United States Department of the Interior

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Mountain-Prairie Region

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Memorandum

To: Regional Director, Bureau of Reclamation, Salt Lake City, Utah
Area Manager, Bureau of Reclamation, Provo, Utah
Program Manager, Central Utah Project, Bureau of Reclamation, Provo, Utah
Superintendent, Bureau of Indian Affairs, Fort Duchesne, Utah

From: ACTING Regional Director, Region 6
Deputy U.S. Fish and Wildlife Service
Denver, Colorado

Subject: Update of the Reasonable and Prudent Alternative in the July 1998 Biological Opinion for the Duchesne River Basin

INTRODUCTION

The 1998 Duchesne Biological Opinion determined that historic operations and the development of new project water in the Duchesne River Basin contributed to the endangerment of the listed fishes and was likely to jeopardize the continued existence of the Colorado pikeminnow (formerly known as Colorado squawfish), razorback sucker, humpback chub, and bonytail also was likely to adversely modify their critical habitat in the Duchesne, Green, and Colorado Rivers. The Reasonable and Prudent Alternative (RPA) for the 1998 Duchesne Biological Opinion required implementation of several actions including followup studies to evaluate and refine flow recommendations for the Duchesne River. On completion of the flow studies consultation was to be reinitiated or the final biological opinion amended to include final flow recommendations based on study results. Based on discussions with the various parties the USFWS has determined to amend the 1998 Duchesne Biological Opinion with the updated information. This amendment provides a summary of new information on the biology and habitat requirements of the Colorado pikeminnow, razorback sucker, and final flow recommendations for flows to support these species in the Duchesne River (Appendix A). It also provides a new RPA that updates and replaces the original RPA developed for the 1998 Duchesne Biological Opinion. All other sections of the 1998 Duchesne Biological Opinion remain in effect and are unchanged, including the project description, estimates of depletions, status of the species, conclusions and incidental take statement.

SUMMARY OF NEW INFORMATION

Between 1997 and 2000, the Upper Colorado River Basin Endangered Fishes Recovery Implementation Program (RIP) in cooperation with the Ute Indian Tribe (Tribe) conducted studies to define use of larval, juvenile and adult fishes in the Duchesne River (Brunson and Christopherson 2003, Modde and Haines 2003), identify flows needed to maintain existing habitat complexity (Gaueman, Wilcock, and Schmidt 2003) and identify the base flows that contribute to the recovery of endangered fishes (Haines and Modde 2003). A synthesis report (Modde and Keleher 2003) also was developed that provided flow recommendations for the Duchesne River based on the research conducted in that system and other relevant information.

Species Composition

Adult fish surveys conducted in the Duchesne River in 1993 (Cranney 1994) found a total of 7 native and 10 nonnative fish species. More intensive surveys between 1997 and 1999 (Modde and Haines 2003) also found a similar fish community comprised of 7 native and 15 nonnative species. The most abundant large-bodied fishes in the river were flannelmouth sucker (*Catostomus latipinnis*) and carp (*Cyprinus carpio*). The most abundant small-bodied, nonnative fishes in the lower 54 kilometers (km) (34 miles (mi)) of the Duchesne River were red shiner, (*Cyprinella lutrensis*) and fathead minnow (*Pimephales promelas*) (Brunson and Christopherson 2003). Other native species including Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), bluehead sucker (*Catostomus discobolus*), and roundtail chub (*Gila robusta*) were poorly represented in the collections. In the 1997-1999 collections, flannelmouth sucker was the most abundant species and native fishes were numerically as abundant as nonnative fishes (Modde and Haines 2003). Between 1997 and 1999 a survey of juvenile fish did not definitively document the presence of larval or young-of-the-year Colorado pikeminnow or razorback sucker and found bluehead sucker young only in low numbers. In addition, few young-of-the-year channel catfish, a common nonnative adult fish collected in the lower Duchesne River, were collected. However, early life stages of most other suckers and cyprinids were found in the river (Brunson and Christopherson 2003), along with adults (Modde and Haines 2003), indicating that the lower Duchesne River supports a permanent resident fish population. More recently, northern pike (*Esox lucius*), smallmouth bass (*Micropterus dolomieu*), and black crappie (*Pomoxis nigromaculatus*) have been introduced into the Uintah Basin and smallmouth bass have established self-sustaining populations in the Duchesne River.

COLORADO PIKEMINNOW

Colorado pikeminnow are the primary species of concern in the Duchesne River. Previous studies and observations have shown pikeminnow to occur in the lower 78 km (49 mi) of the Duchesne River (Modde and Keleher 2003). However, little information was known of pikeminnow use of the Duchesne River above razorback sucker critical habitat located in the lower 4 km of the river (2.5 mi). New data indicate that Colorado pikeminnow most frequently utilized the reach between river kilometers 12.8 and 24.6 (river miles 8.0 and 15.4) and studies conducted by Gaeuman et al. (2003) found that this reach has more channel complexity (i.e., greater sinuosity, greater range in substrate size, higher gradient) than lower reaches of the river. These findings are consistent with other studies on the Colorado River that found Colorado pikeminnow prefer diverse habitat types (Osmundson 1999).

In recent surveys Colorado Pikeminnow have been collected in the Duchesne River as late as November and as early as February. Available evidence from radiotelemetry studies (Modde and Keleher 2003) suggests that although the river has not been sampled during winter months, most pikeminnow do not remain in the Duchesne River during colder months but appear to utilize it primarily during the spring and summer months. Limited use of the Duchesne River during the winter base flow period may be a response to the periodic occurrence of extremely low base flows in the river that have occurred in the last 60 years. The appearance of pikeminnow in the Duchesne River now coincides with increased flows in the mainstem. Green River, particularly during years of higher than average flows, and at least through the peak flood flows during low flow years. The Duchesne River may provide opportunities for foraging by local pikeminnow. Many individuals spend several months in the tributary and depend on prey species that are produced there. Fish surveys found all life stages of the most probable prey species for Colorado pikeminnow inhabiting the Duchesne River (Brunson and Christopherson 2003, Modde and Haines 2003). Daily patterns of movement coincide with the diurnal/nocturnal periods linked to feeding behavior, which also indicate that the pikeminnow are using these habitats for foraging. Because fish occupying the Duchesne River during these periods have the option to reside in the Green River, it appears they are opting to use the Duchesne River, most likely because of a bioenergetic advantage (Modde and Keleher 2003). Although most Colorado pikeminnow are not present during the late fall and winter months, the year-around production in the Duchesne River is necessary to provide the prey base for pikeminnow when they are present (Modde and Keleher 2003).

Many pikeminnow captured in tributaries including the Duchesne River have been less than 500 millimeters (Modde and Keleher 2003). This indicates that these habitats may be important to young adult Colorado pikeminnow attempting to find areas to occupy outside established home ranges of larger adults. These combined data indicate that the Duchesne River contributes to recovery of Colorado pikeminnow in those years when an abundant prey base is available and flows allow access (Modde and Keleher 2003).

Baseflow Recommendations

Baseflow recommendations for maintenance of Colorado pikeminnow in the Duchesne River focus on passage needs and maintenance of a level of biological productivity necessary to sustain aquatic productivity and prey base (Modde and Keleher 2003). Flows recommended for Colorado pikeminnow passage were estimated as the discharge needed to provide a depth of at least 30 centimeters (cm) (11.8 inches) in the deepest area of the channel. Depth criteria used to define passage were based on fish morphology, and were proposed for the Gunnison River by Burdick (1997) and also applied to the Yampa River by Modde et. al (1999). Flows of 115 cubic feet per second (cfs) in the Duchesne River provide maximum thalweg depths greater than 30 cm in the majority of riffle crossections and a maximum depth of 20 cm in all riffles which would allow for passage of all but the largest fish. Passage flow recommendations were made for the period between March 1 and June 30 when Colorado pikeminnow utilize the river most heavily.

The productivity component of the base flow recommendation was based on the premise that riffle habitats represent an important determinant for fish abundance and that primary and secondary production in shallow water habitats, i.e., riffles, form the energetic base that supports the prey base for Colorado pikeminnow in the Duchesne River (Modde and Keleher 2003).

Stanford (1994) noted that rivers of the Upper Colorado River Basin were capable of supporting very productive benthic food webs on cobble substratum of riffles in steeper segments and stated that food webs were more stable, complex, and productive in the upstream reaches of the potamon associated with cobble substrates. The majority of the lower Duchesne River between Myton and the confluence with the Green River represents a transition between rithron (headwater) and potamon (downstream) reaches. Data from the Upper Colorado River indicated that primary and secondary production was greatest in the upstream, higher gradient reaches with more riffle (Lamarra 1999) which coincided with the highest density of fishes (Osmundsen 1999). Osmundsen (1999) also stated that riffles were islands of productivity that were related to carrying capacity of fish. Gelwick (1990) documented a similar relationship of riffles to fish abundance in smaller aquatic systems.

Modde and Keleher (2003) quantified the relationship between flows and aquatic production in the Duchesne River. They employed a curve-break method similar to that described by Gippel and Stewardson (1998) to define base flow needs for aquatic productivity. Using riffles as an indirect index of biological production, the curve-break methodology defines a flow, which represents an index discharge below which habitat conditions rapidly decline, such that small additional reductions results in disproportionate impacts to stream productivity. Thus, reductions in flow below the curve-break result in large reductions in habitat and the greatest rate of invertebrate habitat loss (Lohr 1993). The curve-break represents the most efficient flow relative to flow reduction and biological production. However, the curve-break in itself is not a minimum flow but an index below which aquatic productivity in the stream decreases rapidly. Flows less than the index flow identified by the curve-break may not produce lasting negative impacts if they occur infrequently.

Using the curve-break methodology, Modde and Keleher (2003) identified an index discharge of 115 cfs as the flow below which major reductions begin to occur in riffle habitats in the Duchesne River. They further refined the minimum flow recommendation to maintain aquatic productivity by recommending that flows below 115 cfs not occur at a frequency any greater than the 25-year period of record at the Randlett Gage (1975-2000). This was based on the assumption that flows in the river over the last 25 years have been sufficient to maintain an adequate prey base for Colorado pikeminnow. They also recommended that baseflows to sustain stream productivity should not drop below 50 cfs. At 50 cfs 50 percent of the riffle habitat in the Duchesne River remains inundated, an approximate minimum requirement for maintaining aquatic biota.

RAZORBACK SUCKER

The historic distribution of razorback sucker in the Green River system extended from the Colorado River confluence upstream to near Green River, Wyoming (Jordan 1891, Everman and Ruter 1895, Sigler and Miller 1963, Baxter and Simon 1970, Quarterone 1993). Although still widely distributed in the main-stem and lower sections of major Green River tributaries, razorback sucker presently occupy only a portion of their former range. The largest concentration of razorback sucker currently exists in low-gradient flat water reaches of the middle Green River below the Yampa River confluence down to the confluence with the Duchesne River, including the lower few kilometers of the Duchesne River (Tyus 1986, Muth et al. 1998). Very little historical documentation exists on the presence of razorback sucker in

the tributaries of the Green River. No record of razorback sucker captures in the Duchesne River exists before 1978. Most of these fish have been captured in the lower 4 km (2.5 mi) of the river during the spring months when this area is influenced by water elevations of the Green River. In the Green River they have been observed in tributary mouths and floodplain outflows in the spring, especially following spawning in late May and June.

Razorback sucker do not migrate as far to spawning areas as Colorado pikeminnow, nor do they exhibit fidelity to spawning sites (Modde and Irving 1999). Following spawning, larvae emerge during peak flood flows and are believed to drift into floodplain wetlands that provide nursery habitat (Muth et al. 2000, Modde et al. 2001). After spending one to two growing seasons in the biologically rich floodplain wetlands, razorback sucker return to the mainstem river (Modde 1996, UDWR unpublished data). Outside of the lower Yampa River and areas influenced by the Green River, razorback sucker do not appear to be common in the tributaries of the Green River sub-basin. However, the species appears to use habitats in lower portions of tributaries and areas associated with confluence of tributaries and the mainstem river during pre- and post-spawning periods. Modde and Irving (1998) demonstrated that most razorback sucker adults in the middle Green River moved into flooded environments (e.g., floodplain habitats and tributary mouths) soon after spawning. Tyus and Karp (1990) and Modde and Wick (1997) suggested that use of warmer and more productive habitats by adult razorback sucker during the breeding season is related to temperature preferences and abundance of appropriate food.

The Duchesne River upstream of critical habitat is not currently utilized to a significant degree by razorback sucker; however, the lower 4 km (2.5 mi) of the river appears to be important to populations in the Green River, in particular during the spring. Implementation of flow recommendations designed primarily to benefit Colorado pikeminnow and the aquatic productivity in the Duchesne River also will benefit razorback sucker and razorback sucker critical habitat in the Green River by providing and maintaining habitat in the lowermost portions of the Duchesne River and contributing flows that help inundate floodplains in the Green River below the Duchesne River.

Channel Maintenance Flows

Channel maintenance flow recommendations for the Duchesne River were developed by Gaeuman, Wilcock, and Schmidt (2003), to provide for the geomorphic processes that form and maintain current habitat (including prey base) for Colorado pikeminnow and razorback sucker. These processes are based on the flows needed to mobilize bed load, maintain channel movement, and transport fine sediment. Channel and habitat maintenance flows of the Duchesne River were evaluated from the mouth of the Uintah River near Randlett, Utah, to the confluence of the Duchesne with the Green River 27 km (17 mi) downstream by Gaeuman, Wilcock, and Schmidt (2003). The study site included designated critical habitat for razorback sucker which extends 4 km (2.5 mi) upstream from the Green River. The area evaluated also contains significant native fish populations important as a prey base for foraging Colorado pikeminnow (Brunson and Christopherson 2003, Modde and Haines 2003, Modde and Keleher 2003).

Stream channel morphology is a function of water discharge, the type and amount of sediment being transported and the character of the materials making up the channel bed and banks. It is critical for channel maintenance that the sediment transport capacity through a river reach is

sufficient to transport the sediment load supplied to the reach. Loss of sediment transport capacity affects the quality and availability of physical habitat used by aquatic biota. Gravel substrates can become choked with fine sediment impacting macroinvertebrate production and the availability of spawning sites for some fish species. Increased sediment deposition in backwaters and side channels can reduce channel complexity and habitat diversity. Flow regimes needed to maintain these elements of physical habitat must exceed certain discharge thresholds in order to transport the imposed sediment load. For example, maintenance of a productive gravel substrate requires discharges sufficient to mobilize the stream bed so that fine sediment can be flushed from the subsurface. Maintenance of backwater and side channel habitats requires discharges capable of scouring sediment from these areas.

Discharges necessary to access high bars and secondary channels may cause bank erosion and redistribute bed sediment. These high flows create disturbance and maintain the structural elements that provide the basis for diversity in aquatic and riparian habitat. Islands, backwaters, side channels, and oxbow lakes are created by high flows which provides complex aquatic habitat. Physical complexity has been shown to be an important factor for habitat use among Colorado pikeminnow (Osmundson 2001).

Gaueman et al. (2003) identified four important discharge thresholds needed to maintain habitat for the Colorado pikeminnow and razorback sucker in the Duchesne River, these included:

1) Discharges Necessary to Access High Bars and Secondary Channel--Discharges of approximately 3,000 cfs and a recurrence interval of 1.7 years were found to be sufficient to produce flow into the main chute channels and secondary channels. Floods ranging from the 2-year to the 2.6-year events were required to initiate significant flow on high bar surfaces. The average discharge that inundates these surfaces was 4,000 cfs. Flows capable of inundating the floodplains and higher bar ridges are larger than a 3.2-year flood event and may be approximated by the 6-year flood event.

2) Discharges Necessary to Entrain Gravel--Riffles are areas of high in-stream productivity and are maintained by the frequent mobilization of bed gravels. Entrained gravels typically move during flood and come to rest at places that have lower shear stress than nearby areas. The discharges necessary to entrain gravel were determined by reach-averaged shear stress. The threshold of entrainment over riffles and runs were at discharges of approximately 4,000 cfs.

3) Channel-forming Discharges--Gaueman et. al (2003) identified flows needed to maintain channel configuration through a cfs-day approach (see pages 84-85 of his report for detailed explanation). Using this approach he recommended an average annual target of 7,000 cfs-days. This approach involves calculating the total volume of water each year in excess of the 4,000 cfs gravel entrainment threshold and averaging over an extended time period. For example, in a given year if the mean daily flow never exceeded 4,000 cfs there would be 0 cfs-days for the year. If in a given year mean daily flows were at 7,000 cfs for 1 day, 6,000 cfs for 3 days, and 5,000 cfs for 6 days, the cfs-days for that year would be 15,000. A long-term average of 7,000 cfs-days per year in excess of the particle entrainment threshold would ensure that critical geomorphologic processes such as gravel entrainment and transport, bank erosion, and movement of fine sediments in the channel is accomplished

in the Duchesne River. Little channel forming activity occurs during periods when the volume of stream flow in excess of the channel-forming discharge of 4,000 cfs is less that 7,000 cfs-days per year. Physical habitat is created and maintained during decades when the volume of stream flow in excess of 4,000 cfs is greater than 7,000 cfs-days per year.

4) Discharges Necessary to Flush Fine Sediment--Loss of fine sediment transport capacity due to water diversions has historically resulted in the loss of habitat in the lower Duchesne River. Fine sediment transport capacity adequate to prevent further habitat loss can be maintained by a combination of the proposed channel-forming flow regime and additional flushing flows. The proposed flushing flows identified by Gaueman et. al (2003) consist of 7 days with discharges greater than 3,000 cfs in 30 percent of all years, and 7 days with discharges greater than 2,500 cfs in an additional 30 percent of all years.

Gaueman et. al (2003) noted during his study that existing measurements of suspended sediment concentrations in the lower Duchesne River were inadequate for making well-constrained estimates of suspended sediment loads during high discharge periods. He recommended that an extended sampling program to monitor suspended sediment concentrations in the lower Duchesne River during peak flow events should be undertaken.

REASONABLE AND PRUDENT ALTERNATIVE

On January 21-22, 1988, the Secretary of the Department of the Interior; Governors of Wyoming, Colorado, and Utah; and the Administrator of the Western Area Power Administration signed a Cooperative Agreement to establish the RIP. An objective of the RIP was to recover the listed species while providing for new water development in the Upper Colorado River Basin.

In order to further define and clarify processes outlined in sections 4.1.5, 4.1.6, and 5.3.4 of the RIP, a section 7 agreement, and a Recovery Action Plan (RIP RAP) were developed (USFWS 1993). The Agreement established a framework for conducting section 7 consultations that allow the RIP to serve as the RPA for jeopardy depletion impacts related to new projects and all impacts associated with historic projects in the Upper Basin. Procedures outlined in the agreement are used to determine if sufficient progress is being accomplished in the recovery of endangered fishes to enable the RIP to serve as a reasonable and prudent alternative to avoid jeopardy. The RIP RAP was finalized on October 15, 1993, and has been reviewed and updated annually.

In accordance with the agreement, the USFWS assesses the impacts of projects that require section 7 consultation and determines if progress toward recovery has been sufficient for the RIP to serve as a reasonable and prudent alternative. If sufficient progress is being achieved biological opinions are written to identify activities and accomplishments of the RIP that support it as a reasonable and prudent alternative. If sufficient progress toward the recovery of the endangered fishes has not been achieved by the RIP, actions from the RIP RAP are identified which must be completed to avoid jeopardy to the fishes. For historic projects, these actions

serve as the reasonable and prudent alternative as long as they are completed according to the schedule identified in the RIP RAP. For new projects, these actions serve as the reasonable and prudent alternative as long as they are completed before the impact of the project occurs.

In determining if sufficient progress has been achieved, the USFWS considers--(a) actions which result in a measurable 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; (b) status of fish populations, (c) adequacy of flows, and (d) magnitude of the project impact. In addition, the USFWS considers support activities (funding, research, information, and education, etc.) of the RIP if they help achieve a measurable 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. The USFWS evaluates progress separately for the Colorado River and the Green River sub-basins; however, it gives due consideration to progress throughout the Upper Colorado River Basin in evaluating progress toward recovery.

This amendment to the 1998 Duchesne Biological Opinion provides an updated RPA to the 1998 Duchesne Biological Opinon that addressed both historic and new Federal projects, as well as existing State and private projects totaling 548,000 acre-feet (af) of depletions to the Duchesne and Green Rivers. The USFWS has determined, based on the analysis of the hydrological and biological information that currently exists, that if RIP participants, in cooperation with responsible Federal agencies, agree to carry out all the following elements (approved as part of the 2004 RIP RAP) then these actions will avoid the likelihood of jeopardizing the continued existence of endangered fishes and avoid destruction or adverse modification of critical habitats for all Federal projects listed in Table 1 of the 1998 Duchesne Biological Opinion. It is the RIP's responsibility to ensure that all elements of this reasonable and prudent alternative are completed and/or implemented in cooperation with the Federal action agencies and consistent with RIP schedules.

The following elements contained in the RIP RAP (USFWS 2004) will serve as the reasonable and prudent alternative for historic and planned water depletions in the Duchesne River Basin as describe in the 1998 Duchesne Biological Opinion. This RPA updates and replaces the RPA found in the original 1998 Duchesne Biological Opinion. Specific RPA elements are underlined and numbered as they appear in the Recovery Action Plans for 2004 (USFWS 2004). Additional text has been added to provide background, current status and recommendations for the various action plan items contained in this RPA. This updated RPA includes items from the original 1998 Duchesne Biological Opinion as well as some new items. Due to the fact that the RIP has been actively implementing actions to benefit the listed fish in the Green and Duchesne Rivers some of the items identified in this RPA have already been completed and are identified as such.

GREEN RIVER ACTION PLAN–DUCHESNE RIVER

I. Provide And Protect Instream Flows. Revised flow recommendations for the Duchesne River called for in the RPA for the 1998 Duchesne Biological Opinion were developed by the RIP and finalized in 2003. An informal Duchesne River Working Group (DRWG) also was formed in 2004 to address issues involved with implementation of the flow recommendations, including water availability, water management and protection of instream flows. This working

group should be made permanent with representatives that could include but is not limited to the USFWS, the RIP, Utah Department of Natural Resources (UDNR), Utah Division of Wildlife Resources (UDWR), Utah Division of Water Resources, Utah Division of Water Rights Central Utah Water Conservancy District (CUWCD), Utah Reclamation Mitigation and Conservation Commission (URMCC), U.S. Department of the Interior Central Utah Project Completion Act Program (CUPCA), Bureau of Reclamation (BOR), the Tribe, Bureau of Indian Affairs (BIA), Associated Water Users of the Duchesne and Strawberry Rivers, Duchesne County Water Conservancy District, Uinta County Water Conservancy District, and other affected stakeholders. The UDNR and USFWS will serve as co-leads to facilitate smooth functioning of the DRWG. The purpose of the working group would be to provide effective coordination of the flows in the Duchesne River in order to help meet flow recommendations and protect instream flows. The DRWG in cooperation with the RIP will identify the timing and volume of water available to meet the flow recommendations, assess measurement of instream flows and diversions, coordinate flow releases and development of any necessary agreements to provide and protect flows in the Duchesne River. Participation of the Tribe is particularly important as the title to the bed of the Duchesne River in many cases is in the United States in trust for the Tribe, and the Tribe maintains senior water rights in the Duchesne River. Therefore, management and protection of flows within boundaries of the Reservation will require Tribal as well as State action. A primary product of the working group would be a water management plan that would identify shortages, potential sources, issues and logistics of providing flows to achieve the objective of meeting the 2003 Flow Recommendations and to recommend to the USFWS viable options and alternatives for achieving flows. This plan would primarily serve as an instrument for coordination of activities by various agencies and could be used to document procedures agreed upon by the DRWG for certain water management activities if desired. Specific activities would be coordinated on a year-to-year basis by the DRWG. Test flows have already been implemented to provide initial information on management of water in the Duchesne system, but it is anticipated that approximately 4 years will be required to collect the needed information. Target date for completion of the plan is December 2009.

There are various potential sources of both temporary and long-term water that may be available to meet the Duchesne River flow recommendations. These include--2,900 af annually from secession of Daniels Transbasin Diversion, 65 af annually from water conservation projects conducted under section 207 of CUPCA, and an unknown amount from the 44,400 af dedicated to instream flows in the upper Duchesne River as part of the Central Utah Project (CUP). Additional sources of water to meet flow needs in the Duchesne River also could be available through efficient coordination of river and reservoir operations, regulation of reservoir releases, leasing or acquisition arrangements, use of return flows currently occurring in the system, pumping from the Green River to replace existing instream diversions, increased efficiency of existing diversions, and other projects and sources not yet identified.

I.A. Identify Initial Year-Round Flows Needed For Recovery. This item has been completed. Initial flow recommendations were based primarily on historic hydrology. These flows were identified and summarized in a letter by the USFWS to the Program Director of the RIP on March 9, 1995, and were included in the 1998 Duchesne Biological Opinion. However, initial flow recommendations were never implemented.

I.A.1. Conduct Hydrology/Water Availability Study. This item has been completed. The CH2M Hill (1997) conducted a study with the main purpose of determining the effect of existing projects (both existing and future operation) on Duchesne River flows and to identify possible water sources that could be used to augment river flows, if needed, to meet preliminary flow recommendations that were identified in the 1998 Duchesne Biological Opinion. The study pointed to several potential water sources including--Bonneville Unit Fishery Flows, Daniels Creek Diversions, Land Purchase and Fallow, Conservation Projects-Delivery Systems, On-Farm Conservation Projects, and Purchase of Existing Water in Storage.

I.A.2. Conduct Followup Studies To Evaluate And Refine Flow Recommendations. This action has been completed. The Final Report, Flow Recommendations for the Duchesne River with a Synopsis of Information Regarding Endangered Fishes (Modde and Keleher 2003), was approved by the RIP in 2003. The year-round flow recommendations establish flow targets that are designed to provide for the physical process needed to maintain channel complexity and substrate quality (high flow needs) and also maintain adequate flows for endangered fish access and aquatic productivity needed to sustain the prey base for Colorado pikeminnow (base flow needs). A complete description of the flow recommendations to be implemented based on the synopsis report by Modde and Keleher (2003) and other research are provided in Appendix A. The flow recommendations provided in Appendix A revise and replace the interim flow recommendations contained in the 1998 Duchesne Biological Opinion.

I.B. State Acceptance Of Flow Recommendations. The following items under 1B Duchesne River Action Plan would be accomplished by the State of Utah in cooperation with the DRWG.

I.B.1. Review Scientific Basis. This action has been completed. The State of Utah as a member of the RIP reviewed and approved the Flow Recommendations for the Duchesne River with a Synopsis of Information Regarding Endangered Fishes (Modde and Keleher 2003).

I.B.2. Assess Legal And Physical Availability Of Water. This action has been partially completed. Legal and physical availability of water to meet the 2003 flow recommendations is currently being assessed by the State of Utah and members of the DRWG. All Federal projects are being evaluated to determine legal and physical availability of water. Bonneville Unit Fishery Flows, Daniels Creek Diversion, Land Purchase and Fallow, Conservation Projects-Delivery Systems, On-Farm Conservation Projects, Pumping from the Green River, and Direct Purchase have been identified as having potential for providing water to help meet flow recommendations. This task is ongoing but an initial assessment has been made and potential sources identified in this RPA. Recommended completion date for this task is December 2009.

I.C. Legally Protect And Deliver Identified Flows. The State of Utah will work with the DRWG to legally protect flows that are being delivered to meet the flow recommendations contained in this amendment. The new Duchesne River at Randlett gage has been installed and is providing data to the U.S. Geological Survey (USGS) internet page. Additional measurements and regulation ability may be needed to protect instream flows past existing diversion structures.

Options to manage and/or legally protect flows will be assessed by the DRWG and recommendations made to the USFWS. The Duchesne/Strawberry River commissioner is developing a list of sites to modify that could provide additional measurement and regulation ability.

I.C.1.a. Determine Amount Of Water Available From Federal Projects For Fish Use. This task is part of the coordinated reservoir operations (see section I.D.)

I.C.2.a. Determine The Amount Of Water Available From The Daniels Diversion For Endangered Fish Use And Pattern And Location For Delivery. This item has been partially completed. Initial estimates indicate that up to 2,900 af of water may be available from the Daniels Diversion to supplement Duchesne River flows. Pattern and location for delivery are yet to be determined.

I.C.2.b. Develop Agreements, If Feasible, To Deliver And Protect Water Available From Daniels Diversion. The DRWG will develop the appropriate agreements for use of any available water from the termination of Daniels Diversion for instream flows in the lower Duchesne River.

The 2004 RIP RAP identified this item for completion in FY 2005. A completion date of December 2006 is recommended for the determining the feasibility and identifying options to deliver and protect any water available from the termination of the Daniels Diversion. The USFWS anticipates that implementation of this RIP RAP item will occur in conjunction with the overall effort to deliver and protect flows.

I.D. Coordinate Reservoir Operation.

I.D.1. Determine Feasibility And Benefits Of Coordinated Reservoir Operation. The BOR initiated a coordinated reservoir operations study that was scheduled for completion in June 2003. This study should be brought to completion as soon as practical so that the DRWG has the information necessary to effectively coordinate implementation and protection of instream flows.

I.D.2. Develop Agreements, If Feasible, To Coordinate Reservoir Operation And Protect Flows To The Green River. The Strawberry Aqueduct and Collection System of the Bonneville Unit of the CUP has a commitment under Public Law 102-575 to release 44,400 af of storage as defined in the 1980 Instream Flow Agreement as amended in 1990. Flows can be released at Upper Stillwater Dam into Rock Creek, Currant Creek Dam into Currant Creek, Soldier Creek Dam into the Strawberry River and bypassed at Vat Diversion Dam into the West Fork of the Duchesne River. The Interagency Biological Assessment Team makes recommendations to the USFWS and CUWCD on how the 44,400 af should be managed to benefit fisheries in the upper river. Historically, flows that are released to the Upper Duchesne River and its tributaries have not been protected down the river system through the lower Duchesne River.

Much of the Bonneville Unit fisheries water (44,400 af) currently flows down through the lower reaches of the Duchesne and is accounted for in the historic gaged data. The DRWG will identify what role the fishery flows can play in meeting flow recommendations for the lower Duchesne, quantify availability of water (volume and timing), and develop agreements if feasible to deliver a portion of the 44,400 af of water from Bonneville Unit fishery flows as part of the CUP instream flow agreement. The DRWG will work with this and other potential sources identified by the coordinated reservoir operations study to protect endangered fish and their critical habitat in the lower Duchesne River.

The 2004 RIP RAP identified this item for completion in FY 2005 (December 2005) pending completion of the revised Flow Recommendations. Due to delays in finalizing the Flow Recommendations and in completing the Coordinated Reservoir Operations Study, a completion date of December 2009 is recommended.

I.E. Examine The Feasibility Of Other Options For Obtaining Water. This action is ongoing. Members of the DRWG are examining other options for obtaining water as part of its ongoing efforts to identify and provide water to meet the flow recommendations

I.F. Determine Need And Feasibility Of Additional Gaging. The DRWG with the assistance from the USGS has established a new gaging station at Randlett. The need for additional gages will be evaluated by the DRWG on a continuing basis.

I.F.1 Construct Additional Gages As Needed. Movement of existing gages or construction of new gaging stations will be conducted as needed starting in FY 2004 and will be complete in FY 2006 or earlier.

I.G. Evaluate And Revise As Needed, Flow Regimes To Benefit Endangered Fish Populations. Periodic monitoring of fish populations and habitat should be conducted by the RIP to evaluate the effectiveness and efficiency of the flow recommendations presented in this amendment. Ongoing nonnative fish control projects should be designed to also generate required status information on Colorado pikeminnow when possible. These activities will be conducted consistent with overall Recovery Program priorities on an annual and long-term basis.

II. Restore Habitat. There are no actions listed for the Duchesne River under Restore Habitat in the 2004 RIP RAP.

III. Reduce Negative Impacts Of Nonnative Fishes And Sportfish Management Activities.

III.A.1. Identify Most Damaging Nonnative Fishes. This task has been completed. Reports addressing this issue include Hawkins and Nesler (1991), Lentsch et al. (1996) and Tyus and Saunders (1996).

III.A.2. Assess Options To Control Negative Interactions From No nnative Fishes From The Duchesne River To Benefit Colorado Pikeminnow And Razorback Sucker Young-Of-The-Year. This task has been completed.

III.A.3. Implement And Evaluate The Effects Of Viable Measures To Control Negative Interactions From Nonnative Fishes.

III.A.3.a. Evaluate The Feasibility Of Screen On Bottle Hollow Reservoir To Control Nonnative Fish Escapement And Explore Alternative Funding Sources. This task has been completed.

III.A.3.a(1) If Feasible And Necessary, Screen Bottle Hollow Reservoir. This task has been completed. The outlet to Elder's Pond located downstream of Bottle Hollow was screened in 2002. This prevents access by nonnative fish in Bottle Hollow to the Duchesne River.

III.A.3.b. Evaluate Escapement Of Nonnative Fishes From Starvation Reservoir And Feasibility Of Screening. This task is ongoing but completion has been delayed due to the current drought. Project will be completed in 2005 or as soon as hydrologic conditions are suitable.

III.A.3.b.(1) If Feasible And Necessary Screen Starvation Reservoir. This task will be dependent on the results of III.A.3.b.

III.A.3.c. Remove Nonnative Fish (Smallmouth Bass, Channel Catfish, And Northern Pike). Although initiated in 2003 limited action was undertaken in 2003 and 2004 due to low water conditions in the Duchesne River. Some removal may be initiated in 2005 pending availability of water. This RIP RAP item should be expanded to allow for additional nonnative fish removal in out years, if removal is determined by the Recovery Program to be effective and needed to achieve Recovery Goals.

GREEN RIVER ACTION PLAN--MAINSTEM

I. Provide And Protect Instream Flows. A number of RIP RAP items relating to Flaming Gorge Dam and Green River Flows are included in the RPA for the Duchesne River Biological Opinion since operations of Flaming Gorge Dam are intended in part to offset depletions in the Duchesne River.

I.A. Green River Above Duchesne River.

I.A.3.a. Operate Flaming Gorge Dam Pursuant To The Biological Opinion (1992) To Provide Summer And Fall Flows. This RIP RAP item has been implemented and is ongoing. It is intended to provide for summer/fall flows required in the 1992 Biological Opinion.

I.A.3.b. Operate Flaming Gorge Dam To Supply Winter And Spring Test Flows For Research Purposes. This item has been completed. A final report has been prepared based in part on the research flows that presents year-round flow recommendations.

I.A.3.c. Complete National Environmental Policy Act On Reoperation Of Flaming Gorge Pursuant To Biological Opinion. This RIP RAP item is not yet complete. The National Environmental Policy Act (NEPA) compliance and a Record of Decision on the operation of

Flaming Gorge Dam to meet Green River Flow recommendations has been ongoing since FY 2000 and has been delayed several times. The 2004 RIP RAP calls for completion in FY 2004. Latest estimates are that NEPA compliance will be completed and a ROD will be issued in FY 2005.

I.A.3.d. Operate Flaming Gorge Dam To Provide Winter And Spring Flows And Revise Summer/Fall Flows, Pursuant To The Biological Opinion. This RIP RAP item is behind schedule. Flaming Gorge Dam is currently being operated in compliance with the 1992 Biological Opinion on the Operation of Flaming Gorge Dam. The BOR is presently preparing an Environmental Impact Statement (EIS) and Biological Assessment in preparation for implementing the "Flow and Temperature Recommendations for Endangered Fishes in the Green River Downstream of Flaming Gorge Dam" (Muth et al. 2000). The RIP RAP Green River Action Plan (2004) targets implementation of the Flow and Temperature Recommendations beginning in FY 2004. Due to the importance of the Green River to the endangered fishes and the role of Flaming Gorge in compensating for depletions in the Duchesne River timely completion of this item is needed. Recommend completion of this task no later than April 2005.

I.A.4.a. Protect Summer/Fall Flows. The 1992 Biological Opinion on the Operation of Flaming Gorge Dam required that within 2 years of the issuance of the Biological Opinion that flows in the Green River be protected from Flaming Gorge Dam to the confluence of the Duchesne River. It also stated that upon completion of the 5-year research program (Flaming Gorge) that BOR will work within the RIP to develop a mechanism to provide legal protection of flows for other seasons and other sections of the Green River. If legal protection is not accomplished, reinitiation of section 7 consultation (for Flaming Gorge Dam) will be required.

I.A.4.a.(1) Hold Public Meetings To Establish Future Appropriation Policy. This task was completed in October 1994.

I.A.4.a.(2) Adopt And Implement New Policy. The Utah State Engineer adopted a policy in November 1994 which protected Summer/Fall fish flows in the Green River from Flaming Gorge to the Duchesne River.

I.A.4.b. Protect Winter/Spring Flows. The 1992 Biological Opinion on the Operation of Flaming Gorge Dam required that within 2 years of the issuance of the Biological Opinion that flows in the Green River be protected from Flaming Gorge Dam to the confluence of the Duchesne River. It also stated that upon completion of the 5-year research program (Flaming Gorge) that BOR will work within the RIP to develop a mechanism to provide legal protection of flows for other seasons and other sections of the Green River. If legal protection is not accomplished, reinitiation of section 7 consultation (for Flaming Gorge Dam) will be required.

I.A.4.b.(1) Hold Public Meetings To Establish Future Appropriation Policy. The RIP RAP (2004) targeted public meetings on Winter/Spring flows for FY 2004-2005. This item is not yet complete.

I.A.4.b.(2) Adopt And Implement New Policy. The RIP RAP (2004) targeted the protection of Winter/Spring flows for FY 2004-2005. This item is not yet complete. This policy will be completed after the Record of Decision for the Flaming Gorge EIS (estimate April 2005).

I.B. Green River Below Duchesne River.

I.B.1. Initially Identify Year-Round Flows Needed For Recovery While Providing Experimental Flows. This task has been completed. Flow and Temperature Recommendations for Endangered Fish in the Green River Downstream of Flaming Gorge Dam (Muth et al. 2000) was completed and approved by the RIP in 2000.

I.B.2. State Acceptance Of Initial Flow Recommendations.

I.B.2.a. Review Scientific Basis. This action has been completed. The State of Utah as a member of the RIP reviewed and approved in 2000 the "Flow and Temperature Recommendations for Endangered Fish in the Green River Downstream of Flaming Gorge Dam" (Muth et al. 2000).

I.B.2.b. Assess Legal And Physical Availability Of Water From Green River And Tributaries. This task is ongoing under the DRWG.

I.B.3. Legally Protect Identified Flows. The 1992 Biological Opinion on the Operation of Flaming Gorge Dam required that within 2 years of the issuance of the Biological Opinion that flows in the Green River be protected from Flaming Gorge Dam to the confluence of the Duchesne River. It also stated that upon completion of the 5-year research program (Flaming Gorge) that BOR will work within the RIP to develop a mechanism to provide legal protection of flows for other seasons and other sections of the Green River. If legal protection is not accomplished, reinitiation of section 7 consultation will be required.

I.B.3.a. Hold Public Meetings To Establish Future Appropriation Policy. The RIP RAP (2004) targeted public meetings on year round flows below the Duchesne for FY 2004-2005. This item is not yet complete.

I.B.3.b. Adopt And Implement A New Policy (New Appropriations Subject To Flow Criteria). The RIP RAP (2004) targeted the protection of flows in the Green River below the Duchesne for FY 2004-2005. This item is not yet complete. Recommend completion of new policy after the Record of Decision for the Flaming Gorge EIS (estimate December 2004)

III. Reduce Impacts Of Nonnative Fishes And Sportfish Management Activities.

III.A.3. Identify And Control Sources Of Catfish And Centrarchids In The Middle Green River. The 2004 RIP RAP identified this task as complete due largely to completion of several planning efforts. The Nonnative Strategic Plan (Tyus and Saunders 1996) identified the middle and lower portions of the Green River as high priorities for nonnative fish control. The Duchesne River was considered a medium priority; however, the plan also calls for addressing the major tributary seed sources that contribute nonnative fishes to high priority reaches. In

addition, a report by Jackson and Badame (2002) addressed control of nonnative fishes in the Middle Green. A nonnative fish removal workshop conducted by the RIP in December 2003 identified the Duchesne River as a high priority area for the removal of smallmouth bass.

Nonnative control efforts in the Green River have been expanded to include problem species in the Duchesne River. Additional nonnative control efforts in the Green are a priority for the RIP and future on the ground control efforts are expected (Bob Muth pers. comm.).

IV. Manage Genetic Integrity And Augment Or Restore Populations (Stocking Endangered Fishes).

IV.A.1.c. Implement An Augmentation Plan On The Middle Green River. The augmentation plan has been implemented and is being revised as needed.

IV. General Recovery Support Action Plan.

IV.D. Plan, Design, And Construct Needed Facilities.

IV.D.2.a. Ouray. Originally designated as IV.E.2.a. (Ouray Expansion) in the RPA to the 1998 Duchesne Biological Opinion, the construction of Ouray National Fish Hatchery and ancillary facilities has been essentially completed. This hatchery, a key reproduction facility, is designed to assist in the recovery of all four listed Colorado endangered fishes.

SUMMARY

Significant progress was made implementing the previous RPA in the 1998 Duchesne Biological Opinion, particularly in research and preparatory work for implementing on the ground actions. This amended RPA includes items carried over from the RPA for the 1998 Duchesne Biological Opinion as well as new tasks. Those items which have already been completed are summarized in Table 1. The RPA items that are ongoing or not yet complete are summarized in Table 2. Recommended completion dates also are provided in Table 2 for tasks that are on going or past due according to the 2004 RIP RAP.

Table 1. Completed RPA Items (as of December 2004).

GREEN RIVER ACTION PLAN--DUCHESNE RIVER	
I.	Provide And Protect Instream Flows.
I.A.	Identify Initial Year-Round Flows Needed For Recovery.
I.A.1.	Conduct Hydrology/Water Availability Study.
I.A.2.	Conduct Followup Studies To Evaluate & Refine Flow Recommendations.
I.B.	State Acceptance Of Flow Recommendations
I.B.1.	Review Scientific Basis.
I.C.2.a.	Determine Amount Of Water Available From Daniels Diversion For Endangered Fish Use & Pattern & Location For Delivery.
III.	Reduce Negative Impacts Of Nonnative Fishes & Sportfish Management Activities.
III.A.1	Identify Most Damaging Nonnative Fishes.
III.A.2.	Assess Options To Control Negative Interactions From Nonnative Fishes From Duchesne River To Benefit Colorado Pikeminnow & Razorback Sucker Young-Of-The-Year.
III.A.3.a.	Evaluate Feasibility Of Screen On Bottle Hollow Reservoir To Control Nonnative Fish Escapement & Explore Alternative Funding Sources.
III.A.3.a.(1)	If Feasible & Necessary, Screen Bottle Hollow Reservoir.
GREEN RIVER ACTION PLAN--MAINSTEM	
Green River Above Duchesne River	
I.	Provide & Protect Instream Flows.
I.A.3.a.	Operate Flaming Gorge Dam Pursuant To Biological Opinion (1992) To Provide Summer & Fall Flows.
I.A.3.b.	Operate Flaming Gorge Dam To Supply Winter & Spring Test Flows For Research Purposes.
I.A.4.a.	Protect Summer/Fall Flows.
I.A.4.a.(1)	Hold Public Meetings To Establish Future Appropriation Policy.
I.A.4.a.(2)	Adopt & Implement New Policy.
I.B.1.	Initially Identify Year-Round Flows Needed For Recovery While Providing Experimental Flows.
Green River Below Duchesne River	
III.	Reduce Negative Impacts Of Nonnative Fishes & Sportfish Management Activities.
III.A.3.	Identify & Control Sources Of Catfish & Centrarchids In Middle Green River.
IV.	Manage Genetic Integrity & Augment Or Restore Populations (Stocking T&E Fish).
IV.A.1.c.	Implement An Augmentation Plan On Middle Green River.
GENERAL RECOVERY PROGRAM SUPPORT ACTION PLAN	
IV.D.	Plan Design & Construct Needed Facilities.
IV.D.2.a.	Ouray.

Table 2. The RPA Items Not Yet Complete (as of December 2004).

2004 RIPRAP	ACTIVITY	LEAD	EST COMPLETION
GREEN RIVER ACTION PLAN-DUCHESNE RIVER			
I.	Provide & Protect Instream Flows.		
I.B.	State Acceptance Of Flow Recommendations.		
I.B.2	Assess Legal & Physical Availability Of Water.	Utah	12/07
I.C.	Legally Protect & Deliver Identified Flow.		
I.C.2.a.	Determine Amount Of Water Available From Daniels Diversion For Endangered Fish Use & Pattern & Location For Delivery.	DRWG	
I.C.2.b.	Develop Agreements If Feasible To Deliver & Protect Water From Daniels Diversion.	URMCC	12/05
I.D.	Coordinate Reservoir Operation.		
I.D.1.	Determine Feasibility & Benefits Of Coordinated Reservoir Operation.	BOR	3/04
I.D.2.	Develop Agreements If Feasible To Coordinate Reservoir Operation & Protect Flows To Green River.	DRWG	12/07
I.E.	Examine Feasibility Of Other Options For Obtaining Water.	DRWG	Ongoing
I.F	Determine Need & Feasibility Of Additional Gaging.	DRWG	12/04
I.F.1	Construct Additional Gages As Needed.	DRWG	12/06
I.G.	Evaluate & Revise As Needed Flow Regimes To Benefit Endangered Fish Populations.	USFWS/RIP	Ongoing
III.	Reduce Negative Impacts Of Nonnative Fishes & Sportfish Management Activities.		
III.A.3.a.(1)	Evaluate Escapement Of Nonnative Fishes From Starvation Reservoir & Feasibility Of Screening.	UDWR	12/05
III.A.3.b.(1)	If Feasible & Necessary Screen Starvation Reservoir.	TBD	TBD
III.A.3.c.	Remove Nonnative Fish (Smallmouth Bass, Channel Catfish, Northern Pike).	USFWS	Ongoing
GREEN RIVER ACTION PLAN-MAINSTEM			
GREEN RIVER ABOVE DUCHESNE RIVER			
I.	Provide And Protect Instream Flows.		
I.A.4.b.(1)	Hold Public Meetings To Establish Future Appropriation Policy (Winter/Spring Flows).	Utah	9/05
I.A.4.b.(2)	Adopt & Implement New Policy (Winter/Spring Flows).	Utah	9/05
GREEN RIVER BELOW DUCHESNE RIVER			
I.	Provide & Protect Instream Flows.		
I.B.2.	State Acceptance Of Flow Recommendations (Year-Round Flows Below Duchesne).		
I.B.2.b.	Assess Legal & Physical Availability Of Water From Green River & Tributaries	Utah	9/04
I.B.3.a.	Hold Public Meetings To Establish Future Appropriation Policy.	Utah	12/04
I.B.3.b.	Adopt & Implement New Policy.	Utah	12/04
III.	Reduce Negative Impacts Of Nonnative Fishes & Sportfish Management Activities.		
III.A.3	Identify & Control Sources Of Catfish & Centrarchids In Middle Green River.	UDWR	Ongoing

CONCLUSIONS

The natural conditions of the Duchesne River have been significantly modified through flow changes, habitat changes, and introduction and establishment of nonnative fish. These modified conditions in the Duchesne River are similar to other rivers in the upper Colorado River basin. The Upper Colorado River Endangered Fishes Recovery Program has completed many activities throughout the upper Colorado River basin to move toward recovery of the listed fish. The USFWS has concluded that although the flow related recovery actions will not be sufficient to fully offset all the adverse effects of historic and new water depletions, it is expected that a combination of flow and non-flow management activities will provide suitable habitat for increasing numbers of the endangered fishes and likely restore critical habitat areas that have been substantially modified or lost to adequately offset such depletions and to avoid take including harm as defined in the Endangered Species Act. Ongoing or planned Recovery Program actions for the endangered fishes in the Colorado River include augmentation of spring peak flows, providing adequate base flows, implementing control measures for nonnative fishes, restoring access to historically occupied river reaches and habitats, and augmentation of populations through stocking to assist in reestablishing viable populations (particularly bonytail and razorback sucker). The life history of the endangered fishes suggests that populations are recruitment-limited (Wydoski and Wick 1998); therefore, ensuring adequate levels of recruitment appears to be critical for their recovery. The expected long-term response of the endangered fishes to habitat restoration and population augmentation (where needed) will be a function of the enhancement of populations through increases in abundance, expansion of current distributions, and restoration of viable population structure (i.e., all stages present and successful recruitment of young to adult stocks).

This amendment and attachment provides an updated RPA, including target flow recommendations (Appendix A) for the Duchesne Biological Opinion. These recommendations include flow targets for both peak and baseflows. Baseflow targets include a recommendation to maintain a minimum baseflows of at least 50 cfs year-round and to maintain flows from March 1 through June 30 at 115 cfs.

The USFWS recognizes that the flow recommendations as described in Appendix A may not be met in all years, particularly in times of drought. However, it is expected that the DRWG will provide information and mechanisms to meet the flows with at least the frequency that they have been met in the last 25 years which should preserve existing conditions for endangered fish in the river and will work toward the goal of achieving the desired targets that are identified in the attached recommendations. The DRWG will determine on an annual basis the availability and timing for delivery of water to meet the flow targets for the endangered fish in the lower Duchesne River. The DRWG also will review the operation of the river and recommend modified methods of operation that would provide for project deliveries and also increase the flows in the lower Duchesne River. On years when the flows may not be completely met, the workgroup will provide to the USFWS information which will allow the USFWS to determine what water is available to assist the USFWS in determining the priority and timing to use such water to work toward achieving the flow targets.

The USFWS concluded in the 1998 Duchesne Biological Opinion that the effect of implementation of the RPA described in that biological opinion would avoid the likelihood of jeopardy to the Colorado squawfish and razorback sucker and any adverse modification of critical habitat in the lower Duchesne River. This amendment updates and replaces the 1998 Duchesne Biological Opinion RPA. Implementation of the new RPA similarly avoids the likelihood of jeopardy to the Colorado squawfish and razorback sucker and any adverse modification of critical habitat in the Duchesne River. The USFWS believes the actions included in this amendment must be accomplished on schedule to halt further habitat degradation and promote restoration of important habitats and enhancement of endangered fish populations. The USFWS recognizes that the flow recommendations will not be met for all months of the year in some years; however, the USFWS anticipates that the combination of flow and non-flow recovery actions throughout the upper Colorado River basin will result in increased populations of endangered fishes and restore critical habitat. The USFWS will use fish population responses to determine if the recovery actions are producing the desired positive results, but because the endangered fishes are long-lived, detection of responses to recovery actions may take several years. Ultimately, the anticipated long-term species response to the Recovery actions is attainment of recovery goals.

Future decisions about endangered fish needs on the Duchesne River must be based on the best scientific and commercial data available, and will be largely dependent on evaluation of current management actions and ongoing research throughout the Colorado River Basin. Several uncertainties exist in the data collected on the Duchesne River, in particular, the accuracy of the Randlett gage has been suspect and future decisions and recommendations will incorporate any refinements in stream gaging on the Duchesne River.

The USFWS also recognizes that the Upper Colorado Endangered Fishes Recovery Program may adjust dates and time frames for certain activities referenced in this biological opinion as a result of shifts in priorities, drought conditions, and available funding. These changes are made through adjustments to the RIP RAP and are subject to USFWS approval. To the extent that such adjustments by the Recovery Program affect dates in this biological opinion, these adjustments are recognized by the USFWS as modifying dates for those activities in the biological opinion.

Successful implementation of all elements of this reasonable and prudent alternative will allow the RIP to serve as the reasonable and prudent alternative for Federal actions which result in depletion impacts to the Duchesne River.

Copies of this document will be distributed to State agencies, the Northern Ute Tribe, water user groups, and other interested parties. Thank you for your assistance and cooperation in formulating this revised RPA to the 1998 Duchesne Opinion and for your interest in conserving endangered species

Attachment

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APPENDIX A
DUCHESNE RIVER FLOW RECOMMENDATIONS

Introduction

Between 1997 and 2000, the Upper Colorado River Basin Endangered Fishes Recovery Implementation Program conducted a series of studies to define larval, juvenile, and adult fish use in the Duchesne River [Early life-stage and fish community investigations in the lower Duchesne River, 1997-1999 (Brunson and Christopherson 2003)]; identify flows needed to maintain existing habitat complexity [High flow requirements for channel and habitat maintenance of the lower Duchesne River between Randlett and Ouray, Utah (Gaueman, Wilcock, and Schmidt 2003)]; and, identify the base flows that contribute to the recovery of endangered fishes [Base flow needs for endangered fish in the Duchesne River (Haines and Modde 2003)]. A synthesis report, Flow Recommendations for the Duchesne River With a Synopsis of Information Regarding Endangered Fishes, Modde and Keleher (2003), also was developed that provides flow recommendations for the Duchesne based on the research conducted in the Duchesne River and other relevant information. The Duchesne River flow recommendations presented herein are consistent with and based on information contained in the aforementioned reports though some recommendations have been simplified for clarity and ease of implementation. Readers are urged to refer to the summary of new information contained in the amendment to the biological opinion, original reports, and other supporting documents for additional background and detailed information.

Flow Recommendations for the Duchesne River

Duchesne River flow recommendations are dependent on hydrologic conditions in a given year with greater flows recommended in wet years than dry. Recommended flows are intended to maintain the existing level of habitat availability and endangered fish use. The recommendations are based on an integration of physical processes needed to maintain channel complexity and substrate quality (High Flow Recommendation) with maintenance of adequate flows needed for endangered fish access, and aquatic productivity needed to sustain prey base for Colorado pikeminnow (Base Flow Recommendation).

High Flow Recommendations

High flow recommendations were designed to maintain the geomorphic processes that form and maintain the present level of channel complexity that in turn dictates habitat availability for endangered fishes, and provide discharge needed to rearrange and clean substrate which determines biological productivity. Two different approaches are presented to maintain channel geometry, channel forming, and maintenance processes (High Flow Recommendation). The approaches are compatible and result in similar flows recommendations that support the current habitat in the Duchesne River but represent varying degrees of flexibility in their implementation.

High Flow Recommendation - Alternative 1

In the first alternative an instantaneous peak flow of 8,400 cfs needs to recur in 8.2–10 percent of years (approximately 10-year recurrence interval) and flows between 2,500 and 5,600 cfs need to occur at the specified durations during 7 of 10 years as outlined in Table 1. The occurrence of 8,400 cfs in 8.2-10 percent of years will promote channel migration, maintain off-channel

topographic complexity, maintain channel dimensions, and rejuvenate riparian vegetation. Intense scouring of the channel bed will remove fine sediment from the gravel framework, and fine sediment will be flushed from the full range of low velocity habitats along the lower Duchesne River. These processes are necessary to maintain the current level of channel integrity and habitat diversity now present in the Duchesne River. Flows between 3,000 and 5,000 cfs for the duration identified in Table 1 for the wet hydrological years (435,000 to 765,000 af) will result in widespread bed entrainment that maintains riffle and pool topography, maintains channel dimensions, and contributes to channel migration. Regular flow events exceeding the bankfull stage are necessary to prevent the establishment of riparian vegetation within the bankfull channel. In addition, fine sediment will be flushed from gravel substrates and from many low velocity habitats adjacent to the main channel. In average flow years (224,000 to 435,000 af), flows of 2,500 cfs for 7 days will transport fine sediment delivered to the lower Duchesne River that will balance the sediment budget and prevent fine sediment accumulation in low-velocity habitats (Modde and Keleher 2003).

High Flow Recommendation - Alternative 2

An alternate approach to providing the flows necessary to maintain the geomorphologic processes identified above is through a cfs-day approach. This approach is based on the findings by Gaeuman et. al (2003) that an average annual channel-forming stream volume of at least 7,000 cfs days per year is sufficient to promote channel migration and maintain channel integrity. Gaeuman et. al (2003) found that widespread gravel entrainment occurs over significant portions of the channel at discharges near 4,000 cfs in the lower Duchesne River. A discharge of approximately 4,000 cfs also was necessary to initiate flow over high bar surfaces in the river channel. Therefore, they estimated the threshold discharge for channel maintenance in the study area as approximately 4,000 cfs. The total volume of flows exceeding this threshold magnitude for a given year (i) can be expressed by the variable T_i in the units of cfs-days. This quantity represents the sum of the differences between the mean daily discharge and the specified channel maintenance threshold for all flows greater than the threshold. T_i is calculated as:

$$T_i = \sum_{j=1}^{n} \left[\overline{Q}_{Tij} - 4000 \right]^b$$

where $\overline{Q}Tij$ represents the mean daily discharge in cfs on the n days during year i on which the daily mean was greater than 4,000 cfs, and b is assumed equal to 1. All days during the year on which the daily mean discharge was less than 4,000 cfs are discarded. Under this approach the total volume of water each year in excess of the 4,000 cfs particle entrainment threshold is averaged over an extended period of record. For example, if a daily mean discharge of 5,300 cfs occurred on 2 separate days (n=2) during year i, and the daily mean discharge was less than 4,000 cfs on all other days of the year the total volume of flow in excess of the 4,000 cfs channel forming threshold (T_i) would be 2,600 cfs-days. In a given year if the mean daily flow never exceeded 4,000 cfs there would be 0 cfs-days for the year. If in a given year mean daily flows were at 7,000 cfs for 1 day, 6,000 cfs for 3 days, and 5,000 cfs for 6 days the cfs-days for that year would be 15,000. A long-term average of 7,000 cfs-days per year in excess of the particle entrainment threshold would ensure that critical geomorphologic processes such as gravel entrainment and transport, bank erosion and movement of fine sediments in the channel is accomplished in the Duchesne River (Gaeuman et. al 2003).

Table 1. High Flow Recommendations for the Lower Duchesne River - Alternative 1.

Hydrologic Category	Percent Occurrence	Flow & Duration Targets	Description of Anticipated Effects
Extremely Wet (> 765,000 af)	10%	8,400 instantaneous 5,600 at least 1day 5,100 at least 2 days 4,700 at least 4 days 4,400 at least 7 days 4,000 at least 10 days 3,000 at least 17 days	The occurrence of 8,400 every 10 years will promote channel migration, maintain off-channel topographic complexity, maintain channel dimensions, and rejuvenate riparian vegetation. Intense scouring of the channel bed will remove fine sediment from the gravel framework, and fine sediment will be flushed from the full range of low velocity habitats along the lower Duchesne River. These processes are necessary to maintain the current level of channel integrity and habitat diversity now present in the Duchesne River.
Wet (435,000 to 765,000 af)	30%	5,600 at least 1day 5,100 at least 2 days 4,700 at least 4 days 4,400 at least 7 days 4,000 at least 10 days 3,000 at least 17 days	Widespread bed entrainment will maintain riffle and pool topography, maintain channel dimensions, and contribute to channel migration. Regular flow events exceeding the bankfull stage are necessary to prevent the establishment of riparian vegetation within the bankfull channel. In addition, fine sediment will be flushed from gravel substrates and from many low velocity habitats adjacent to the main channel.
Average (224,000 to 435,000 af)	30%	2,500 at least 7 days	These flows will transport fine sediment delivered to the lower Duchesne River in order to balance the sediment budget and prevent fine sediment accumulation in low velocity habitats.
Dry (< 224,000 af)	30%	No peak flow recommendation	

Base Flow Recommendation

Base flow recommendations are separated into two periods and are outlined in Table 2. Recommendations for the base flow period are intended to meet two important needs-- (1) Colorado pikeminnow passage requirements (March 1-June 30) and, (2) maintenance of a minimum level of instream productivity in order to support a prey base for the Colorado pikeminnow for the remainder of the year (July 1-February 28).

Base flow recommendations for the Duchesne River were developed using empirical data to define minimum flows required for Colorado pikeminnow passage and flow levels below which aquatic habitats necessary to maintain a prey base are rapidly reduced. Base flow recommendations also were predicated on the assumption that flows in the Duchesne River during the last 25 years (approximately three generations of Colorado pikeminnow) have been generally adequate to maintain existing numbers of pikeminnow and the required prey base now utilizing the river. This approach has resulted in recommendations that are variable and dependent on yearly runoff and seasonal hydrology, but also establish minimum flow targets.

Base Flow Passage Recommendation

The base flow recommendation for Colorado pikeminnow passage (March 1-June 30) overlaps with the high flow recommendation and is intended to cover the pre- and post-runoff period. The passage flow recommendation is to target flows similar to the recent period of record[1], keeping flows at or above 115 cfs when possible in dry years. Targeting flows similar to the last 25 years with a 115 cfs minimum primarily provides for maintenance of fish access and passage for adult Colorado pikeminnow in the Duchesne River. Passage flows are most important during the spring and early summer (March 1-June 30) when most Colorado pikeminnow have been observed using the river. Flows of 115 cfs provide a depth of at least 30 cm through 22 of 27 riffles and depths of at least 20 cm in all riffles in the lower river up to Randlett gage which would permit passage of all but the largest fish (Moode and Keleher 2003). In addition, flows of 115 cfs or greater also would ensure that the productive riffle habitats used by Colorado pikeminnow are largely inundated and available to pikeminnow for foraging (Haines and Modde 2003).

Base Flow Productivity Recommendation

The base flow recommendation for instream productivity is intended to maintain the prey base for Colorado pikeminnow that utilize the Duchesne River system. This portion of the base flow recommendation focuses on the summer/fall/winter period (July 1-February 28) and targets flows similar to those observed in the recent period of record with a recommended minimum target of 50 cfs. Maintenance of flows during the summer/fall/winter base flow period similar to the recent period of record with a minimum to prevent short term catastrophic loss of aquatic habitat would ensure that adequate prey populations for the Colorado pikeminnow are maintained in the Duchesne River.

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[1] Recent Period of Record defined as 1977-2002 at Randlett Gage, Duchesne River.

Haines and Modde (2003) used the wetted perimeter methodology to estimate the flows needed to maintain biological productivity and a curve-break analysis to define a flow that would maintain the greatest amount of habitat with the least volume of flow. The curve-break analysis identified a flow of 115 cfs as the flow in which a major reduction in habitat occurred in riffle areas, which would in turn result in similar reductions in invertebrate and fish production. They also estimated that a 50 percent loss of total riffle wetted perimeter occurred at a flow of 50 cfs. Modde and Keleher (2003) using information generated in the report by Haines and Modde (2003) recommended that flows not drop below 50 cfs in the Duchesne River below Randlett due to large losses of habitat and productivity associated with those very low flows.

For the purpose of comparison, base flows needs also were estimated using a widely applied reconnaissance technique, the Montana Method, Tennant (1976). The Montana method recommends a base flow of 60 percent of the unregulated average annual flow (AAF) of a stream or river to maintain excellent to outstanding habitat for most aquatic life forms during their primary growth period. The method recommends 30 percent of the AAF to sustain good survival habitat and minimum instantaneous base flows equal to 10 percent of a stream's AAF to maintain short term survival habitat for aquatic organisms. The same criterion applied to the Duchesne River would result in base flows as follows:

- 60 percent of the AAF or 645 cfs would maintain excellent to outstanding habitat.

- 30 percent of the AAF or 322 cfs would maintain good survival habitat.

- 10 percent of the AAF or 107 cfs would be a minimum instantaneous flow necessary to sustain short term survival habitat for aquatic organisms. The unregulated AAF for the Duchesne River at Randlett was estimated to be approximately 1,075 cfs and was derived from Table 5-2 of the report entitled Duchesne River hydrology and water availability study prepared by CH2M Hill (1997).

A comparison of base flow needs as generated by the two methods shows that the USFWS recommendations are lower than baseflows that would result from the Montana Method. This can be attributed in part to the more detailed information collected for the USFWS recommendation compared to the Montana Method which does not require site specific crossectional information. However, the level of channel innundation or wetted perimeter that would be maintained by the USFWS baseflow recommendations correspond to what is recommended under the Montana Method. Tennant's recommendation for 30 percent of the AAF to maintain good survival habitat is based on maintaining a flow at which a majority of the substrate in the stream would be covered except for wide shallow riffle or shoal areas. Similarly Tennant's recommendation for 10 percent of the AAF to maintain minimum survival habitat is largely based on statistical relationship in his study streams that showed 10 percent of the AAF was sufficient to maintain approximately 50 percent of the wetted perimeter. Haines and Modde (2003) in their study on the base flow needs for endangered fish projected that a flow of 115 cfs maintained approximately 70 percent of the total riffle wetted perimeter and a flow 50 cfs maintained approximately 50 percent of the total riffle wetted perimeter at their study crossections on the Duchesne River. This correlates well with Tennant's recommendations for flows to maintain good and minimum survival habitat respectively.

Maintenance of flows similar to the recent period of record (Table 3) with flows of at least 115 cfs during March through June and 50 cfs or greater during July through February would provide passage in the Duchesne River for pikeminnow during the months they have been commonly documented in the River. In addition, the recommended level of base flows would provide good to excellent habitat for the aquatic prey base in approximately 40 percent of the years and minimal to good habitat in the remaining years.

Table 2. Base Flow Recommendations for the Duchesne River Measured at the Randlett Gage[2].

Base Flow Passage Recommendation (March 1 - June 30)	**Base Flow Productivity Recommendation (July 1 - February 28)**
Flows similar to the recent period of record with a target flow of 115 cfs or greater between March 1 and June 30. • Flow management efforts should focus on prevention of flows <50 cfs in very dry years with consideration given to supplementing flows to 115 cfs, if water is available.	Flows similar to the recent period of record[3] with a target of 50 cfs or greater between July 1 and February 28. • During average to wet years (< 50% exceedance) target flows similar to the recent period of record. • During average to dry years (≥50% exceedance) target flows of 50 cfs or greater. • Flow management efforts should focus on prevention of flows <50 cfs.

Summary

The base flow recommendation establishes two target flows. The passage flow recommendation is for flows similar to the 1977-2002 period of record with a target flow of at least 115 cfs from March 1 to June 30, in dry years, to ensure passage of Colorado pikeminnow in the Duchesne River. The aquatic productivity base flow recommendation similarly targets flows consistent with the recent period of record but with a target flow of at least 50 cfs from July 1 to February in dry years to maintain aquatic productivity.

Meeting Flow Recommendation Targets

The flow recommendations specifically address the reach of the Duchesne River downstream from the confluence of the Uintah River. Compliance with the recommendations should be measured at Randlett or other comparable gage(s). Instream flows needs for the Duchesne River upstream of the Randlett gage were not specifically quantified. However, due to the documented occurrence of Colorado pikeminnow in the Duchesne River upstream to Myton and the importance of upstream areas to prey fish production it recommended that a significant portion of the water delivered to the target reach (below Randlett) be delivered from the Duchesne River above the confluence with the Uinta River in order to provide some level of minimum flows in the Duchesne River between Myton and the Randlett Gage for fish passage and biological productivity in that stream section.

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[2] See section on Meeting Base Flow Recommendation for description of flow augmentation priorities.

[3] Recent Period of Record defined as 1977-2002.

Additional hydrologic information is provided in Tables 3, 4, and 5. These tables summarize flows in the recent period of record and provide an indication of stream flows under current operations in the system. As such they are useful in helping to identify the time periods which should be targeted for additional flow management in order to achieve flow targets . Table 3 provides average monthly flows and exceedance levels for a series of water years from the recent period of record. Table 3 with the addition of minimum flow targets should be used as a general guide for instream flows in the Duchesne River. Table 4 shows the number of occasions by water year and exceedance level and month that flows have dropped below 115 cfs and provides both an indication of when flows drop below optimum for fish passage and when aquatic productivity begins to be significantly reduced. Table 5 shows similar data for when flows have dropped below 50 cfs and provides an indication of when flows are so low that 50 percent or greater of the aquatic riffle habitats are lost and flows are at or below minimums need to maintain long-term aquatic productivity.

Meeting High Flow Recommendation

High flow recommendations for the Duchesne River are consistent with high flows that have occurred in the1977-2002 period of record and no special or extraordinary management is considered necessary to continue to meet the high flow component of these recommendations.

Meeting Base Flow Recommendation

In meeting the base flow recommendations it is important to target flows similar to the 1977-2002 period of record (Table 3) not just minimum targets. Periods of higher base flow that provide increased access for Colorado pikeminnow in the system and in particular, more favorable habitat for the aquatic food base are needed to compensate for drought years when flows are low and aquatic habitat and productivity are reduced. It is not anticipated that special flow management actions will be required to meet flows above the identified minimums since these flows already occur in the river.

However, there are a number of occasions in the recent period of record when the minimum passage and aquatic productivity base flow targets have not been met. Table 4 shows that the minimum passage flow of 115 cfs during March-June is largely met in average to wet years or approximately 50 percent of all water years. Some passage occurs in water years ranging from 85 to 50 percent exceedance (approximately 35 percent of water years) and fish passage flows are generally insufficient for extended periods of time in low water years greater than 85 percent exceedance (approximately 15 percent of water years).

Similarly, the minimum aquatic productivity base flow of 50 cfs from July through February is consistently met in up to 40 percent of all water years when flows are at the 40 percent exceedance level and less. Flows can fall below 50 cfs at variable levels ranging from 0 to 27 times per month (average 8.9 days/month) at flow levels between 90 percent exceedance and 40 percent exceedance levels (approximately 50 percent of all water years) and consistently fall below 50 cfs at water years equivalent to 90 percent exceedance or greater (approximately 10 percent of the time). In addition, flows can occasionally fall below 50 cfs (average 5.8 days/month) during the March through June period in water years that range between 75 and 90 percent exceedance (approximately 15 percent of all years) and consistently drop below 50 cfs during 90 percent exceedance years and greater (10 percent of all water years).

Priorities for water management are based on the need to maintain aquatic productivity in the system. Highest priority is given to maintaining flows during the growing seasons and secondarily during the spring and winter seasons. Flows for passage are considered a lower priority since pikeminnow have not been shown to be permanent residents in the Duchesne River and currently flow regimes similar to the recent period of record would ensure at least some access from the Green River in 8 of 10 years. Based on these priorities and also the uncertain nature of water supplies in the Duchesne River system, the USFWS recommends the following order of priorities for water management:

1) Highest priority should be given to implementing actions to meet the 50 cfs aquatic productivity base flow during the months of July through October. Maintaining habitat during the summer growing season will likely provide the greatest benefit to organisms that are important to aquatic productivity in the river system.

2) Consideration should be given to enhancing base flows to meet a 50 cfs target during the spring months of March through June during low flow years. Providing minimum flows during those months would enhance the aquatic productivity of the system by providing favorable conditions for aquatic production early in the growing season.

3) During extreme low flow years water supplies, if available should be managed to meet a 50 cfs target during the winter months of November through February. Providing a flow of at least 50 cfs during the winter months would help prevent winter kill of organism and loss of habitat through dessication.

4) Consideration also should be given to supplementing flows to meet passage requirements (115 cfs) for Colorado pikeminnow during the March through June period if water is available. However, base flows to maintain aquatic productivity are considered a higher priority.

The USFWS recognizes that the flow recommendations may not be achievable in all years. However, by using the recommendations as a framework to help guide flow management in the system, conditions can be improved for the endangered fishes such that the Duchesne can contribute to the overall recovery of the Colorado pikeminnow and razorback sucker.

Uncertainties

There are several uncertainties associated with the research and supporting hydrology on which the flow recommendations are based. These include:

1) Flow measurements were based on records from the USGS Randlett gage. Due to icing, channel configuration, and difficulty maintaining a rated crossection, some of the data is estimated. As a result of difficulties associated with the gage it was moved to a new location in 2004. If new information shows that the Randlett data have been consistently incorrect the flow recommendations will need to be reevaluated.

2) Gaeuman et al. (2003) stated that "significant uncertainty exists regarding the accuracy of the ratings relations for high discharges when a disproportionately large quantity of sediment is transported." This was due to the fact that of the 136 measurements of suspended sediment concentrations used to develop rating relations only 2 were taken at discharges grater than the 1.5-year flood (1,840 cfs). Gaueman suggested that estimates derived from the ratings relations may be low and underestimate the amount of sediment transported during infrequent high discharge events or during particularly wet years. A more detailed description of uncertainties associated with the flow recommendations can be found in the report by Modde and Keleher (2003) on page 27.

3) Calibration flows for the model used to determine the wetted perimeter-discharge relations and base flow needs (Haines and Modde 2003) were higher than the actual flows modeled which may have introduced an extrapolation error. Bovee and Milhous (1978) recommended that the useful range of extrapolation is 0.4 to 2.5 times the calibration flow. Haines and Modde (2003) simulated flow levels between 1 and 300 cfs with about half of the simulations exceeding the recommended range, potentially resulting in a 50 to 60 percent error (Bovee and Milhous 1978).

As a result of the uncertainties identified in that report, the USFWS recommends that, though the flow recommendations were based on the best available information, fish populations and habitat be periodically monitored to ensure that the recommendation are appropriate for the system and are having the desired effect of maintaining Colorado pikeminnow use in the river system.

Table 3. Duchesne River at Randlett, Average Monthly Flows (cfs) for Representative Water Years 1977-2002[4].

Exceedance	WY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL af
4%	1983	1,405	1,025	984	973	909	1,197	836	1,391	7,988	2492	878	788	1,256,984
8%	1984	1,529	1,443	1,353	1,246	984	995	722	2,182	2,434	1047	861	736	940,536
10%	1998	1,367	829	788	784	814	789	426	666	3,524	1549	600	805	779,732
15%	1986	279	479	522	483	767	800	638	1,758	5,501	818	223	486	765,616
20%	1999	834	1,038	787	636	794	684	329	679	3,736	477	432	970	683,841
25%	1997	101	237	297	277	349	856	657	1,586	2,409	160	396	1,264	517,880
30%	1985	1,124	1,014	706	593	468	709	467	1,184	1,050	347	190	345	496,018
40%	1982	228	174	312	445	629	569	551	1,074	2,462	762	187	546	476,903
50%	1978	62	78	99	172	250	345	420	292	1,846	131	49	63	227,964
60%	1988	260	278	349	318	398	573	279	194	142	120	115	89	188,114
70%	2001	75	104	215	198	218	206	121	941	288	59	44	39	151,770
75%	1993	71	77	101	98	112	199	134	683	600	90	96	89	142,170
80%	1989	95	128	110	119	138	261	193	82	104	53	68	81	86,359
85%	1991	98	85	104	106	144	106	51	51	349	91	108	144	86,147
90%	1992	113	115	113	165	191	171	55	59	79	98	62	75	79,915
95%	1977	115	125	127	150	185	173	37	49	65	46	38	47	69,506
98%	1990	53	43	40	43	51	88	42	49	301	80	44	84	55,311
100%	2002	32	75	97	94	129	137	30	27	23	7	6	54	42,654
AVERAGE		436	408	395	383	418	492	333	721	1,828	468	244	372	391,523

[4] Data provided by Central Utah Water Conservancy District.

Table 4. Duchesne River at Randlett, Number of Days with Flows <115 cfs for Representative Water Years[5].

WYOMING TOTALS														
Exceedance	**WY**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**Total**
4%	1983	0	0	0	0	0	0	0	0	0	0	0	0	0
8%	1984	0	0	0	0	0	0	2	2	0	0	0	0	0
10%	1998	0	0	0	0	0	0	0	0	0	0	0	0	4
15%	1986	0	0	0	0	0	0	0	0	0	0	0	0	0
20%	1999	0	0	0	0	0	0	0	0	0	0	0	0	0
25%	1997	21	0	0	0	0	0	0	0	0	7	0	0	28
30%	1985	0	0	0	0	0	0	0	0	0	2	3	0	5
40%	1982	3	0	0	0	0	0	0	0	0	0	0	0	3
50%	1978	31	30	19	0	0	0	0	6	0	21	31	30	168
60%	1988	0	0	0	0	0	0	0	8	15	19	10	23	75
70%	2001	29	20	2	0	0	5	18	3	10	31	31	30	179
75%	1993	30	30	29	30	16	0	14	12	0	25	23	25	234
80%	1989	29	8	18	13	7	0	13	28	21	29	29	24	219
85%	1991	26	30	25	23	0	17	30	30	7	27	21	13	249
90%	1992	21	12	13	0	0	1	30	22	30	21	31	30	211
95%	1977	14	20	1	0	0	6	29	29	26	29	29	30	213
98%	1990	30	30	31	31	27	23	30	30	10	29	31	28	330
100%	2002	31	30	30	31	6	6	30	31	30	31	31	29	316
AVERAGE		15	12	9	7	3	3	11	11	8	15	15	15	124

[5] Data provided by Central Utah Water Conservancy District.

Table 5. Duchesne River at Randlett, Number of Days with Flows <50 cfs for Representative Water Years[6].

WYOMING TOTALS														
Exceedance	**WY**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**Total**
4%	1983	0	0	0	0	0	0	0	0	0	0	0	0	0
8%	1984	0	0	0	0	0	0	0	0	0	0	0	0	0
10%	1998	0	0	0	0	0	0	0	0	0	0	0	0	0
15%	1986	0	0	0	0	0	0	0	0	0	0	0	0	0
20%	1999	0	0	0	0	0	0	0	0	0	0	0	0	0
25%	1997	0	0	0	0	0	0	0	0	0	0	0	0	0
30%	1985	0	0	0	0	0	0	0	0	0	0	0	0	0
40%	1982	0	0	0	0	0	0	0	0	0	0	0	0	0
50%	1978	1	0	0	0	0	0	0	0	0	13	21	12	47
60%	1988	0	0	0	0	0	0	0	0	0	0	0	0	0
70%	2001	0	0	0	0	0	0	0	0	0	8	20	27	55
75%	1993	0	0	0	0	0	0	3	1	0	4	3	0	11
80%	1989	0	0	0	0	0	0	10	3	0	17	11	13	54
85%	1991	0	0	0	0	0	0	17	18	0	0	0	0	35
90%	1992	0	0	0	0	0	0	14	3	1	0	10	2	30
95%	1977	0	0	0	0	0	0	24	19	17	21	25	16	122
98%	1990	16	29	27	24	15	7	23	21	3	1	21	2	189
100%	2002	27	0	0	0	0	0	26	29	28	31	31	12	184
AVERAGE		2	2	2	1	1	0	7	5	3	5	8	5	41

[6] Data provided by Central Utah Water Conservancy District.

Literature Cited

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