to be made to the Flow Recommendations to improve habitat and conserve the razorback sucker and pikeminnow populations, Reclamation will follow the modified recommendations. If the modified flow recommendations are outside the scope of analysis in this BO, or Reclamation's Final Environmental Impact Statement, additional analysis may be needed.

The Service agrees that following the Flow Recommendations will likely benefit the species and lead to recovery. The Service commends Reclamation and other entities in the San Juan Basin for their dedication to creating the SJRRIP and supporting the efforts that directly led to the creation of the Flow Recommendations; actions aimed at not merely avoiding jeopardy and adverse modification of critical habitat but at recovering the razorback sucker and pikeminnow. However, the operation of Navajo Dam, apart from mimicking the natural hydrograph, does include adverse effects to the pikeminnow and razorback sucker. Those effects are: 1) Depletions of 27,428 af from reservoir pool evaporation; 2) release of cold water from Navajo Dam; and 3) changes in channel morphology. These past and present effects have been discussed in the Environmental Baseline portion of this document. The baseline effects are those that occurred up to the time of the analysis of the action (i.e., the biological assessment). However, these effects, as they occur in the future, are also effects of the proposed action (e.g., the continued operation of Navajo Dam, in accordance with the Flow Recommendations). Consequently, the ongoing actions are parsed out and analyzed as effects in this section.

1) Depletions

A direct effect of the proposed action is the 27,428 af depletion caused by evaporation from Navajo Reservoir. This is considered a historic depletion that creates an ongoing effect that will continue into the future. The evaporation depletion is included in the Riverware Model, which was used to determine if the Flow Recommendations could be met. The evaporation depletion was included and analyzed during the formulation of the Flow Recommendations for recovery of the listed fish species (Holden 1999).

The Service believes that managing the reservoir releases to be consistent with the Flow Recommendations is necessary for the conservation and recovery of the endangered fish and the Service expects an overall, long-term beneficial effect to result from implementation of the Flow Recommendations. The depletion of 27,428 af every year from the reservoir does not preclude implementation of the Flow Recommendations which are necessary for the recovery of the endangered fish species.

2) Cold water releases
Cold water released from Navajo Dam inhibits pikeminnow and razorback sucker spawning above the confluence with the Animas River, and delay spawning downstream (Holden 1999). The Service considers the effects of cold water releases to be a continued adverse effect of operating Navajo Reservoir to meet Colorado River Storage Project Navajo Unit authorized purposes and contracts. Holden (1999) indicates that pikeminnow could have spawned at Archuleta, 84 miles upriver from the only known pikeminnow spawning activities documented since construction of Navajo Dam. Miller (SJRRIP Biology Committee, pers. comm., 2004) indicated that pikeminnow could have historically spawned at the Navajo Dam site, 93 miles upriver from known post-dam spawning sites. Prior to dam construction, water temperatures at Archuleta were above the threshold spawning temperature of 20° C (68° F) for approximately 2 months (Holden 1999). After dam construction water temperature is rarely over 15° C (59° F) (Holden 1999) and is too cold for successful pikeminnow spawning. The threshold temperatures for spawning at Shiprock (approximately 125 km [78 mi] below the dam) occur about 2 weeks later on average than pre-dam (Holden 1999). Consequently, spawning is unlikely to occur from Navajo Dam to the confluence of the Animas River and would be delayed for two weeks or more from the confluence with the Animas River down to Shiprock. A delay in spawning reduces the amount of time YOY have to grow before winter and could lead to smaller, less fit YOY, and reduce survival.

Because the combination of a suitable spawning bar and suitable temperatures occur so far downstream on the San Juan, there is a greater chance that larval fish will drift into Lake Powell and be lost from the population. Dudley and Platania (2000) found that drifting larval pikeminnow would be transported from the Mixer to Lake Powell in about three days. The farther upstream spawning occurs, the better chance that larvae would have of being retained above the canyon reach, which begins around RM 67. Once larvae enter the canyon, it is believed most are transported to Lake Powell or become trapped in unsuitable habitats where they perish. During their first year of life, pikeminnow prefer warm, turbid, relatively deep (averaging 0.4 m [1.3 feet]) backwater areas of zero velocity (Tyus and Haines 1991). The San Juan River below RM 67 provides very little habitat with those characteristics.

Mimicry of a natural hydrograph has not improved the temperature pattern for the native fish (Holden 1999); spring peak releases from the reservoir decrease spring and early summer temperatures (May, June, and July). While cold water releases are not beneficial to the two listed species, operation of Navajo Dam in accordance with the Flow Recommendations is still beneficial to the species.

3) Channel morphology
The intent of the flow targets outlined in the Flow Recommendations is to construct cobble bars, scour fine sediment from the interstitial spaces of cobble bars so they are suitable for pikeminnow spawning, flush sediments from backwaters, maintain channel complexity, create nursery habitat, and improve water temperatures for spawning. Preliminary results indicate that implementation of the Flow Recommendations are maintaining appropriate habitats for the

endangered fishes. However, the time frame for monitoring has been short and channel morphology typically changes slowly. Although it is difficult to assess the long-term effectiveness of the Flow Recommendations on backwater habitat until the river experiences another hydrologic wet cycle (Bliesner 2004), the Service believes that managing the reservoir releases to be consistent with the Flow Recommendations is necessary for the conservation and recovery of the endangered fish and expects an overall, long-term beneficial effect to result from implementation of the Flow Recommendations.

Effects of the action on pikeminnow and razorback sucker critical habitat

Operating Navajo Reservoir to implement the Flow Recommendations is intended to have an overall beneficial effect to the primary constituent elements of pikeminnow and razorback sucker critical habitat, with the exception of water temperature as discussed above. Based on the monitoring that has occurred since 1991, the Flow Recommendations appear to be maintaining appropriate nursery and spawning habitat (Bliesner 2004). The trend towards channel narrowing has flattened or stopped since 1988 (Bliesner 2004). Although there has been a significant decrease in backwaters, this may be a consequence of the current drought and limited number of years of monitoring. Other low velocity habitats have not decreased significantly (Bliesner 2004). Since 1992, the trends in island area and island number (a measure of habitat complexity) have shown slight (but statistically insignificant) increases in all reaches except for one (Bliesner 2004). The amount of sand in cobble bars has remained low, indicating cobble bars have remained suitable for spawning (Bliesner 2004). All of these elements indicate that appropriate nursery and spawning habitat are being maintained.

If additional projects and depletions occur in the San Juan River Basin, the amount of water available to the river will be reduced further. The Flow Recommendations were developed to provide suitable flows for the endangered fish given the 65 year period of record. The hydrologic model on which the Flow Recommendations is based is currently being updated and revised and will include hydrologic data through 2000 (R. Bliesner, Keller-Bliesner Engineering, pers. comm., 2004). It will not be until 2006, at the earliest, that the drought years of 2002 and 2003 will be incorporated into the model because of the lag time it takes to calculate and update depletions that occur in the basin. However, even when the drought years are incorporated into the model, it is not anticipated that the Flow Recommendations would change as a result (R. Bliesner, Keller-Bliesner Engineering, pers. comm., 2004). Flow recommendations would only change if the SJRRIP biology and hydrology committees recommended a change (Bliesner, Keller-Bliesner Engineering, pers. comm. 2004).

Because of current depletions, there are limitations on the amount of water that can be delivered to the river. As mentioned in the Environmental Baseline, the largest spring peak flow to occur in the 40 years since the construction of Navajo Dam is 15,200 cfs (2.5 percent of the years) (measured at the USGS Bluff gauge, May 30, 1979). In the 49 years prior to dam construction there were spring peak flows greater than 15,200 cfs in 13 years (26 percent of the time). Because of the current drought conditions and short period of time that the Flow Recommendations have been in place, it is unknown if a peak flow of 10,000 cfs will be

sufficient to maintain the channel and habitat complexity over the long-term. However, monitoring of key habitat characteristics is ongoing. We expect that adjustments to the Flow Recommendations will be made if long-term monitoring indicates that changes are warranted.

After reviewing the current status of Colorado pikeminnow and razorback sucker, the environmental baseline, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the action, as proposed, is not likely to destroy or adversely modify designated critical habitat.

Interrelated and Interdependent effects

The Animas La-Plata Project is interrelated to the reoperation of Navajo Dam because implementation of the Flow Recommendations was a condition of the reasonable and prudent alternative for the Animas La-Plata Project consultation. Implementation of the Flow Recommendations was part of the proposed action for Navajo Indian Irrigation Project and therefore it is also an interrelated effect of the proposed action. In addition, Navajo Indian Irrigation Project could not operate without the presence of Navajo Dam, which is another reason why it is interrelated with this proposed action. Because the effects of both of these projects were already considered in previous consultations, they are part of the environmental baseline of this consultation.

Cumulative effects

Cumulative effects include: The effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this BO. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. Cumulative effects include:

1) *Future depletions and diversions from the San Juan River Basin that do not have a Federal nexus and therefore have not completed section 7 consultation.* We believe most of these depletions are accounted for in Table 2, and are therefore considered in meeting the Flow Recommendations. There are irrigation ditches and canals below Navajo Dam that could entrain pikeminnow and razorback sucker: Citizens, Hammond, Fruitland, San Juan Generating Station, Jewett Ditch, Four Corners Power Plant Diversion, and Hogback. Increased urban and suburban use of water, including municipal and private uses will increase demands for water. Further use of surface water from the San Juan River will reduce river flow and decrease available habitat for the razorback sucker and pikeminnow. Livestock grazing may adversely impact razorback sucker and pikeminnow by removal of water for drinking and the reduction in soil water holding capacity in the floodplain, and resulting reduction in base flows.

2) *Increases in development and urbanization in the historic floodplain that result in reduced peak flows because of the flooding threat.* Development in the floodplain makes it more

difficult to transport large quantities of water that would overbank and create low velocity habitats that the razorback sucker and, pikeminnow need for their various life history stages.

3) *Contamination of the water (i.e., sewage treatment plants, runoff from feedlots, and residential development).* A decrease in water quality could adversely affect the razorback sucker and pikeminnow, and their critical habitat.

4) *Gradual change in floodplain vegetation from native riparian species to non-native species (i.e., Russian olive).* Channel narrowing leads to a deeper channel with higher water velocity. Pikeminnow and razorback sucker larvae require low velocity habitats for development. Therefore, there will be less nursery habitat available for both species.

5) *The presence of striped bass and walleye in Lake Powell constitutes a future threat to pikeminnow and razorback sucker in the San Juan River.*

6) *Increased boating, fishing, off-highway vehicle use, and camping in the San Juan River is expected to increase as the human population increases.* Potential impacts include angling pressure, non-point source pollution, increased fire threat, and the potential for harassment of native fishes.

Conclusion

The Service believes that managing the reservoir releases to be consistent with the Flow Recommendations is necessary for the conservation and recovery of the endangered fish. While operating Navajo Dam according to the Flow Recommendations has adverse effects on the two listed fish species, the Service expects an overall, long-term beneficial effect to result from implementation of the Flow Recommendations.

Cold water releases from Navajo Dam may inhibit pikeminnow and razorback sucker spawning above the confluence with the Animas River, and delay spawning downstream (Holden 1999) and the Service considers the effects of cold water releases to be a continued adverse effect of operating Navajo Reservoir to meet Colorado River Storage Project Navajo Unit authorized purposes and contracts.

The Service recognizes that who depletes and the amount of water they deplete may vary from year to year. Consequently, water users assume the risk that the future development of senior water rights, including Tribal water rights, may result in shortages of water to junior users. Nothing in this BO precludes any new depletion that results from the exercise of senior water rights within the action area. Based on this understanding, the Service believes that nothing in this BO directly affects or impairs Tribal trust resources within the San Juan River Basin.

Pikeminnow and Razorback Sucker

After reviewing the current status of the pikeminnow and razorback sucker, the Environmental Baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the proposed action, as described, is not likely to jeopardize the continued existence of the pikeminnow and razorback sucker and is not likely to adversely modify or destroy their designated critical habitat. The rationale for our opinion is set out below.

According to the "Principles for Conducting Endangered Species Act Section 7 Consultations on Water Development and Water Management Activities Affecting Endangered Fish Species in the San Juan River Basin" (2001) (Principles) the Service must determine if progress toward recovery of the two fish species has been sufficient for the SJRRIP to serve as a Reasonable and Prudent Measure. To make this determination we have reviewed the Program Evaluation Report (Holden 2000), The Long Range Plan (1995), scopes of work proposed for 2004, SJRRIP Biology Committee meeting notes, hydrological and biological data, and have spoken with SJRRIP committee members to evaluate the effectiveness of the Flow Recommendations and other elements of the SJRRIP in conserving populations of pikeminnow and razorback sucker in the San Juan River.

Under the Principles, we are to determine progress toward recovery based on (SJRRIP 2001):

1) Actions that will result in a measurable positive population response, a measurable improvement in habitat for the fishes, legal protection of flows needed for recovery, or a reduction in the threat of immediate extinction.
2) Status of fish populations.
3) Adequacy of flow.
4) Magnitude of the impact of the activity (including but not limited to, contaminant and fish migration impacts).

It is the intent of the SJRRIP to provide demographically and genetically viable populations of the pikeminnow and razorback sucker in the San Juan River (Holden 2000). Demographically viable populations are self-sustaining with natural recruitment and an appropriate size and age-structure. Genetically viable populations are of sufficient size that inbreeding is not a concern (Holden 2000). The primary goals of the initial SJRRIP studies were to determine the factors that are limiting the pikeminnow, razorback sucker, and other native fishes, and to determine ways to reduce or eliminate the limiting factors. Because the numbers of pikeminnow and razorback sucker were so few at the time research began, population monitoring was an immediate need.

While initial emphasis was on identification of limiting factors, the seven-year research period also addressed recovery potential through mimicry of the natural hydrograph and study of hatchery-reared endangered fishes released into the San Juan River. The seven objectives identified in the 1995 Long Range Plan pertained to: 1) development of interim management objectives for the endangered fishes and native fish community, 2) habitat identification and restoration, 3) endangered fish species restoration and native fish community management, 4)

non-native fish species management, 5) water quality impacts, 6) public awareness, and 7) adaptive management. The 1995 Long Range Plan identified tasks and milestones for each of these objectives. A total of 51 tasks were listed, of which 22 were identified as milestones. Of these, 42 tasks and 14 milestones have been completed or are ongoing (SJRRIP 2002b), indicating that progress is being made.

One way for us to evaluate if SJRRIP actions have led to a positive population response is to determine if the short-term (2002-2006) population response criteria developed in 2001 are likely to be met. The population response criteria for pikeminnow and razorback sucker are listed below. Population responses for each criterion are summarized from electronic mail received from Dale Ryden (Service, in. litt. 2004).

Pikeminnow

1A) *Collection of 10 or more pikeminnow (greater than 350 mm [13.8 in] total length) during a standardized monitoring trip.* On the fall 2003 standardized monitoring trip, 32 pikeminnow with total lengths ranging from 150-259 mm (5.9 to 10.2 in) were captured. These fish were from the fall 2002 stocking. In 2004, no adults were collected during the monitoring trip; however, 159 juveniles were caught, the only year other than 1998 that over 100 pikeminnow were caught during an adult monitoring trip ((Ryden and McAda 2005c).

1B) *A population estimate of pikeminnow (greater than 350 mm [13.8 in] total length) which is significantly greater (alpha = 0.05) than the Ryden (2000a) estimate of 50 fish. This estimate (N=19; 95 percent CI 10-42) was for adult fish collected between RM 136.6 and 119.2 and is the only such metric available for this species in the San Juan River.* If criterion 1A is met in large enough numbers, it may be possible to meet this goal's target by 2006.

2A) *Presence of wild larval or YOY pikeminnow in standardized monitoring collections in 2 of 5 years.* The capture of wild larval pikeminnow has been infrequent. Larval pikeminnow were caught in 2001 and two individuals were caught in 2004 (Brandenburg and Farrington 2005). Not until stocked pikeminnow become adults and begin reproducing in fairly large numbers will wild larval fish begin to be detected more regularly. The very low survival rates observed from previous (1996-2000) stocking/augmentation of early life stage pikeminnow and the subsequent lack of recruitment of those fish into adulthood is partially responsible for this criterion not being met. However, the lack of wild adult fish and associated progeny is also a factor.

2B) *Range expansion above Hogback Diversion following removal and/or modification of this and other fish barriers identified by the SJRRIP.* This criterion has been met. Cudei Diversion has been removed from the river and both Hogback Diversion and the PNM Weir have fish passage structures that are in operation. Studies are now in progress to assess the need for fish passage at both the Arizona Public Service Weir and the Fruitland Diversion. Pikeminnow are being stocked on an annual basis upstream of all of these diversions, as well as below Hogback.

Razorback sucker

1A) *Collection of more than 20 razorback sucker greater than 300 mm (11.8 in) total length during the annual fall standardized monitoring.* This criterion was met in 2002 (23 fish caught), but fell 2 fish short in 2003. In 2004, the criteria was met again when 113 razorback sucker were caught.

1B) *Collection of greater than 0.15 razorback sucker greater than 300 mm (11.8 in) total length per hour of electrofishing.* This criterion was met in 2002, 2003, and 2004 with 0.25, 0.19, and 1.21 razorback sucker/hour of electrofishing caught in each year, respectively.

2) *Evidence of reproduction (i.e., presence of wild larvae and/or YOY) during standardized monitoring in at least 2 of 5 years.* This criterion has been met. Larval razor back suckers have been caught in every year from 2000 to 2004 (Brandenburg et al. 2003, Brandenburg and Farrington 2005).

From these data, we conclude that the razorback sucker and pikeminnow populations in the San Juan River are more secure today than they were through the 1980s and 1990s and that the threat of extinction has been reduced. Of the two species, the razorback sucker population currently appears to be benefiting more from management efforts. The number of razorback sucker larval fish caught appears to be increasing (Brandenburg et al. 2003) and in 2003, two juvenile razorback sucker (249 and 274 mm TL) were collected in the lower San Juan River (at RM 35.7 and 4.8, respectively). Their size at time of capture and lack of a PIT tag strongly implies that these are likely wild-produced progeny of stocked razorback sucker, providing the first evidence of recruitment in the San Juan River. Between 1991 and 1995, 19 (17 adult and 2 juvenile) wild pikeminnow were collected in the San Juan River by electrofishing (Ryden 2000a). In 2003 alone, 32 sub-adult pikeminnow were caught during the fall standardized monitoring trip. While it is still too early to determine if these fish will survive to the adult stage and reproduce, the trend is encouraging. Because the effective riverine habitat in the San Juan River has been shortened by 87 km (54 mi) by inundation of Lake Powell and 150 km (93 mi) by cold water releases from Navajo Dam, it is unclear if truly self-sustaining populations of pikeminnow can be established without the presence of warmer water so that spawning can occur farther upstream. However, with continued management (e.g., adherence to the Flow Recommendations, removal of fish passage barriers) and stocking/augmentation, it is expected that population numbers will increase and be maintained.

The action that has probably led to the largest population response is stocking/augmentation because it has had the direct effect of increasing fish numbers. Because both species are long-lived it will take many years to determine whether the SRIP is successful. Other actions that have been taken by the SJRRIP that are intended or expected to have a positive population response are:

1) Removal of barriers. The amount of connected habitat available to the fish has been increased through installation of fish passage and removal of barriers. The more stream miles available to the fish, the greater the likelihood that they can find suitable habitat for all life stages.

2) Removal of non-native fish. While a positive endangered fish population response cannot yet be linked to this effort, it is expected that the amount of predation and competition between native and non-native fish is reduced, promoting the survival of native fish.

3) Implementation of the Flow Recommendations. With the Flow Recommendations in place, the annual hydrograph mimics the natural hydrograph much better than in the pre-Flow Recommendations period. The fish have a peak spring flow for spawning and the summer base flows are lower, more closely resembling the pre-dam conditions. We expect that creating a more natural hydrograph through implementation of the Flow Recommendations should have a beneficial effect on native species compared to the pre-Flow Recommendation conditions. However, because population numbers of the endangered fish were so low when the Flow Recommendations were implemented and because so many actions began occurring simultaneously, documenting a positive population response that is a direct result of any one particular action alone is not possible.

The hydrograph produced through the implementation of the Flow Recommendations is a significant improvement over the pre-Flow Recommendation years. Although the shape of the hydrograph can be mimicked, the magnitude of historic peak flows cannot be met. If these peak historic flows could be met, it is possible that they might be beneficial for the maintenance of complex channel morphology. During the time that the Flow Recommendations have been in place, there has been a decline in backwaters. However, this may be an effect of the continuing drought and not the flows. Other low velocity habitats have not decreased significantly (Bliesner 2004). If any low velocity habitat (e.g., shorelines, secondary channels, eddies, pools) is suitable nursery habitat, then the loss of backwaters may not have a detrimental effect on the pikeminnow and razorback sucker, at least at the current population levels (W. Miller, SJRRIP Biology Committee, pers. comm., 2004).

Other conditions we must consider in evaluating habitat conditions are: 1) The Flow Recommendations have been implemented for a short period of time; 2) the channel may still be adjusting to the new hydrologic regime and changes in watershed conditions; and 3) we are in the midst of a drought and there has not been a Class A (10,000 cfs) or B (8,000 cfs) flow since 1997. Large, infrequent flows can alter the channel significantly and it is unknown if the current trends seen in channel morphology are due to the lack of peak flows since 1997, or the lack of a peak flow of between 16,000 and 50,000 cfs that occurred historically. It appears that implementation of the Flow Recommendations has maintained nearly all important physical habitat characteristics over the last several years (Bliesner 2004). As studies continue and the Flow Recommendations are implemented over a longer period of time, the improvement, maintenance, or deterioration of habitat can be assessed more accurately. The SJRRIP has appropriate long-term monitoring in place to make this assessment.

The magnitude of the proposed action is large since it affects the full length of San Juan River occupied by the two endangered fish and extends in perpetuity. Because of the large magnitude, it is essential that the SJRRIP continue with at least the same level of agency commitment,

intensity, and funding to be able to monitor and counteract the effects of this proposed action and all the projects that are linked to it (e.g., Animas-La Plata Project, Navajo Indian Irrigation Project, and numerous smaller projects). As full implementation of projects increases in the basin, leading to greater depletions, the SJRRIP will need to determine if, and when, conditions which currently are not detrimental to the endangered fishes (e.g., water quality) become more severe with additional depletions. Continued long-term monitoring is essential, and initiating new studies may also be needed.

The SJRRIP has implemented new studies over time to help understand the biological and physical characteristics of the San Juan River, and the Service believes that the SJRRIP has been prudent in its selection of research topics and monitoring (Table 5). Two areas of research that the Service would like to be pursued are 1) the effects of colder water temperatures on the survival and recruitment of razorback sucker and pikeminnow and 2) the magnitude and effects of entrainment into diversion canals on both species. There are plans by the SJRRIP to examine both of these topics.

The SJRRIP has been instrumental in the development and implementation of the Flow Recommendations. The benefits of implementing the Flow Recommendations outweigh impacts from depletions, cold water releases, changes in channel morphology associated with the action; and are expected to lead to the conservation and recovery of the species.

Incidental Take Statement

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of an incidental take statement. Our incidental take statement is specific to a particular life stage and that stage only. For example, the following incidental take statement is specific to larval fish. We make no assumptions about how many adult fish these larval fish may produce and do not predict the number of juvenile or adult fish lost based on the larval number taken.

The measures described below are non-discretionary, and must be undertaken by Reclamation so that they become binding conditions of any grant or permit issued to any applicants, as appropriate, for the exemption in section 7(o)(2) to apply. Reclamation has a continuing duty to

regulate the activity covered by this incidental take statement. If Reclamation (1) fails to assume and implement the terms and conditions, or (2) fails to require applicants to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Reclamation must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement ((50 CFR §402.14(i)(3)).

Amount or Extent of Take

Based on the best available information concerning the habitat needs of this species, the project description, and information furnished by Reclamation, from the date of this final BO, take of razorback sucker and pikeminnow will occur in the form of harm, harassment, and kill from cold water releases.

Colorado pikeminnow

The Service anticipates that pikeminnow larvae will be taken as a result of this proposed action. This incidental take is expected to be in the form of harm, harass, and kill as the result of cold water releases from Navajo Dam during the spawning season.

Cold water releases

Cold water releases restrict the upper end of potential spawning habitat to areas between the Animas River and RM 132, where documented spawning locations occur, increasing the chance that larval fish will drift downstream into Lake Powell and be lost from the population. Collections of larvae and YOY downstream of known spawning sites in the Green and Yampa Rivers demonstrate that larval pikeminnow drift downstream after hatching (Haynes et al. 1984, Nesler et al. 1988, Tyus 1990, Tyus and Haines 1991). There is speculation that the large volume of cold water in the upper Green River may be a major reason why larval pikeminnow drift so far downstream (Holden 2000). Dudley and Platania (2000) found that drifting larval pikeminnow would be transported from the Mixer spawning area in the San Juan River to Lake Powell in about three days. For those larval fish not carried into Lake Powell, a delay in spawning (which reduces the amount of time YOY have to grow before winter) and overall colder water temperatures (resulting in slower growth), could lead to smaller, less fit YOY, and reduce survival.

There are 108 km (67 mi) of river between known pikeminnow spawning habitat and the canyon reach of the San Juan River where a lack of suitable habitat and higher water velocities preclude most pikeminnow from surviving or sweep them into Lake Powell. Since surveys were initiated, the majority of the total YOY pikeminnow collected in the San Juan River were at the inflow to Lake Powell (Archer et al. 1995, Buntjer et al. 1994, Lashmett 1994, Platania 1990). Truncating the functional spawning portion of the San Juan River with cold water releases from Navajo Dam harms many larvae by transporting them into Lake Powell where the presence of predatory fish and lack of suitable habitat probably lead to complete mortality. If warmer temperatures allowed spawning higher in the San Juan River, there would be a proportionate decrease in the number of

larvae swept into Lake Powell because of the increased area in which larvae could find low velocity habitats for maturation.

However, it is likely that even if suitable spawning habitat were available upstream, only a portion of the pikeminnow in the river would use these upstream sites. Because of fidelity to spawning locations, pikeminnow currently using the Mixer most likely will continue to do so. A high percent of the larvae produced at the Mixer are likely lost to Lake Powell. The construction of Glen Canyon Dam and the creation of Lake Powell is a separate Federal action. Take of larvae lost to Lake Powell from the proximity of the Mixer to Lake Powell cannot be ascribed to the operation of Navajo Dam but should be part of the Glen Canyon Dam consultation. If Lake Powell did not exist, larvae produced at the Mixer would have a much greater probability of survival. Therefore, take will be evaluated at one or more sites above the Mixer.

Some portion of larvae lost to Lake Powell can be attributed to the operation of Navajo Dam because the pikeminnow may spawn farther upstream in the San Juan River. We assume that because pikeminnow spawn in relatively high velocity habitats at the Mixer, the majority (75 percent) of emerging larvae are entrained in the current as they emerge and are eventually carried to Lake Powell. One-fourth, by chance, enter backwaters and other low velocity habitats and have the opportunity to survive. If spawning could occur upstream as far as Navajo Dam, 151 km (94 mi) above the Mixer, larvae produced at this location would have a greater chance of entering backwaters or other low velocity habitat before reaching Lake Powell. However, even if spawning occurred here, it is likely that some (smaller) portion of larvae would end up in Lake Powell because of the relatively high gradient of the San Juan River and relative scarcity of backwaters and low velocity habitats compared to other upper Colorado River Basin rivers.

It is difficult to determine the potential number of larvae that are killed or harmed from the inability of pikeminnow to spawn farther upstream for the following reasons: 1) Even if suitable spawning habitat were available higher in the system, we cannot determine the number of fish that would use those areas. It is possible that the Mixer would remain the preferred spawning site even if other spawning habitat is available; 2) If pikeminnow were to use spawning habitat upstream of the Mixer, not all of them would spawn at Navajo Dam, some might use habitat relatively close to the Mixer, others could use intermediate areas. We assume that fish that spawned closer to the Mixer would lose a greater number of their larvae than would fish that spawned higher in the system. It is impossible to determine how many fish once spawned at particular locations in the river or predict how many fish might spawn at particular locations in the future. It is possible that because of lower water temperatures, larval fish that do survive are less fit. However, we have inadequate information to evaluate if this is true, and what effect it may have on survival.

The recovery goals for pikeminnow in the San Juan River call for 1,000 age-5 plus fish. We assume that these fish are sexually mature and that approximately half of these fish (500) will be females. Of those 500 we estimate that 70 percent (350) would use the Mixer for spawning and that 150 would use the area between the Mixer and Navajo Dam if the temperature were suitable. For lack of better information we assume that the 150 fish would use three areas above the Mixer

in equal proportions (50 at each site): one near the dam site, one half way between the Mixer and the dam site, and one a few miles above the Mixer.

Average fecundity of 24, 9-year old females was 77,400 (range, 57,766–113,341), and average fecundity of 9, 10-year old females was 66,185 (range, 11,977–91,040) (Hamman 1986). Using the average of these numbers (72,000 eggs/female) and assuming 50 females use each site, we estimate 3,600,000 eggs will be produced at each site. The survival rate for age-0 fish is estimated at 0.15 (Ryden 2003a), thus 540,000 larvae would be produced at each site. At the upper site we assume that 70 percent of the larvae would survive and 30 percent would be carried to Lake Powell, at the middle site 50 percent would survive and 50 percent would be carried to Lake Powell, and at the lower site 35 percent would survive and 65 percent would be lost to Lake Powell. From this we estimate that larval pikeminnow take will be 162,000 from the upper site, 270,000 from the middle site, and 351,000 from the lower site. Total larval take for all three sites would be 783,000 larvae per spawning season.

What is outlined above is the maximum number of larvae we expect to be taken, until the fish is delisted. If we assume that meeting the goal of 1,000, age-5 plus fish will occur in 5 years, and that the population increases by equal increments each year, then 156,600 could be taken in year one, 313,200 in year two, 469,800 in year three, 626,400 in year four, and 783,000 in year five, or once the pikeminnow is delisted.

Razorback sucker

The Service anticipates that razorback sucker larvae will be taken as a result of this proposed action. This incidental take is expected to be in the form of harm, harass, and kill as the result of cold water releases from Navajo Dam during the spawning season.

Cold water releases

McAda and Wydoski (1980) and Tyus (1987) reported springtime aggregations of razorback suckers in the upper Colorado River Basin, in off-channel habitats and tributaries; such aggregations are believed to be associated with reproductive activities. Tyus and Karp (1990) and Osmundson and Kaeding (1991) reported off-channel habitats to be much warmer than the main stem river and that razorback suckers presumably moved to these areas for feeding, resting, sexual maturation, spawning, and other activities associated with their reproductive cycle. Spawning has not been observed directly in the upper Colorado River Basin, but aggregations of ripe razorback sucker indicate that spawning occurs in broad alluvial, flat-water regions over large gravel/cobble bars and coarse sand substrates, at water temperatures of 9–20°C, in velocities less than 1.0 m/s (3.3 ft/s), and depths of less than 1.0 m (3.3 ft) (Holden 1999).

Razorback sucker have high reproductive potential. McAda and Wydoski (1980) reported an average fecundity (N=10) of 46,740 eggs/fish (range=27,614 to 76,576). Survival of young fish appears to be extremely low. No value for first year survival was found but when small razorback sucker have been stocked, it appears that nearly 100 percent have perished (Ryden 2001). Predation by non-native fishes and lack of adequate food have been hypothesized as

reasons for the low survivorship. For this take statement we assume that only one percent of larval razorback sucker survive in the San Juan River.

While spawning has not been observed in the San Juan River, aggregations of ripe adult razorback sucker have been collected at RM 100.2 and RM 17.8 (Ryden, Service, in litt. 2004). Both of these locations are below the Mixer and any larvae that are carried into Lake Powell from these locations should be attributed to the construction of Glen Canyon Dam. As was outlined for pikeminnow, it is difficult to determine the number of larvae that are potentially killed or harmed from the inability of razorback sucker to spawn farther upstream for the following reasons: 1) Even if suitable spawning habitat were available higher in the system, we do not know the number of fish that would use those areas. It is possible that razorback sucker would continue to use the lower reaches of the San Juan even if they could spawn farther upstream; 2) If razorback sucker were to use spawning habitat upstream of the Mixer, not all of them would spawn at Navajo Dam, some might use habitat relatively close to the Mixer, others could use intermediate areas. We assume that fish spawning closer to the Mixer would lose a greater number of their larvae to Lake Powell than would fish that spawned higher in the system. Take will be evaluated at one or more sites above the Mixer.

The recovery goals for razorback sucker call for 5,800 age-3 fish (Service 2002b). We assume that 70 percent of razorback sucker will spawn at the Mixer or below. The recovery plan assumes a male to female ratio of 3:1 (Service 2002b), which means of the 5,800 razorback suckers, only 1,450 would be female. We assume that 70 percent of the females will spawn at the Mixer or below and 30 percent (435) would spawn upstream if the temperatures were suitable. As we did for pikeminnow, we will assume that one-third of these fish (145) would spawn at the dam site, one-third would spawn at an intermediate location (145), and one-third near the Mixer (145). At an average fecundity of 46,740 eggs/female, 6,777,300 eggs would be produced at each site, but only 67,773 (one percent) of these would survive. We assume that razorback sucker spawn in similar habitats as do pikeminnow, so we are using the same percentages for entrainment of larvae as for pikeminnow.

Consequently, of the larvae spawned at the upper site we would expect 70 percent retention and a 30 percent loss to Lake Powell, at the intermediate site 50 percent retention, and at the lower site, 35 percent retention. From this we estimate larval razorback sucker take to be 20,332 from the upper site, 33,886 from the middle site, and 44,052 from the lower site. Total larval take for all three sites could be 98,270.

What is outlined above is the maximum number of larvae we estimate could be taken, until the razorback sucker is delisted. If we assume that meeting the goal of 5,800 age-3 fish will occur in 15 years, and that the population increases by equal increments each year, then 6,551 larvae could be taken in year one, 13,102 in year two, 19,653 in year three, and so on until the fish is delisted (total take equals 98,270 at that point).

The Service anticipates incidental take of razorback sucker and pikeminnow will initially be difficult to detect and monitor because of the small number of adults, the small size of the

species' larvae, and the wide area over which take is anticipated. However, the level of take of this species can be measured by extrapolating from the number of larvae captured, the amount of flow that goes through the larval capture device, the amount of time that the capture device is in place, the proportion of the river sampled, and the amount of time (number of days) that larvae are present in the drift. Details of monitoring take should be decided in coordination with the Service.

Effect of the Take

In the accompanying BO, the Service determined that the level of anticipated take is not likely to result in jeopardy to the razorback sucker and pikeminnow or destruction or adverse modification of their critical habitat.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of the razorback sucker, and pikeminnow,

1) In coordination with the New Mexico Ecological Services Field Office, work with the SJRRIP to develop and incorporate into their Long Range Plan a methodology and accompanying protocol to monitor incidental take of larval pikeminnow and razorback sucker by October 1, 2006.
2) Reclamation will continue funding the SJRRIP to avoid jeopardy as a reasonable and prudent measure to minimize take.

Terms and Conditions

Compliance with the following terms and conditions must be achieved in order to be exempt from the prohibitions of section 9 of the ESA. These terms and conditions implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1.1) Cooperatively, Reclamation and the SJRRIP will document the results of larval monitoring in an annual report to the Service.

1.2) Reclamation, in coordination with the SJRRIP and Service, shall evaluate the current water temperature modeling study and determine if further research is warranted. Any resulting appropriate options should be implemented and funded through the SJRRIP.

Reinitiation Notice

This concludes formal consultation on the proposed project. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) The amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; (4) data indicate that the Flow Recommendations (current or revised) are not meeting the intended needs to maintain channel morphology or endangered fish populations; or (5) a new species is listed or critical habitat designated that may be affected by the action.

Implementation of the SJRRIP's Flow Recommendations is expected to result in a positive population response for the pikeminnow and razorback sucker in the San Juan River. If a positive population response for both species is not realized as measured by the criteria developed by the SJRRIP dated July 6, 2001, this may be considered new information that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion and could require reinitiation. If reinitiation is necessary, the Service will follow the procedures regarding reinitiation of consultation pursuant to the "Principles for Conducting Endangered Species Act Section 7 Consultations on Water Development and Water Management Activities Affecting Endangered Fish Species in the San Juan River Basin." In addition, the Integration Report by the SJRRIP was not ready for the Service to use in its assessment of the Program while preparing this BO. If new information is presented in the Integration Report that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, reinitiation of this consultation would be required. Finally, no take has been permitted for entrainment. If, in the future, entrainment may take listed fish, further consultation will be required.

Please contact Mike Buntjer of our New Mexico Ecological Services Field Office at 505-761-4733, if you have any questions about this BO.

Brian Hanson

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cc:

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Appendix A
Tables and Figures

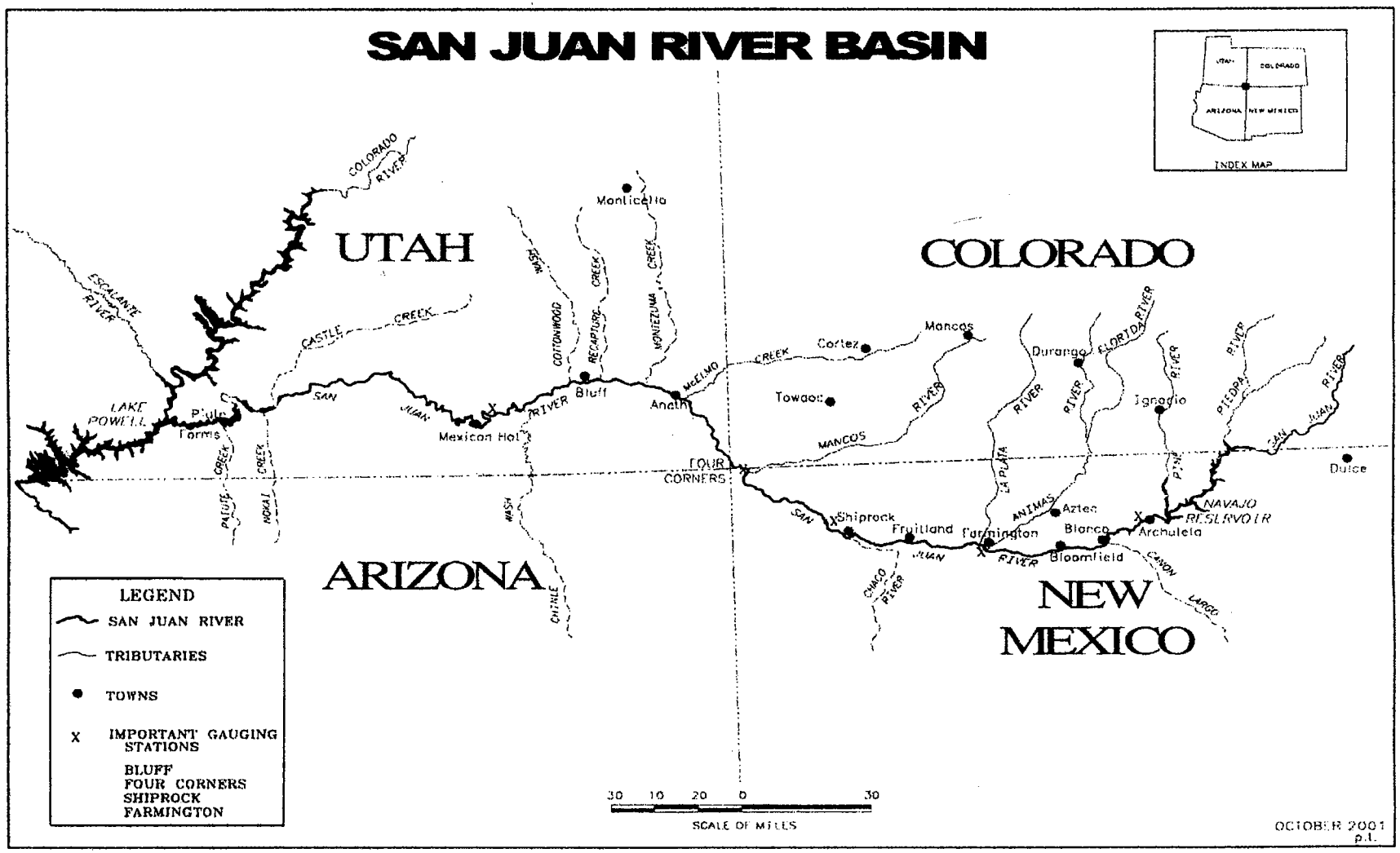


Figure 1. Proposed action area includes the San Juan River Basin to the full pool of Lake Powell. This area is depicted in Figure 1. Flow recommendations are targeted for the 180 miles of the San Juan River between the Animas River confluence and Lake Powell.

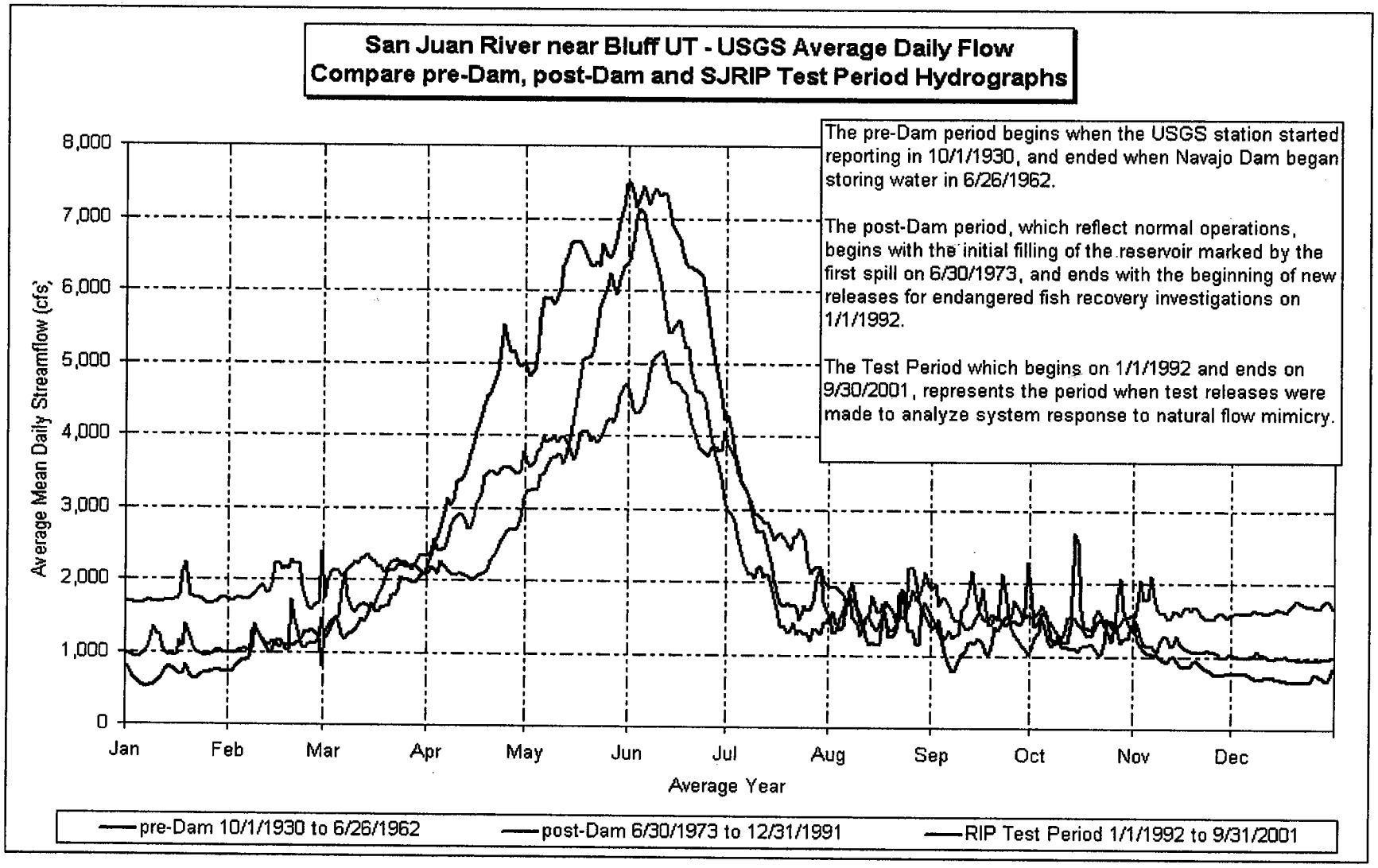
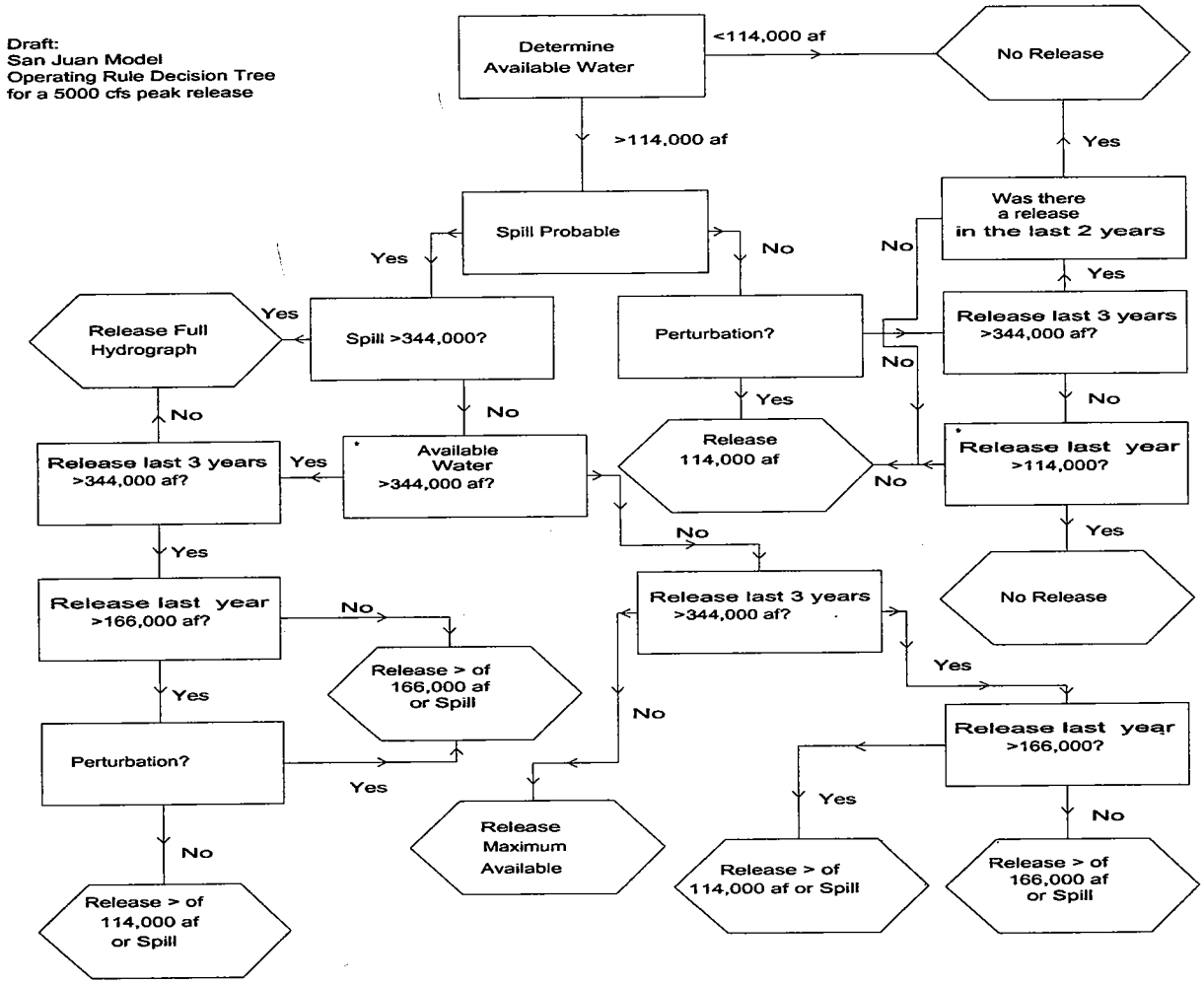


Figure 2. . Graph comparing pre-Navajo Dam, post-Navajo Dam (pre-Flow Recommendations), and proposed action flow of San Juan River past the Bluff gage.

Figure 3. Decision tree for determining releases from Navajo Dam.



Taken from: May 1999 SJRIP Biology Committee flow recommendations Report

Table 1. Summary of San Juan River Basin Depletions [1,2,3]

FEIS - Navajo Reservoir Operations

Table II-1.-Summary of San Juan River Basin depletions for each alternative 1,2, 3

Nov-05 Depletion category	No Action Alternative (acre-feet/year)	250/5000 Alternative (acre-feet/year)	500/5000 Alternative (acre-feet/year)
New Mexico depletions			
Navajo lands Irrigation depletions			
Navajo Indian Irrigation Project	143,600 [4]	280,600 [4]	280,235 [4]
Hogback	26,163	12,100 [5]	12,065 [5]
Fruitland	10,233	7,898 [5]	7,898 [5]
Cudei	900	900	900
Chaco River offstream depletion	2,832 [6]	2,832 [6]	2,832 [6]
Whiskey Creek offstream depletion	523 [6]	523 [6]	523 [6]
Subtotal	184,251	304,853	304,453
Non-Navajo lands Irrigation depletions			
Above Navajo Dam - private	738	738	738
Above Navajo Dam -Jicarilla	2,195 [7]	2,195 [7]	2,195 [7]
Animas River	36,711	36,711	36,711
La Plata River	9,739	9,808	9,808
Upper San Juan	9,137	9,137	9,045
Hammond Area	10,268	10,268	10,164
Farmers Mutual Ditch	9,532	9,532	9,532
Jewett Valley	3,088	3,088	3,088
Westwater	110	110	110
Subtotal	81518	81,587	81391
Total New Mexico irrigation depletions	265,769	386,440	385,844
Non-Irrigation depletions			
Navajo Reservoir evaporation	29,209	27,350	26,274
BHP Navajo Coal Company	39,000	39,000	38,981
San Juan Generating Station	16,200 [8]	16,200 [8]	16,200 [8]
Industrial diversions near Bloomfield	2,500	2,500	2,500
Municipal and industrial uses	8,454	8,454	8,432
Scattered rural domestic uses	1,400 [6]	1,400 [6]	1,400 [6]
Scattered stock ponds and livestock uses	2,200 [6]	2,200 [6]	2,200 [6]
Fish and wildlife	1400 [6]	1,400 [6]	1400 [6]
Total New Mexico non-irrigation depletions	100,363	98,504	97,387
San Juan-Chama Project exportation	107,514	107,514	107,514
Unspecified minor depletions	1500 [9]	4,500 [10]	4,486 [10]
Animas-La Plata Project		13,600	13,600
JANNRWSP	6570 [11]	6,570 [11]	6570 [11]
Total New Mexico depletions	481,716	617,128	615,401

Colorado depletions						
Upstream of Navajo Reservoir						
Upper San Juan	10,858		10,858		10,858	
Navajo-Blanco	7,865		7,865		7,865	
Piedra	8,098		8,098		8,098	
Pine River	71,671		71,671		71,671	
Subtotal	98,492		98,492		98,492	
Downstream of Navajo Reservoir						
Florida	28,607		28,607		28,607	
Animas	25,113	12,	25,119	12,	25,119	12,
La Plata	13,245	13	13,245	13	13,245	13
Long Hollow Reservoir Project	1,339	13	1,339	13	1,339	13
Mancos	19,530		19,532		19,532	
McElmo Basin imports	-11,769		-11,769		-11,769	
Subtotal	76,065		76,073		76,073	
Animas-La Plata Project			43,533		43,523	
Total Colorado depletions	174,557		218,098		218,088	
Colorado and New Mexico combined depletions	656,273	6,	835,226	6,	833,489	6,
Utah depletion	9,140	14	9,140	14	9,140	14
Arizona depletion	10,010	6	10,010	6	10,010	6
Grand total	675,423		854,376		852,639	

[1] The State of New Mexico does not necessarily agree with the depletions shown in terms of constituting evidence of actual water use, water rights, or water availability under the Compact. The SJRBRIP Hydrology Committee uses a hydrology model disclaimer that reads in part, the model data methodologies and assumptions do not under any circumstances constitute evidence of actual water use, water rights, or water availability under Compact apportionments and should not be construed as binding on any party."

[2] The New Mexico Interstate Stream Commission (NMISC) and the San Juan Water Commission (SJWC) believe there are inconsistencies in depletion calculations (communications from NMISC and SJWC dated April 3 and March 21, 2002, respectively).

[3] It should be noted that full development of State compact water and Indian trust water is not included in this table. Only existing projects and projects with Endangered Species Act and NEPA compliance are included in the depletion table.

[4] Includes 10,600 acre-feet per year of annual groundwater storage. At equilibrium, the No Action Alternative drops to 133,000 acre-feet per year and the Action Alternatives drop to 270,000 acre-feet per year.

[5] Accounts for 16,420 acre-feet per year transferred from Hogback, including the Hogback Extension, and Fruitland Projects to NIIP.

[6] Indicates off stream depletion accounted for in calculated natural gains. The combined figures for the NM portion include 2,185 acre-feet of historic and existing uses of Jicarilla Apache settlement water rights for scattered off stream depletions on the reservation.

[7] The Jicarilla Apache Nation recognizes this historic depletion as 2,195 af, but it was modeled as 2,190 af on average.

[8] Water contract with the Jicarilla Apache Nation for long-term depletions for San Juan Generating Station.

[9] 1,500 acre-feet per year of depletion from minor depletions approved by SJRRIP in 1992.

[10] Includes an additional 3,000 acre-feet per year of depletion from 1999 Intra-Service consultation, a portion of which may be In Colorado. This amount includes 780 acre-feet of water subcontracted by the Jicarilla Apache Nation to "minor contractors" below Navajo Dam.

[11] Jicarilla Apache Nation Navajo River Project Biological Opinion lists this depletion as 6,654 af, but model configuration shows 6,570 af on average. The model configuration is shown.

[12] Includes the Red Mesa Reservoir Enlargement depletion in the amount of 997 af.

[13] Long Hollow Reservoir Project Biological Opinion lists this depletion as 1,535 af. Model configuration shows this as 1,339 af for Long Hollow Reservoir Project and an additional 198 af is included in the La Plata category.

[14] 1,705 acre-feet per year San Juan River depletion, 7,435 acre-feet per year offstream depletion.

Table 2. Consultations that use reoperation of Navajo Reservoir as part of their ESA compliance. COE=Army Corps of Engineers, BR = Reclamation, FS = USDA Forest Service, BIA, = Bureau of Indian Affairs, ALP= Animas La Plata Project, PNM = Public Service Company of New Mexico, RPA = Reasonable and Prudent Alternative, NLAA = Not Likely to Adversely Affect.

Consultation #	Date	name	depletion (af)	Duration	Comment	current depletion
CO-95-F-028	5/17/1996	Los Pinos River intake COE (CO)	225.00	none given	Southern Ute Indian Tribe project, part of Animas-La Plata baseline. Jeopardy. No take anticipated. RPA: Reoperation of Navajo Dam to mimic the natural hydrograph of the San Juan River, as agreed to as a result of the ALP consultation.	225
CO-98-F-002	3/4/1998	Mancos Water Conservancy BoR (CO)	200.00	25 (expires 2020)	Jeopardy. No take anticipated. RPA: Reoperation of Navajo Dam to mimic the natural hydrograph of the San Juan River, as agreed to as a result of the ALP consultation.	200
Minor Depletions I	5/21/1999	minor depletions	3,000.00	5 years	batched in 3,000 af blocks. One block is full	3,000
2-22-91-F-241, 2-22-92-F-080, 2-22-99-F-381	7/14/1999	Completion of Navajo Indian Irrigaiton Project	270,000.00	none given	Not Likely to Adversly Affect based in part on reoperation of Navajo Reservoir	204,000.00
CO-00-F-016	6/19/2000	Animas-La Plata Project	57,100.00	perpetual	non-jeopardy. Inability to meet the Flow Recommendation is trigger for re-initiation. Take considered with implementation of Recovery Program. None anticipated as a result of proposed action.	0.00
2-22-00-I-469	2/15/2001	Public Service Company of NM Water Contract with Jicarillas - BOR	16,200.00	01/01/06 - 12/31/27	Originally a BOR contract with PNM. NLAA based on construction of San Juan Generating Station fish passage, reoperation of Navajo Dam, and Reclamations participation in the SJBRIP	16,200.00

Consultation #	Date	name	depletion (af)	Duration	Comment	current depletion
CO-01-F-052	6/6/2002	Red Mesa Reservoir -COE (CO)	2,199.00	none given	Covered in April 25, 1996 Jeopardy biological opinion (1202 AF/yr historic and 997 AF/yr new) RPA 50,000 $ to Utah for hatchery pond. [New B.O. issued 6/6/02. Non-jeopardy. Take considered with implementation of Flow Recs. None anticipated as a result of proposed action.]	1,202.00
CO-02-F-017	10/21/2002	Lake Capote Dam Replacement Project - BIA (CO)	108.00	Perpetual	Non-jeopardy. Take considered with implementation of Flow Recs. None anticipated as a result of proposed action.	0.00
GJ-6-CO-03-F-010	11/24/2003	Williams Creek-Squaw Pass – FS (CO)	202.00	Perpetual	Non-jeopardy. Take considered with implementation of Flow Recs. None anticipated as a result of proposed action.	202.00
CO-96-F-003	3/7/1996	Programmatic Opinion - Forest Service, Colorado	34,656.32	none given	An additional 283.87 af new depletion is shown in minor depletion log. / Jeopardy. No take anticipated. RPA: Reoperation of Navajo Dam to mimic the natural hydrograph of the San Juan River, as agreed to as a result of the ALP consultation.	34,656.00
CO-02-F-016	9/3/2002	Bigbee #2 Lateral Project – Alpine Lakes Ranch- FS (CO)	334.00	none given	Non-Jeopardy. No take anticipated.: Reoperation of Navajo Dam to mimic the natural hydrograph of the San Juan River, as agreed to as a result of the ALP consultation.	336.00
Minor Depletions II	ongoing	minor depletions	2,485.00	5 years	batched in 3,000 af blocks. One block is full	2,500.00
CO-03-F-008	3/15/2004	Three Springs Development	514	none given	2 historic depletions of 249 and 265	514
2-22-02-F-402	4/7/2004	Navajo River Water Development Plan	8,500	Perpetual	Non-jeopardy. No take anticipated. 6,654 new 1,846 historic. Consistency with Flow Recommendations in proposed action.	0
total depletions			395,725.32			263,035.00

Table 3. Status of pikeminnow and razorback sucker outside the San Juan River.

Species Status	RIVER		
SPECIES	MIDDLE GREEN (includes the Yampa river from Craig to Echo Park, White River from Taylor Dam to Green River confluence, and the mainstem Green River from Split Mountain to Sand Wash)	LOWER GREEN (Sand Wash to Colorado River confluence)	COLORADO
Colorado pikeminnow	About 3,500, based on data collected in 2000.	Population estimates initiated in 2001; data being analyzed and estimates continuing in 2003.	About 700, based on data collected in 2000.
Razorback sucker	<100 wild adults; population being augmented through stocking; augmentation is being expanded with excess fish stocked into selected floodplain depressions; stocked fish are returning to spawning bar.	Few adults; population being augmented through stocking.	Few adults; population being augmented through stocking

Table 4. Timeline for Environmental Baseline eras and factors affecting the species.

	Pre-Navajo Dam	**1963-1992 Pre-SJRIP**	**7-year research period (1991-1997)**	**1999-present post-flow recommendations**
Water temperature	Benign	Cold water	Cold water, colder spring release	Cold water, colder spring release
Channel morphology	Increased sediments, complex channel	Channel simplification,	Some slowing in negative trends seen in previous era	Drought has not allowed for high flows to create habitat
Timing and magnitude of flow	Unregulated. Very large volume spring floods. Low summer base flow.	Smaller spring volume and higher summer base flows	Test flows to identify magnitudes and durations that could restore lost habitat.	Drought has not allowed for high flows.
Inundation of river habitat with a lake	No Reservoirs	Navajo Reservoir and Lake Powell removed 130 km of river.	No change	No change
Riparian vegetation changes	Some establishment of non-natives	Improved conditions for non-natives	Less conducive than pre-dam for non-native plants	Less conducive than pre-dam for non-native plants
Fish passage barriers	None. Glen Canyon Dam and Navajo Dam - 1963	Diversion structures exist, effectiveness as barriers uncertain.	Potential barriers to listed fish identified.	Removal of most between Lake Powell and Navajo Reservoir
Water Quality	Good to poor depending on land uses i.e. agriculture and grazing	Poor to fair Clean Water Act in 1970s improved water quality	Fair to good. Better knowledge and implementation of CWA	Unknown. Studies discontinued. Anticipated continued Fair-good.

Table 5. Summary of research progress by the San Juan Recovery Implementation Program

San Juan Recovery Implementation Program Studies	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Pre-SJRIP Studies																	
Ichthyofaunal Study, New Mexico-Utah (Platania 1990)	x	x	x														
Nursery Habitat Sampling, UDWR (Platania et al. 2000)				x													
7-Year Research Period and SJRIP Studies																	
Adult Monitoring and Radiotelemetry (Ryden 2000a)					x	x	x	x	x	x	x	x	x	x	x	x	x
Lower San Juan Fish Community Survey (Lashmett 1993)					x	x											
Early Lifestage - Nursery Habitat and Drift (Archer et al. 2000)					x	x	x	x									

San Juan Recovery Implementation Program Studies	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Young-of-the-Year Survey in the Lower San Juan River (Lashmett 1994, 1995)							x	x									
Small bodied fish monitoring (Probst et al. 2000)												x	x	x	x	x	x
Early Lifestage - Nursery Habitat (Archer et al. 2000)									x	x	x						
Drift Netting (Platania et al. 2000)									x	x	x						
Larval Seigning (Plantania et al.)												x	x	x	x	x	x
Secondary Channel Ichthyofaunal Characterization (Propst and Hobbes 2000)					x	x	x	x	x	x	x						
Nonnative Fish Interactions (Brooks et al. 2000)					x	x	x	x	x	x	x						

San Juan Recovery Implementation Program Studies	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Tailwater Trout Fishery Investigations (Ahlm 1993, Larson and Ahlm 1994)					x	x	x	x									
Mapping Instream Habitat Using Airborne Videography (Pucherelli and Clark 1990, Pucherelli and Goettlicher 1992, Goettlicher and Pucherelli 1994, Blisner and Lamara 2000)				x	x	x	x	x	x	x	x	x	x	x	x	x	x
Geomorphic Characterization, River Channel Dynamics, Flow/Habitat Relationships, Hydraulic Modeling, and Temperature Monitoring (Bliesner and Lamarra 2000)						x	x	x	x	x	x	x	x	x	x	x	x
River Operation Simulation Model						x	x	x	x	x	x	x	x	x	x	x	x

San Juan Recovery Implementation Program Studies	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
(Bliesner and Lamarra 2000)																	
Fish Health Surveys (Landye et al. 2000)						x	x	x	x	x	x						
Tributary Fish Community Surveys (Miller and Rees 2000)						x	x										