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FLOW RECOMMENDATIONS FOR THE DUCHESNE RIVER WITH A SYNOPSIS OF INFORMATION REGARDING ENDANGERED FISHES

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Draft Final Report Submitted to the Upper Colorado River Basin Endangered Fishes Recovery Implementation Program
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Acknowledgment and Disclaimer

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Duchesne River, flow recommendations, endangered fishes, nonnative fishes, channel morphology, sediment transport

Executive Summary

The Duchesne River is a highly modified river system that has been influenced by both natural precipitation patterns and intense water development. Currently, most endangered fishes reside in the Duchesne River only during non-winter months. Colorado pikeminnow adults were found in the lower Duchesne River between the confluence and Myton, Utah, (approximately 35 river miles) during the spring and summer months, whereas razorback sucker adults were only captured in the transition reach between the Green and Duchesne rivers in the spring. Few immature Colorado pikeminnow or razorback sucker were collected in the Duchesne River. Adult pikeminnow use of the Duchesne River appeared to be related to opportunistic foraging activity. Several prey species spent their entire life history in the Duchesne River providing a potential prey base for Colorado pikeminnow. The timing of most Colorado pikeminnow entering the Duchesne River coincided with lower temperatures and higher velocities in the main channel.

Flow recommendations for the Duchesne River represent an integration of physical processes needed to maintain channel complexity and substrate quality (high flow needs), with maintenance of adequate flows needed for endangered fish access, and productivity needed to sustain the prey base supporting Colorado pikeminnow (base flow needs). High flow recommendations for the Duchesne River were designed to maintain the geomorphic processes that form and maintain the present level of channel complexity, dictate habitat availability for endangered fishes, and provide discharge needed to rearrange substrate. These processes are based on the flows needed to mobilize bed load, maintain channel movement, and transport fine sediment as described by Gaeuman et al. (2003). Base flow recommendations for endangered fishes in the Duchesne River address flows needed to access available habitat and specifically address the needs of adult Colorado pikeminnow. Because razorback sucker were found in the extreme lower reach of the river during spring flooding, flow needs are provided by the Green River. Base flows recommended for the recovery of Colorado pikeminnow include magnitude, duration and frequency needed to ensure spring and summer access to the river, and flows needed to maintain biological productivity to support the resident prey base for pikeminnow

during the spring and summer.

Flow Recommendations

In order to maintain the present channel forming processes, two compatible high flow recommendations are presented. In the first alternative an instantaneous flow of 8,400 cfs needs to recur in 8.2 – 10 % 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 % 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 acre-ft) 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 acre-ft), 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.

An alternate approach to providing the flows necessary to maintain the geomorphologic processes identified above is through a cfs-day approach. Using this approach an average annual target of 7,000 cfs days is recommended. Under this approach the total volume of water each year in excess of the 4,000 cfs particle entrainment treshold is averaged over an extended period of record.. 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 (Gaeuman 2003).

Base flow recommendations are founded on Colorado pikeminnow passage requirements (March 1-June 30) and 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 (June 30-February 28). The base flow recommendation calls for a minimum flow of 115 cfs between March 1 and June 30 to ensure fish access and passage. During the remainder of the year the base flow recommendation is for a minimum flow of 50 cfs to 115 cfs to ensure adequate prey populations for the Colorado pikeminnow During wet years flows should not fall below 115 cfs. During normal to dry years flows between June 30 and February 28 should not fall below 115 cfs at a frequency greater than that observed in the last 25 year period of record (1977-2002) and every effort should be made to maintain flows above 50 cfs at all times (Table 2).

Introduction and Background

The Duchesne River has the largest drainage among tributaries in the alluvial Green River. The headwaters of Duchesne River are in the southern slope of the Uinta Mountain Range. Several tributaries, including the Strawberry, Lake Fork, and Uinta rivers drain the south slope of the Uinta Mountain Range and enter the Duchesne River, which flows southeasterly to its confluence with the Green River. Except for the lower 6 miles, the Duchesne River has a gradient of approximately 0.002 and the streambed consists primarily of gravel and cobble (Brink and Schmidt 1996). The lower six miles of river is a low gradient (0.0005) transition area and the bottom substrate consists primarily of fine sediment. Brink and Schmidt (1996) provided a historic description of the morphological changes in the Duchesne River during the last century. Changes in both precipitation patterns and water depletions have resulted in narrowing and widening episodes in some reaches and a loss of sinuosity in the lower 6 miles. In describing the lower 15 miles of the Duchesne River, Gaeuman et al. (2003) stated that:

> The 20th century geomorphic history of the lower Duchesne River includes complex adjustments to changes in both sediment supplies and water discharge. The nature of the adjustments are varied both spatially and temporally over a period of at least 65 years, and continues to influence river morphology to the present day. This history can be condensed into a few periods of consistent trends and processes. These are 1) channel narrowing, filling of side channels, and avulsions before 1950, 2) channel metamorphosis involving extreme widening of short reach downstream of Pipeline (rmi) between 1948 and 1987, 3) bend extension with frequent chute cutoffs throughout the middle part of the study area, and 4) relative stability in the upstream part of the study area.

The average annual yield of Duchesne River, measured at the Randlett gage, is estimated to be 768,000 acre feet (CH2MHill 1997). During the period of record from 1970 to 1990, depletions from both private and federal sources have reduced the annual water yield by 54% according to CH2MHill (1997), while information provided by the Utah Assistant State Engineer to the U.S. Fish and Wildlife Service (USFWS 1998) stated that the average depletion from the Duchesne River is 74%. This dramatic reduction in flows has contributed to morphological changes in the Duchesne River (Brink and Schmidt 1996, Gaeuman et al. 2003), which has no doubt affected habitat use and availability for fish. Gaeuman et al. (2003) stated the Duchesne River channel has responded physically to the occurrence of wet and dry cycles in the drainage over the past 50 years, and that the implementation of any flow protection requires recognition of this flow variability. They stated that the Duchesne River channel and floodplain is primarily maintained during the wet periods, and the channel likely accumulates sediment during dry periods. Increases in duration of dry periods limits the ability of wet-period floods to restore channel dimensions and dynamic behavior, which determine habitat and productivity to fishes.

Diversions from the Duchesne River occurred early in the development of the Uintah Basin. Following the establishment of the Ute Reservation in 1861, the Bureau of Reclamation promoted irrigation and by 1899 at least 14 canals had been constructed (Berger et al. 2003). As homesteading began in the early twentieth century and irrigation demands increased, several irrigation companies secured water rights and began diverting water from the Duchesne River drainage (Berger et al. 2003). The first transbasin water diversion, the Strawberry Valley Project, was reportedly activated in 1899 with Strawberry River water transported to the Heber Valley. In 1922, the Bureau of Reclamation constructed Strawberry Reservoir as a storage unit for water diverted from the Duchesne River drainage. This project was absorbed into the Central Utah Project, which was established as part of the Colorado River Storage Act in the 1950's. The Central Utah Project has seven operational units, the largest of which is the Bonneville Unit. The principal purpose of the Bonneville Unit was to transfer 136,000 acre-feet of water annually from the Uintah Basin to the Bonneville Basin. The Bonneville Unit plan included the construction of ten reservoirs, enlargement of existing reservoirs, nine pumping stations, more than 140 miles of tunnels, canals, and aqueducts, as well as 200 miles of pipe drains. A smaller transbasin diversion also delivers up to 31,700 acre-feet of water, at full demand, to the Provo River. The operational plan for transbasin diversions is to divert spring high flows from the Duchesne River basin to storage units that can deliver water to the Wasatch Front. A thorough discussion of federal water development in the Duchesne River drainage is provided in the Fish and Wildlife Service Biological Opinion, Duchesne River Basin (USFWS 1998) and the

Duchesne/Strawberry Water Users Association Hydrologic Web Site System Description (Berger et al. 2003).

Historically, the Duchesne River was important to Colorado pikeminnow and razorback sucker (USFWS 1998). Despite being the largest Green River tributary in the Uintah Basin, the importance of the Duchesne River to endangered fishes has been reduced by barriers to passage, water depletions and interactions with nonnative fishes. Due to water related impacts, the value of the Duchesne River to recovery of endangered fishes was ranked much lower than the White River, which is similar morphologically, hydrologically and geographically (Tyus and Saunders 1996). These environmental changes have created severe pressures on native fish populations forcing behavioral changes to respond to altered habitats that created additional predatory and competitive burdens. Although the potential contribution of the Duchesne River has been reduced, current use of the Duchesne River by endangered fishes (Cranney 1994, Modde and Haines 2003) suggests that this tributary continues to be a resource to Colorado pikeminnow *Ptychocheilus lucius* and razorback sucker *Xyrauchen texanus* and can contribute to recovery of both species. In recognition of this resource the lower 2.5 miles of the Duchesne River was designated as critical habitat for razorback sucker in 1994 (Fed. Reg./Vol. 59, No. 54/Monday, March 21, 1994). In an effort to maintain the present value of the Duchesne River to recovery of endangered fishes, the U.S. Fish and Wildlife Service provided preliminary flow recommendations for the Duchesne River in 1998 (USFWS 1998). These preliminary flow recommendations (Appendix 1), which were based on hydrological history, were to be revised based on studies supported by the Recovery Implementation Program for the Endangered Fishes of the Upper Colorado River (RIP). Between 1997 and 2000, the RIP conducted four coordinated studies that defined use of larval, juvenile (Brunson and Christopherson 2003) and adult (Modde and Haines 2003) fishes in the Duchesne River, identified high flows needed to maintain existing habitat complexity (Gaeuman et al. 2003) and the base flows (Haines and Modde 2003) that contribute to the recovery of endangered fishes. The purpose of this report is to synthesize all available information and recommend flows needed to support endangered fishes in the Duchesne River, and within the constraints of present and future hydrological limitations, assess the potential contribution of the Duchesne River to recovery of endangered fishes. This report will summarize fish use patterns described in the previous studies, and using information presented in the flow needs reports, recommend flows that are needed to maintain the current use of endangered fish in the Duchesne River. Thus, the purpose of this report is to provide recommendations that maintain the present level of habitat complexity and associated geomorphological processes, and baseflows necessary to maintain the present use of the Duchesne River by endangered fishes. Flow recommendations proposed were compared with present water use patterns to determine the extent in which hydrological limitations affect recovery potential within the Duchesne River. The deficit between the recommendation and available water represents the target for future acquisition opportunities.

Fishes of the Lower Duchesne River

Adult fish surveys in the lower Duchesne River were conducted in the last decade by Cranney (1994) and Modde and Haines (2003). Between 1997 and 1999, Modde and Haines (2003) captured 7 native and 15 nonnative fishes in the Duchesne River, which was similar to the 7 native and 10 nonnative fishes collected by Cranney (1994). The only difference in the native fish composition between these two studies was the former study captured speckled dace *Rhynicthys osculus*, and the latter collected mottled sculpin C*ottus bairdi*. Some of the nonnative species collected in the 1997-1999 study were probably present (i.e., fathead minnow *Pimephales promelas*, red shiner, *Notropis lutrensis* and redside shiner *Richardsonius balteatus*) but not collected in 1993, and bluegill *Lepomis macrochirus*, black crappie *Pomoxis nigromaculatu*s and grass carp *Ctenopharyngodon idella* may represent rare species that were captured due to a greater effort in the later study. The most abundant fishes captured in both studies were flannelmouth sucker *Catostomus latipinnis* and carp *Cyprinus carpio.* In 1993, carp dominated fish numbers, and flannelmouth sucker was the second most abundant species in the Duchesne River (Cranney 1994). Other native species including Colorado pikeminnow, razorback sucker, bluehead sucker *Catostomus discobolus*, and roundtail chub *Gila robusta* were poorly represented in the spring 1993 collection. 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). Native fish more abundant in the later survey were mountain whitefish and bluehead sucker. In both studies, the principal nonnative fishes, in addition to carp, were white sucker *Catostomus catostomus*, channel catfish *Ictalurus punctatus* and smallmouth bass *Micropterus dolomieu*. In an earlier survey that sampled three stations below the Myton Townsite diversion by the U.S. Fish and Wildlife Service in 1975, a different fish community was represented in which carp and smallmouth bass were less important numerically, and channel catfish, flannlemouth sucker and bluehead sucker were more abundant (Mullan, 1976). It is not clear whether the differences observed in twenty years was a change in actual composition or is an artifact of the methods used (i.e., electrofishing vs piscicides), although, it is probable that smallmouth bass have increased since their introduction in 1970.

Between 1997 and 1999 a survey of juvenile fish included four native and fourteen nonnative fishes (Brunson and Christopherson 2003). Additional juvenile nonnative fishes, not observed in the adult surveys, inlcuded largemouth bass *Micropterus salmoides*, brook stickleback *Culea inconstans*, and sand shiner *Notropis stramenius*. The former two species were rare, but sand shiners were fairly abundant (Brunson and Christopherson 2003). Brunson and Christopherson (2003) reported that early life stages of most fishes found in the lower Duchesne River were collected. Among native fishes, larvae of Colorado pikeminnow and razorback sucker were not definitively documented (although two juvenile pikeminnow and a possible razorback sucker larva were collected), and bluehead sucker larvae and juveniles were rare. Few young-of-the-year channel catfish, a common nonnative adult fish collected in the lower Duchesne River, were collected. Because early life stages of most suckers and cyprinids (except listed species) were found in the river (Brunson and Christopherson 2003), and adults of these fish were also found in electrofishing collections in December and March (Modde and Haines 2003), it is reasonable to assume they are permanent residents of the lower Duchesne River.

Nonnative Fish Introductions

The species composition of fish in the Duchesne River reflects evolutionary ancestry and the results of nonnative introductions. The more abundant large-bodied nonnative fishes, common carp, white sucker, and channel catfish have been in the Green River system, and most likely the Duchesne River, for nearly a century. The common carp were stocked throughout the U.S. in the latter nineteenth century by the U.S. Fish Commission and were stocked in Utah in 1881 (Sigler and Miller 1963). White sucker were introduced into the Colorado River basin in the 1860's and 1870's (Woodling 1985), and again in the first quarter of the twentieth century (Holden and Stalnaker 1975). The first introductions of channel catfish in the Colorado River took place in either1892-1893 or 1906 (Miller and Alcorn 1946) and became established throughout the Colorado basin by the early 1900s (Holden and Stalnaker 1975). Sigler and Miller (1963) reported green sunfish *Lepomis cyanellus* were stocked into Utah in 1881 and distributed throughout the state shortly afterward. Largemouth bass and bluegill were stocked into Pelican Lake in 1954 (Ed Johnson, UDWR, Personal Communication) and are the most likely source of these species to the Green River in the Uintah Basin. More recently, northern pike *Esox lucius*, smallmouth bass and black crappie have been introduced into the Uintah Basin. Northern pike were stocked into Elkhead Reservoir in 1977 as a sport fish and later escaped into the Yampa River and is currently reproducing successfully in the Yampa River basin (Colorado Division of Wildlife 2001). Because few immature fish have been collected in the Utah reaches of the Green River, it is probable that most northern pike collected in the Uintah Basin originated from the Yampa River. Black crappie also originated from Colorado, a result of illegal introduction into Kenney Reservoir in the 1980's (Martinez 1986, Trammell 1991). In 1970, the U.S. Fish and Wildlife Service introduced smallmouth bass into the Uinta River, with the concurrence of the state of Utah and the Ute Indian Tribe, to provide recreational fishing opportunity (Mullan 1973). Since being introduced in both the Duchesne River and basin reservoirs, smallmouth bass have established self-sustaining populations.

The most abundant small-bodied, nonnative fishes in the lower 34 miles of the Duchesne River were red shiner and fathead minnow (Brunson and Christopherson 2003). Both the red shiner and fathead minnow were introduced into the Colorado River basin in the 1950's, (Minckley 1973) and quickly established populations throughout the basin. The sand shiner, a common fish in the lower Duchesne River, was first introduced into the Colorado River basin in the 1930's (Minckley 1973) and first reported in the upper basin in 1971 (Holden and Stalnaker 1975). The brook stickleback was first reported in the Green River in the mid 1990's (Modde and Haines 1996). Grass carp have not been reported in the literature to occupy the upper Colorado River basin, but have been collected in the Duchesne River (FWS and UDWR unpublished records) in the Colorado River (Doug Osmundson, Personal Communication) and in the Green River in Utah (Tom Chart, Personal Communication).

Colorado pikeminnow

The Colorado pikeminnow is the largest North American cyprinid, reaching lengths as much as five feet and living up to 45 years (Tyus 1991). The presence of Colorado pikeminnow were reported by explorers in the Green River mainstem as early as the nineteenth century (Vanicek 1967), and were utilized as food by early settlers in the Uintah Basin in early twentieth century (Quartarone 1993). The Colorado pikeminnow is endemic to the Colorado River and once occupied the mainstem river and major tributaries from Mexico to Wyoming (Tyus 1991). Although once more abundant in the lower basin prior to major environmental alteration, the Green River subbasin now supports the largest existing population of Colorado pikeminnow (Tyus 1991). Within the Green River subbasin only two spawning sites have been documented (Yampa River and Gray Canyon reaches) and fish migrate as far as 250 miles in one direction to one of these sites on the descending limb of the hydrograph (Tyus and Karp 1989). Fidelity to spawning sites have been reported in which fish in the middle Green River tend to use the Yampa River spawning site and fish in the lower Green River (downstream of the White River use the Gray Canyon site (Tyus 1990, Irving and Modde 2000). Following spawning, several studies have documented adult pikeminnow returning to the approximate locations occupied prior to spawning migrations (Tyus 1990, Irving and Modde 2000, Miller and Modde 2001). Larval pikeminnow emerge from spawning gravels and drift from the high gradient spawning reaches downstream in excess of 50 to 150 miles to low gradient alluvial reaches of river where they spend their first growing season in off-channel backwaters (Tyus and Haines 1991). Little is known of the habitat needs of juvenile to subadult pikeminnow (70-200 mm) but they appear to be more abundant in the lower reaches of the Green River occupying both backwater and mainchannel habitats (McAda et al. 1998). As adults, pikeminnow occupy the mainstem river and larger tributaries in the Green River subbasin. Pikeminnow are piscivorous as small as 50 mm, and the diet of fish over 200 mm consists solely of fish (Vanicek 1967).

Following implementation of the Endangered Species Act, surveys to monitor the species began in 1986, but were largely confined to locations later designated as critical habitat (McAda et al. 1998). Because only the lower 2.5 miles of Duchesne River is designated as critical habitat for the 'large river' endangered fishes, little information exists on their presence or distribution further upstream. Cranney (1994) conducted the first survey of endangered fishes in the lower Duchesne River above the critical habitat designation. In a single pass, Cranney (1994) captured seven Colorado pikeminnow, and four razorback sucker between Myton (rmi ~34) and the confluence of the Green River. All endangered fish were captured below Randlett, with Colorado pikeminnow captured as far upstream as river mile 13.7, and a razorback sucker was captured at river mile 11.4. Cranney (1994) summarized observations in previous agency survey data and anecdotal observations that reported pikeminnow in the Duchesne River as high as river mile 50, as early as 1956 by UDWR survey crews. However, the Myton Townsite Diversion at approximately river mile 35 represents an upstream barrier at almost all flows. The presence of the diversion, which was completed before 1920, no doubt limited upstream movement during most years. However, Colorado pikeminnow were observed in a 1956 stream survey as far upstream as river mile 50 (Bridgeland) and at least two anglers reported catching pikeminnow (in excess of 4 lbs.) above the Myton Townsite Diversion in the 1980's. Historical reports of Colorado pikeminnow in the Duchesne River are similar to the White River where fish were first reported by anglers in the 1940's (Seethaler 1978). The first scientific documentation of pikeminnow in the White River was between 1968 and 1970 (Everhart and May 1973, in Lentsch et al. 2000).

Among the tributaries of the Green River, the Yampa and White rivers represent a significant resource to Colorado pikeminnow. However, little was known of the pikeminnow use in the Duchesne River above critical habitat (rmi 2.5). Recent telemetry data (Modde and Haines 2003) provided strong evidence that, contrary to the other two large tributaries, most pikeminnow only use the Duchesne River during the spring and summer months. Within the Duchesne River, Colorado pikeminnow were found between the upstream barrier at the Myton Townsite Diversion (rmi ~ 35) and confluence of the Green River, although most fish were captured below the confluence of the Uinta River (rmi 15.4). The river reach most frequently used by radio-implanted fish was between rmi 8.0 - 15.4, which was similar to the distribution of pikeminnow captured by electrofishing. This reach has more channel complexity (i.e., greater sinuosity, greater range in substrate size, higher gradient, etc.) as described by Gaeuman et al. (2003). Osmundson (2001) reported that Colorado pikeminnow in the upper Colorado River prefer river reaches that contain diverse habitat types.

Colorado pikeminnow displayed a pattern of movement into and out of the Duchesne River, entering the tributary in early spring and leaving between late spring and fall. In 1998, some individuals left the tributary at a time consistent with the spawning migration and returned to the Duchesne River later in the summer, whereas, others left the tributary at the same time in 1998 but did not return to the tributary. Fish exhibiting a home range would be expected to return to the area occupied prior to its spawning migration as observed in the Yampa and White Rivers (Tyus 1986, Irving and Modde 2000, Wick and Hawkins 1989). The fact that most pikeminnow return to areas occupied prior to its spawning migration and remain through the winter months distinguishes fish use of the Duchesne River from the more stable flow regimes in the Yampa and White rivers, where fish return following spawning migration and overwinter. Movement of Colorado pikeminnow out of the Duchesne River in late summer and prior to winter (Modde and Haines 2003) occurred when flows were above average during both the peak and base flow periods. Thus, although flow conditions did not appear to be limiting during the first three years of the study, fish did not establish permanent residency in the Duchesne River. The explanation for the lack of year around use of the Duchesne River by Colorado pikeminnow is not apparent. Failure to use the Duchesne River during the winter base flow period may be a response to the periodic occurrence of extremely low base flows that have occurred in the last sixty years. During the low flow year of 2000, no radio-implanted Colorado pikeminnow were observed in the Duchesne River after May.

Colorado pikeminnow in the Green River use floodplain habitat in the Green River as flood flows occur in the spring (Tyus 1986, Modde and Fuller 2002). Bioenergetically, floodplain habitats offer warmer temperatures, greater prey availability, and lower maintenance requirements (i.e., lower velocities) for large predators such as Colorado pikeminnow. The appearance of Colorado pikeminnow in the Duchesne River coincided with increased flows in the mainstem Green River. Thus, the utility of the Duchesne River to Colorado pikeminnow may be as an energetically favorable environment available in the spring and summer during years of higher than average flows, and at least through the peak flood flows during low flow years. Diel patterns of movement observed in both the 24 hour monitoring and stationary telemetry loggers suggested that fish move to different habitats that roughly coincide with the diurnal/nocturnal periods which are probably linked to feeding behavior (Miller and Modde 1999). However, as flows decline, as in 2000 when peak flows did not exceed 200 cfs, fish used the Duchesne River only a short period. Telemetry observations indicated that after pikeminnow left the Duchesne River, most were located within 22 miles of the Duchesne River confluence. The abundance of both native adult (Modde and Haines 2003) and juvenile (Brunson and Christopherson 2003) fish indicates an abundant prey base available in the Duchesne River for Colorado pikeminnow. Thus, use of the Duchesne River may represent opportunistic foraging behavior by local pikeminnow. As such, the Duchesne River contributes to recovery of Colorado pikeminnow in those years when an abundant prey base is available and flows allow access.

Even though Colorado pikeminnow do not remain in the Duchesne River throughout the entire year, many individuals spend several months in the tributary and depend on prey species that are produced there. Because these fish 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. Thus, although most Colorado pikeminnow are not present during the late fall and winter months, the year-around production in the Duchesne River is needed to provide the prey base for pikeminnow when they are present. Many of the resident suckers and cyprinids in the Duchesne River probably represent prey for Colorado pikeminnow. In this regard, tributaries represent important areas of prey production for Colorado pikeminnow (Stanford 1994). Because nearly half of the pikeminnow captured were less than 500 mm, tributaries like the Duchesne River may be particularly important to young adult Colorado pikeminnow attempting to find areas to occupy outside established home ranges of larger pikeminnow.

Razorback sucker

Just as Colorado pikeminnow, razorback sucker were well distributed in the Green River mainstem in the nineteenth century (Jordan 1891, in Minckley et al. 1991). Early records of razorback sucker indicated they occurred in the Green River as far upstream as Green River, Wyoming (Everman and Rutter 1895). Jordan and Evermann (1896) reported that razorback sucker were " very abundant where the water is not too cold", suggesting that they were widespread. Although the razorback sucker is well documented in the mainstem Green River, little information exists on their presence in tributaries. Minckley et al. (1991) mentioned several references to razorback sucker in tributaries, although most records of razorback sucker in the upper Colorado River basin were in larger tributaries such as the San Juan and Yampa rivers. In the Green River subbasin, Sigler and Miller (1963) mentioned that razorback sucker were captured in the White River, near Ouray Utah but gave no specific information.

Because of their widespread historical distribution, it is likely that razorback sucker occupied at least some portion of the Duchesne River prior to European settlement of the Uintah Basin. BioWest reported the first record of razorback sucker in the Duchesne River in 1978, and surveys by the USFWS captured 21 additional razorback suckers between 1980 and 1984 (Cranney 1994). In the last decade, razorback sucker have been captured on many occasions in the lower Duchesne River (Modde and Wick 1997, unpublished FWS data). Because razorback sucker were present in the Duchesne River in the first attempts to monitor their presence, and have been captured readily in the past decade, it is likely they were present well before the first sampling efforts. However, no documentation exists as to their prior use of the Duchesne River. Cranney (1994) noted that early UDWR summer and fall collections that reported Colorado pikeminnow, did not record razorback sucker captures, which may suggest seasonal and possibly localized historical use.

Razorback sucker are found primarily in mainstem river reaches and some larger tributaries (Minckley et al. 1991). In the Green River, razorback sucker tend to congregate at confluence of tributaries and floodplain outlets both before and just after spawning (Modde and Irving 1998). Fish initiate migration to spawning areas as spring flood flows rise and spawn on the ascending limb of the hydrograph (Tyus and Karp 1990, Modde and Irving 1998). Although it is suspected that multiple spawning areas exist, razorback sucker have only been observed to congregate at two locations, the Escalante spawning bar (rmi 311) and the lower Yampa River in Echo Park (rmi 0.3)(McAda and Wydoski, 1970, Modde and Irving 1999). 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). The majority of fish appear to use the Escalante spawning site, with few fish collected recently at the Echo Park site (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 et al. 1996, UDWR unpublished data).

Most razorback found in the Duchesne River have been captured in the lower 2.5 mi of the river during the spring months (Archer et al. 1986); however, Cranney (1994) observed a single individual at rmi 11.4 in 1993. Although several records of Colorado pikeminnow captures exist in the Duchesne River, no records of razorback sucker captures exist before 1978 (Cranney 1994). Modde and Haines (2003) concluded that most razorback sucker use only the lower reach of the Duchesne River, specifically the area influenced by water elevation of the Green River. Razorback sucker have been observed in tributary mouths and floodplain outflows in the spring, especially following spawning in late May and June (Tyus and Karp 1990, Modde and Irving 1998, Modde 1996). Outside of the areas influenced by the Green River, razorback sucker do not appear to be common in tributaries of the Green River subbasin. Razorback sucker have been reported in the Yampa River as far upstream as Lily Park, (Bestgen 1990), but few have been captured in the White River (one by UDWR, unpublished data, and two by FWS, unpublished data) despite extensive sampling during the last decade. Following collections of larval razorback sucker near the mouth of the San Rafael River, Chart et al. (1999) concluded that razorback sucker may be spawning either in the Green River near the San Rafael or in the San Rafael itself. One possible larval razorback sucker (i.e., not conclusively identified) was collected during this study in 1998, however extensive sampling in 1999 failed to capture any larval razorback sucker (Brunson and Christopherson 2003). Razorback sucker were once common in the Gunnison and San Juan tributaries of the upper Colorado River Basin and in several larger tributaries in the lower Colorado River Basin (Minckley et al. 1991). It is likely that if razorback sucker were more abundant in the Green River subbasin, fish would probably be collected more frequently in smaller tributaries; however, it is unlikely that the Duchesne River upstream of critical habitat would contribute significantly to the recovery of razorback sucker in the Green River subbasin.

Flow Recommendations:

The goal of the following flow recommendations are to maintain the existing level of habitat availability and endangered fish use as presently exists at this time in the Duchesne River. These recommendations address the reach of the Duchesne River downstream from the confluence of the Uintah. Recommendations for the Duchesne River represent the integration of physical processes needed to maintain present channel complexity and substrate quality (high flow needs), with maintenance of adequate flows needed for endangered fish access, and productivity needed to sustain the prey base supporting Colorado pikeminnow (base flow needs). High flow recommendations are physical requirements needed to maintain those processes that form the present level of channel complexity and habitat diversity needed by fish in the Duchesne River. These processes are based on the flows needed to mobilize bed load, maintain channel movement, and transport fine sediment as described by Gaeuman et al. (2003). Thus, the high flow recommendations for the Duchesne River were designed to maintain the geomorphic processes that form the present level of channel complexity that dictate habitat availability for endangered fishes, and provide discharge needed to clean substrate which determines biological productivity.

Given that the Duchesne River provides temporary residence and foraging opportunity to Colorado pikeminnow, the base flows recommended for recovery of endangered fishes are based on passage needs, and a general measure of biological productivity rather than an estimate of useable area. Because adult habitat use is quite flexible, both within and among rivers, we felt a productivity based approach was more useful in determining the contribution of the Duchesne River to recovery of endangered fishes. The productivity component of the base flow recommendation is based on the premise 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. This approach assumes that 1) abundance of aquatic invertebrates is proportional to wetted riffle area, 2) wetted perimeter can be used as an index to riffle area, and 3) reductions in discharge below the wetted perimeter curve-break reduces invertebrate abundance and therefore carrying capacity of fish (Lohr 1993). Several studies have confirmed the relationship of primary and secondary productivity to riffle area (e.g., Buffagni and Comin 2000, Brown and Brussock 1991, Lohr 1993), and the decline of invertebrates abundance following dewatering of riffles (e.g., Ward and Stanford 1979, White et al. 1981). 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 are more stable, complex, and productive in the upstream reaches of the potamon associated with cobble substratum. The majority of the lower Duchesne River between Myton and the confluence with the Green River represents a transition between rithron and potamon reaches. Data from the Upper Colorado River indicated that primary and secondary production was greatest in the upstream, higher gradient reaches with more riffles (Lamarra 1999) which coincided with the highest density of fishes (Osmundson 1999). Osmundson (1999) stated that riffles were ‘islands of productivity’ that were related to carrying capacity of fish. A relationship of riffles to fish abundance in smaller aquatic systems was also observed by Gelwick (1990). Riffle habitats represent an important determinant for fish abundance and we used them as an index for flow needs of endangered fishes in the Duchesne River.

Using riffles as an indirect index of biological production (Collings 1974, Nelson 1980), we selected the wetted perimeter approach using a curve break approach similar to that described by Gippel and Stewardson (1998) to define the base flow recommendation. The curve-break methodology defines a flow, which represents an index discharge below which habitat conditions decline rapidly, such that small additional reductions result in disproportionate impacts to stream productivity. Thus, below the curve break a disproportionate loss in habitat occurs with further reductions in discharge. Lohr (1993) stated that the “greatest rate of invertebrate habitat loss, relative to stream discharge would occur when discharge falls below the wetted perimeter-discharge inflection point”. In this respect, 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 productivity in the stream decreases rapidly. Thus, transgressions represent unfavorable conditions, which may not produce lasting negative impacts at some minimal frequency. For the purposes of this report we define the number of acceptable transgressions as those observed during the last 25 years (Randlett Gage, 1975-2000), which represents approximately three generations of Colorado pikeminnow use in the Duchesne River.

High Flow Recommendations:

The objective of the High flow recommendations for the Duchesne River is to maintain the current geomorphic processes that provide existing habitat for endangered fishes. Specific geomorphic processes in the Duchesne River that need to be maintained include (Gaeuman et al. 2003):

1. gravel transport and bank erosion needed to maintain bend extension and cutoff, and exchange of sediment between the channel, floodplain, and terraces to maintain channel complexity and habitat diversity for the aquatic community,

2. frequent entrainment of gravel to prevent accumulation of fines that reduce biological production, and

3. movement of fine sediment through the lower river to prevent channel simplification.

Based on analysis of three reaches below the Randlette gage, gravel entrainment is widespread at discharges of 4,000 cfs, although at various locations gravel mobility may begin as low as 2,500 cfs or as high as 5,000 cfs. Similarly, local overtopping of high bars adjacent to low-flow channels (i.e., bankfull flows) also occurs at flows of approximately 4,000 cfs.

Two different approaches are presented to maintain channel geometry and channel forming processes. Both approaches result in similar flow recommendations that support the current habitat in the Duchesne River. In the first approach data from the entire period of record at the Randlett gage (1943-2000) was used to define hydrological categories associated with flow recommendations. Four hydrological categories, based on flow frequency, are presented in which three have specific flood flow requirements to maintain channel morphology and move sediment (Table 1). An instantaneous peak flow (8,400 cfs) with a recurrence interval of 10 years and a high flow hydrograph including flows between 2,500 and 5,600 cfs at specified durations for 70% of water years are identified. The purposes of the peak component of the high flow recommendation are to promote channel migration, maintain off-channel topographic complexity, maintain channel dimensions, and rejuvenate riparian vegetation. Peak flows needed for these purposes were determined empirically from aerial photographs (Gaeuman 2003). The peak flow component of the high flow recommendation consists of an instantaneous peak flow of 8,400 cfs with a recurrence interval of approximately 10 years. In addition the high flow recommendation provides lesser flows for the scouring of the channel bed to remove fine sediment from the gravel framework, and flushing of fine sediment from the full range of low velocity habitats along the lower Duchesne River. Flows at various durations and magnitudes between 3,000 and 5,000 cfs (as identified in Table 1) in the wet hydrological years (435,000 to

765,000 acre-ft) 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 acre-ft), 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. .

An alternate approach to providing the flows necessary to maintain the geomorphologic process identified above is through a cfs-day approach. Using this approach the total volume of water in excess of 4,000 cfs each year is averaged over an extended period of record. In a given year if mean daily flows 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 cfs-days. A long-term average of 7,000 cfs-days in excess of the 4,000 cfs particle entrainment threshold would ensure that the specific geomorphic processes identified previously of gravel entrainment and transport, bank erosion and movement of fine sediments in the channel is accomplished in the Duchesne River (Gaeuman 2003).

In addition to magnitude and frequency of occurrence and the period of record over which flows are assessed is an important component of the high flow recommendation. Recurrence intervals for an instantaneous peak flow are intended to refer to the average number of occurrences over a long period of time; for example in the approach using the 10 year recurrence interval the instantaneous discharge of 8,400 cfs can be expected to occur 5 times in 50 years or 10 times in a 100 year period. Similarly, in the second approach the annual average of 7,000 cfs days above gravel entrainment flows should also be determined over an extended time period due to the variability in Duchesne River flows that result from climatic variation. For example, one 30-year period (1953-1982) within the period of record averaged only 4,851 cfs days above 4,000 cfs, demonstrating that relatively few high water years have a significant effect on the long-term average. The high water year of 1983 significantly influenced the average cfs days above 4,000 cfs (8,454 cfs days) for the period of record (1943-2003) at the Randlett gage. In comparison, the period of record preceding 1983 (1943-1982) had an annual average of 6,736 cfs days above 4,000 cfs and the dry period following 1983, (1984-2003) has averaged only 6,007 cfs days above 4,000 cfs. Thus, the variability inherent in the Duchesne River hydrology requires consideration of an extended period of time, i.e., 25-50 years, to allow enough high water years to achieve the high flow recommendation.

In summary, the high flow recommendations in this synopsis are presented as two alternatives; specific flow targets and an energy budget approach based on measurement of flow in cfs days. Both approaches are compatible and result in flows that maintain geomorphologic processes in the Duchesne River and the current level of habitat complexity. However, the use of an energy budget approach based on measurement of flow in cfs-days provides more options and flexibility for meeting the high flow recommendations. Both are also based on flow measurement at Randlett or other comparable gages.

Base Flow Recommendations:

Base flow recommendations for endangered fishes in the Duchesne River address recovery needs for Colorado pikeminnow. Because razorback sucker were found in the extreme lower reach of the river during spring flooding, flow needs are provided by the Green River. Base flows recommended for the recovery of Colorado pikeminnow include magnitude, duration and frequency needed to ensure spring and summer access to the river, and flows recommended to maintain biological productivity to support the resident prey base for pikeminnow during the spring and summer. In recognition of natural variability, base flow recommendations are presented for three symmetrical hydrological categories associated with the occurrence of high, average and low flow years (Table 2).

Flow recommended for Colorado pikeminnow passage was estimated as the discharge needed to provide a depth of 30 cm in the deepest area of the channel. Depth criteria used to define passage was based on fish morphology, and was proposed for the Gunnison River by

Burdick (1997) and applied to the Yampa River by Modde et al. (1999). Flows of 115 cfs in the Duchesne River produced maximum (thalweg) depths greater than 30 cm in 22 of 27 riffle cross sections. Two riffles had depths of 27 cm probably do not represent concerns regarding passage. The remain three riffles had maximum depths ranging from 0.20 to 0.24 m and were located between rkm 10.0 to 20.4. Of the five riffles that had maximum depths less than 30 cm, two had depths greater than 27 cm and all had depths greater than 20 cm. Thus, a discharge of 115 cfs produced maximum depth of at least 0.20 m for all riffles and should allow all but the largest fish access into and out of the Duchesne River. Passage flows should be maintained between March 1 and June 30 annually (Table 2), which is the period when most pikeminnow occupied the Duchesne River as determined by both telemetry and electrofishing surveys (Modde and Haines 2003). The Duchesne River represents a temporary residence for Colorado pikeminnow and if it is to contribute to recovery, these fish need consistent access to the tributary on an annual basis between March and June. During low flow years, such as 2000 flows were well over 115 cfs in March and fish were observed in the Duchesne River in February, but as flows receded in April through May, fish left the river. Thus, unless sufficient flows are available in the Duchesne River, it will not support Colorado pikeminnow.

Fish surveys found all life stages of the most probable prey species for Colorado pikeminnow (i.e., flannelmouth sucker, bluehead sucker, roundtail chub, speckled dace, and possibly other nonnative cyprinids or catostomids) inhabiting the Duchesne River (Brunson and Christopherson 2003, Modde and Haines 2003). Sizes and timing of captures indicated that prey species for Colorado pikeminnow are permanent residents that spend their entire life cycle in the tributary. Thus, in order to maintain a continual prey base available to pikeminnow, minimum flow conditions are required to support prey species throughout the year. The wetted perimeter methodology was used to estimate the flows needed to maintain biological productivity and a curve break point was used to define the flow recommendation reference flow. The curve break flow of 115 cfs was defined as the flow in which a major reduction occurred in riffle area, which would result in a similar reduction in primary and secondary production. This flow magnitude is comparable to minimum flow in other states. Tennant (1975) proposed that a minimum flow sustaining good survival habitat for most aquatic life forms is equal to 30% of the average annual yield for streams and rivers in Montana. The same criterion in the Duchesne River represents 126 cfs (based on data cited by CH2MHill (1999). However, the minimum flow recommendation for the Duchesne River is based on the assumption that an adequate prey base has been maintained during the last three generations of Colorado pikeminnow (~ 25 years) to support the existing number of Colorado pikeminnow occupying the Duchesne River. Given this assumption, transgressions to the curve break flow may occur in the frequency observed during the last 25 years and still maintain the existing number of Colorado pikeminnow. To ensure that transgressions below 115 cfs do not occur at a frequency greater than the pattern observed the last twenty-five years, no more than the observed frequency of incremental flows below 115 cfs is recommended. Because it is likely that flows above the minimum recommendation will enhance habitat available for Colorado pikeminnow, efforts should be made to reduce the observed frequency of trangressions. During the last 25 years, flows below 50 cfs have occurred regularly during 4 years (1989, 1990, 1994, 2002). During these four years, flows less than 50% of the wetted perimeter were exceeded regularly. As a consequence, primary and secondary production was below the magnitude Tennant (1976) described as “recommended to sustain short term survival habitat for most aquatic life forms”. During those low flow years the Duchesne River most likely did not support Colorado pikeminnow.

A minimum flow that inundates an average of 50% of the riffles is recommended to maintain a baseline biological productivity to support the local fish community/pikeminnow prey base in the lower Duchesne River. Based on wetted perimeter methodology, the Oregon Department of Fish and Wildlife recommended a minimum of 50% of the wetted perimeter be maintained to protect aquatic resources (IFC 2002). Tennant (1976) recommended minimum stream flow be no less than 10% of the annual average flow (unregulated flows), which represents approximately 50% of the wetted perimeter in Montana streams. Flows inundating 50% of the wetted perimeter in the lower Duchesne River (based on unregulated flows, i.e., CH2MHill [1999]) is approximately 50 cfs. Unless flows can be maintained above 50 cfs, primary and secondary productivity in the Duchesne River will not likely maintain a continuous resident fish community. In years when 50 cfs is not provided, biological productivity will decline dramatically and have to be replenished in future years. Thus, in years when the above recommendations are not met, the Duchesne River will not contribute to the recovery of the Colorado pikeminnow.

In summary base flow recommendations are based on Colorado pikeminnow passage requirements (March 1-June 30) and 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 (June 30-February 28). The base flow recommendation target a minimum flow of 115 cfs between March 1 and June 30 to ensure fish access and passage. During the remainder of the year the base flow recommendation is for a minimum flow of 50 cfs to 115 cfs to ensure adequate prey populations for the Colorado pikeminnow. During wet years flows should not fall below 115 cfs. During normal to dry years flows between June 30 and February 28 should not fall below 115 cfs at a frequency greater than that observed in the last 25 year period of record (1977-2002) and every effort should be made to maintain flows above 50 cfs at all times (Table 2). Base flow recommendations for this report were developed from information collected primarily downstream of the Randlett gage on the Duchesne River and should be measured at the Randlett or other comparable gage. Instream flows for the Duchesne River upstream of the Randlett gage were not specifically quantified. However, due the documented occurrence of the Colorado pikeminnow upstream in the Duchesne River and the importance of upstream areas to prey fish production it is 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.

Implementation of flow recommendations

Due to the variability in flows through any time period and the close coordination needed between state and county water regulators, we recommend that the Fish and Wildlife Service form a workgroup consisting of state and local stakeholders that will meet as needed during the year to discuss and make recommendations for implementation of flow recommendations.

Comparison of Flow Recommendations with Current Hydrology

High flow recommendations for endangered fishes in the Duchesne River are compatible with flood flows that have occurred within the last 25 years (1975-2000) at the Randlett gage (Table 3). There are discrepancies between the duration components for the high flow recommendations and the last 25 years but they are fairly minor (one or two days of flows between 4,400 and 2,500 cfs). However, it is worthy of note that the high flow year of 1983 contained a much higher number of cfs days above 4,000 cfs than any other year. Nonetheless, the average number of cfs days above 4,000 cfs between 1943 and 1982 (prior to the highest flow on record) was 6,736 cfs days. On the contrary, flows needed for passage and minimum base flows have not occurred at the rate recommended (Table 4). The most difficult portion of the flow recommendations to meet under the current hydrological regime are the passage requirements of 115 cfs between March and June, and minimum base flow requirement of 50 cfs. During the period between 1975 and 2000, passage requirements were met in all but one day, on average, during the wet hydrological years (25% exceedance), but were not met 67 days on average during the nine years observed in the dry hydrological period (75% exceedance) (Table 4). Colorado pikeminnow passage is limited when flows are less than 115 cfs. The curve break flow recommendations above 50 cfs were met during the last 25 year period of record at the Randlett gage (Table 4), however, the average minimum base flow (i.e., 50 cfs) was short by 8 and 39 days, respectively for average and low flow hydrological years (based on 8 and 9 years each within the 25 period of record). Without maintenance of at least 50 cfs, productivity is severely reduced to a level that will not sustain local populations until higher flows are resumed.

Using the time period between 1976 and 2001, the average volume of supplemented water needed to meet flow recommendations for dry, average and high flow categories would be 7,137, 1,068 and 40 acre-feet, respectively.

Logistical Considerations and Limitations

This section provides information on the logistical challenges of implementing a flow recommendation for the lower Duchesne River. In general, the following needs would have to be fulfilled in order to meet base flow recommendations. Specific, extraordinary measures or management is not considered necessary to meet high flow recommendations:

1. a source of water would need to be identified and acquired;
2. water would need to be shepherded to and protected through the target reach which would require a mechanism to measure water passing diversions above and in the target reach; and,
3. reservoir storage would be necessary to implement certain aspects of the recommendation.

Source of Water

The Management Committee of the Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin funded a comprehensive review of the effects of existing and proposed projects on the flow regime in the lower Duchesne River (Water Availability Study; CH2MHill, 1997). Among the study objectives was to locate potential water sources to meet flow deficiencies for endangered fishes.

The report discussed potential sources of water which include existing Bonneville Utah Central Utah Project fishery flows, Daniels Creek diversion, land purchase and fallow, conservation projects such as water delivery improvement projects (i.e. canal lining or piping), on-farm conservation improvements (i.e. sprinkler systems), and purchase of water in existing storage facilities. These potential sources are summarized in the following table:

Table 5: Potential water sources to the Duchesne River.

Source	Amount	Cost (1997)

	(acre-feet)	($/ acre-foot)
Bonneville Unit Fishery Flows	20,000-25,000	0
Daniels Creek Diversions	2,900	0
Land Purchase and Fallow	?	Market Value
Conservation Projects Delivery	?	$1,000-1,500
On-Farm Conservation Projects	?	$1,000-1,500
Purchase of Existing Water Rights Storage	?	Market Value

During a field tour of the lower Duchesne River on 5 May 2003 (see Appendix 2 for field tour summary), the River Commissioner stated that the river was over appropriated (John Swasey, personal communication). To provide for the equitable distribution of a limited water supply, the acreage of crop production dictates the amount of water diverted. On an annual basis, irrigators are required to submit crop reports identifying the area of land in production to the River Commissioner. During dry years, water is delivered according to a “duty” or court distribution order which targets the delivery of 4 acre-feet of water per acre of cropland over the course of the irrigation season (April 1 – October 15). The distribution schedule is based on the typical flow of the river in that early in the irrigation season flow deliveries are low (e.g. 1 cfs per 160 acres of cropland), at peak run-off deliveries are highest (e.g., 1 cfs per 70 acres of cropland), and delivery rates taper off through the irrigation season to their lowest by the end of the irrigation season (e.g. 1 cfs per 250 acres of cropland).

As stated in the Water Availability Study (CH2MHill 1997), “. . . water in the Duchesne River has been diverted and put to beneficial use under state law. The cycle of diversion, use, and flows returning to the river occurs several times as the river flows down the system.” Many of the diversions in the lower Duchesne River including the Duchesne Feeder Canal, the Myton Townsite Diversion, the Ouray School Diversion, Leland Ditch and Jenkins Pump have the right to dry dam the river during irrigation season. In addition, the Duchesne Feeder Canal has winter storage rights in Midview Reservoir and can dry dam the river in the winter (this occurred in the winter of 2002/2003). During irrigation season, water downstream of Myton Townsite Diversion is typically made up of return flows as the river is dry dammed at Myton Townsite Diversion (Swasey, personal communication).

Shepherd and Protect Water

As stated in Section 73-3-3 (11) (a), under Utah Water Rights Law the Division of Wildlife Resources (UDWR) or the Division of Parks and Recreation (UDPR) may file applications for permanent or temporary changes for the purpose of providing water for instream flows, within a designated section of a natural stream channel or altered natural stream channel, necessary within the state of Utah for:

1. the propagation of fish;
2. public recreation; or,
3. the reasonable preservation or enhancement of the natural stream environment.

Protection through a natural river channel for water supplies owned by parties other than those identified in Section 73-3-3 (11) (a) could prove challenging under Utah Water Rights Law. The water must have a point of delivery and demonstrated beneficial use; however, having a point of delivery and demonstrating beneficial use does not ensure that a water supply would remain through a target reach of river. For instance, under current operations in the lower Duchesne River, the river is dry dammed at Myton Townsite Diversion and water downstream is typically made up of return flows. Each consecutive diversion downstream (i.e. Ouray School, Leland Ditch, and Jenkins pump) has a legally protected water right and the capability to dry dam the river; water rights at the lower diversions are simply made up of irrigation return flows. Ensuring protection of flows through a target reach of river under Utah Water Rights Law may require an agreement with UDWR or UDPR for water owned by other entities.

Another challenge for protecting water through the lower Duchesne River is the lack of a mechanism for measuring water in the river beyond diversion points. Many of the lower river diversions do not have a permanent structure across the river channel but consist of temporary dams of river substrate constructed by irrigators to direct water into an irrigation canal. The lack of hard in-river structures at diversion points may be beneficial for river fishes as diversion dams often inhibit fish passage; however, having no hard structure in the river will make it difficult to measure water remaining in the river beyond diversions. Modifications at existing points of diversion would be required to allow for accurate measurement of water.

Supplementation

The Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin provided funding for a study to identify and evaluate opportunities to coordinate reservoir operations in the Duchesne River Basin with the goal of delivering water to the lower Duchesne River to improve habitat for Colorado pikeminnow and razorback sucker (Coordinated Reservoir Study; Fiscal Year 1999 Work Plan). Information from this study may be helpful for clarifying limitations and opportunities to store water in the existing system. Although not complete at the time this report was written, preliminary results from the Coordinated Reservoir Study indicate that nearly all of the excess water in the system is available during run-off on an infrequent basis from Rock Creek and is uncontrollable (Jared Hansen, personal communication). The Coordinated Reservoir Study did not include those portions of the Duchesne River system below Starvation Reservoir (i.e. Moon Lake Reservoir on the Lake Fork River, and the Uinta River).

Reservoir storage, or other water (i.e., water right purchase or out-of-drainage transfers), would be necessary to supplement base flows that have not been available in the past 25 years (see Tables 3 and 4). The base flow requirement (Table 4) for fish passage of 115 cfs was not met on one occasion in wet years, 17 occasions in normal years, and 67 occasions in dry years over the past 25 years. Productivity needs (Table 4) of 50 cfs had 8 discrepancies in normal water years and 39 discrepancies in dry water years over the past 25 years. To eliminate discrepancies, present river flows would need to be supplemented.

Contrary to the base flow requirements, flows required for channel maintenance have, for the most part, occurred in the past 25 years (Table 3), and would require minimal supplementation on the descending limb of the hydrograph.

Uncertainties

Flow measurements were based on records from the USGS Randlett gage. Due to icing, channel configuration at the gage and difficulty maintaining a rated section some of this data is estimated. If it is determined with new gages that the Duchesne and Uinta Rivers above Randlett that Randlett data has been consistently incorrect these recommendations will need to be adjusted accordingly.

Referenced reports provide a relatively good understanding of endangered fish use in the Duchesne River. Most adult Colorado pikeminnow use the Duchesne River in the spring and summer months and razorback sucker use was confined temporally and spatially to the area influenced by the Green River. Early life stages of either fish did not effectively use the Duchesne River, however, if razorback sucker numbers increase, immature and subadult razorback sucker may be found more frequently.

Several uncertainties exist regarding development of high flow recommendations Gaeuman et al (2003). Of the 136 measurements of suspended sediment concentration used to develop the rating relations, only two were taken at discharges greater than the 1.5-year flood (1840 cfs). Therefore, "significant uncertainty exists regarding the accuracy of the ratings relations for high discharges when a disproportionately large quantity of sediment is transported". Alternative methods of estimating the average suspended sediment flux in the lower Duchesne River suggest that estimates derived from the rating relations may be low. The estimated average annual suspended sediment load for the lower Duchesne River, as determined from suspended sediment concentration measurements at the Randlett gage, is at least four-fold less than other estimates (see Gaeuman et al. 2003). The only measurements of suspended sediment concentration at discharges greater than the 1.5-year flood discharge were made on June 2, 1986 and June 22, 1983 when discharges were 9,000 cfs on the rising limb of the annual hydrograph and 11,020 cfs on the falling limb, respectively. The concentrations measured on these two dates were 1,150 mg/L in 1986 and 322 mg/L in 1983. Typical suspended sediment concentrations at high discharges may be much larger than the values obtained by Gaeuman et al. (2003). If so, these curves may significantly underestimate the quantity of sediment transported by infrequent high discharge events or during particularly wet years. Gaeuman et al. (2003) suggest that an extended sampling program to monitor suspended sediment concentrations in the lower Duchesne River during peak flow events may be required to resolve this issue.

Gravel mobility analyses showed that gravel entrainment on the bed of the Duchesne River becomes widespread through riffles and runs at discharges of about 4,000 cfs (Gaeuman et al. 2003). Limited entrainment at some isolated locations may begin at discharges as low as 2,500 cfs, while entrainment at other locations may require more than 5,000 cfs. These estimates are based on data collected from 15 riffle and run locations, and as stated by Gaeuman et al. (2003), they are subject to the uncertainty inherent in modeling. Observations during the spring 2001 peak, which briefly reached 2,900 cfs, showed that 2,900 cfs is sufficient to initiate limited particle movement in certain locations, but is insufficient to produce significant bed mobilization.

Model calibration data for discharges necessary to access high bars and secondary channels was collected at three locations: 24-hour Camp, Above Pipeline, and Wissiup Return and at flow rates of 2,450 cfs, 770 cfs, 1,840 cfs, respectively. These represent the highest flow rates for which the model was calibrated.

Relative to base flows, it is reasonable to assume that productivity in the Duchesne River is an important element in determining the resource value of the Duchesne River to pikeminnow, i.e., by supporting its prey base, but a specific correlation of the number of pikeminnow with primary and secondary productivity was not determined. Rather, guidelines relative to instream productivity determined from other studies were applied to riffle-area/discharge relationships in the Duchesne River to determine base flow needs. Similarly, the minimum flow recommendation is based on minimum production estimates that were developed on riffle area/discharge relationships from other streams and rivers and not specifically determined for the Duchesne River. Therefore, our base flow recommendations represent flows which have been determined to provide adequate production in other western streams and rivers, but, specific production estimates and their relationship to Colorado pikeminnow have not been determined in the Duchesne River. Passage requirements are based on flows defined in other studies, and if correct, should represent accurate estimates of flows needed to access the Duchesne River.

We recommend ,however, that though the flow recommendations contained in this report are based on the best information available at this time that fish population and habitat parameters be periodically monitored in the Duchesne to ensure their adequacy.

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Table 1. High flow recommendations for the lower Duchesne River measured at the Randlett gage.

Hydrologic Category	Percent Occurrence	Flow and Duration Targets	Description of Anticipated Effects
Extremely Wet (> 765,000 acre-ft)	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 ten 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 acre-ft)	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 acre-ft)	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 acre-ft)	30%	No peak flow recommendation	

Table 2. Base flow recommendations for the Duchesne River measured at the Randlett gage.

Hydrologic Category	Base flow Passage Recommendation	Base flow Productivity Recommendation
Wet - Less than 25% Exceedence (total annual runoff 565,000 acre-feet)	**Passage Needs**[1] Target a minimum of 115 cfs between March 1 and June 30. [1]Passage requirements are needed for fish to access the Duchesne River during the time period occupied by most Colorado pikeminnow observed in telemetry studies, i.e., March through June. Flows of 115 cfs provides a maximum depth of at least 30 cm through 22 of 27 riffles and of the remaining five riffles, two had maximum depths of greater than 27 cm and the remaining had depths of at least 20 cm.	**Productivity Needs**[2] Target a minimum flow of 115 cfs. Transgressions that occur between June 30 through February 28 should not exceed:: **Discharge** **Duration (days)** No more than < 115 cfs 0 day < 100 cfs 0 day < 85 cfs 0 day < 60 cfs 0 day < 50 cfs[3] 0 day [2]Cumulative wetted perimeter of the curve break for riffles represented 70% of the maximum riffle wetted perimeter. The frequency of flows below the curve break have occurred in high flow years (25%, 74-26%, and 75% exceedence) during the last 25 years and have maintained the current pattern of Colorado pikeminnow use of the Duchesne River [3]Flows of 50 cfs maintain a minimum of 50% riffle inundation and should be maintained to provide minimum primary and secondary production.

Normal – 26% to 74% Exceedence (total annual runoff greater than 200,000 acre-feet and less than 564,000 acre-feet)	Minimum of 115 cfs between March 1 and June 30.	No more than < 115 cfs 54 days < 100 cfs 47 days < 85 cfs 34 days < 60 cfs 16 days < 50 cfs[3] 0 day
Dry – Greater than 75% Exceedence (total annual runoff less than 200,000 acre-feet)	Minimum of 115 cfs between March 1 and June 30.	No more than < 115 cfs 140 days < 100 cfs 116 days < 85 cfs 92 days < 60 cfs 58 days < 50 cfs[3] 0 day

Table 3. Comparison of the frequency of high flows during the last 25 years with flow recommendations measured at the Randlett gage. Numbers in red represent the frequency of flows not observed in the last 25 years.

Hydrolgic Category	**Percent Occurrence**	**Flow Recommendation**	
Extremely Wet (> 765,000 acre-ft)	10%	Channel Forming and Sediment Transfer Requirements	25 Year Discrepancy
		8,400 instantaneous	0
		5,600 at least 1day	0
		5,100 at least 2 days	0
		4,700 at least 4 days	0
		4,400 at least 7 days	0
		4,000 at least 10 days	0
		3,000 at least 17 days	0
Wet (435,000 to 765,000 acre-ft)	30%	Channel Forming and Sediment Transfer Requirements	25 Year Discrepancy
		5,600 at least 1day	0
		5,100 at least 2 days	0
		4,700 at least 4 days	0
		4,400 at least 7 days	1
		4,000 at least 10 days	2
		3,000 at least 17 days	1
Average (224,000 to 435,000	30%	Channel Forming and Sediment	25 Year Discrepancy

acre-ft)		Transfer Requirements 2,500 at least 7 days 1
Dry (< 224,000 acre-ft)	30%	No peak flow requirements

Table 4. Comparison of base flow frequencies during the last 25 years with flow recommendations (1975-2000) measured at the Randlett gage. Numbers in red represent the average number of days per year during the hydrological category that flows did not meet the recommendation during the last 25 years.

Hydrologic Category	**Base flow Requirements**	**Productivity Needs**		
Wet - Less than 25% Exceedence (total annual runoff 565,000 acre-feet)	**Passage Needs** Minimum of 115 cfs between March 1 and June 30. 25 Yr. Discrepancy Wet Yrs = 1 d	Transgressions that occur between June 30 through February 28:		
		Discharge	**Recommended Duration (days)**	**25 Yr. Discrepancy**
			No more than	
		< 115 cfs	0 day	0
		< 100 cfs	0 day	0
		< 85 cfs	0 day	0
		< 60 cfs	0 day	0
		< 50 cfs[3]	0 day	0
Normal – 26% to 74% Exceedence (total annual runoff greater than 200,000 acre-feet and less than 564,000 acre-feet)	25 Yr. Discrepancy Normal Yrs = 17 d		No more than	**25 Yr. Discrepancy**
		< 115 cfs	54 days	0
		< 100 cfs	47 days	0
		< 85 cfs	34 days	0
		< 60 cfs	16 days	0
		< 50 cfs[3]	0 day	8

Dry – Greater than 75% Exceedence (total annual runoff less than 200,000 acre-feet)	25 Yr. Discrepancy Dry Yrs = 67 d	No more than < 115 cfs 140 days 0 < 100 cfs 116 days 0 < 85 cfs 92 days 0 < 60 cfs 58 days 0 < 50 cfs[3] 0 day 39

Appendix 1. USFWS preliminary flow recommendations (average monthly cfs) for the Duchesne River (USFWS 1998).

Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Dry	109	265	350	345	379	352	199	334	621	40	31	47
Average	216	374	428	410	437	471	370	906	1,600	209	100	105
Wet	331	477	499	477	493	590	603	1,790	2,970	524	285	193

Appendix 2. Spring 2003 Duchesne River Tour Report with Duchesne River

Duchesne River
Tour of Diversions below Starvation Reservoir
Date of Tour May 5, 2003

Attendance

John Swasey, Duchesne River Commissioner
Tim Modde, U.S. Fish and Wildlife Service
Gene Shawcroft, Central Utah Water Conservancy District
Chris Keleher, Central Utah Water Conservancy District
Keith Hooper, Central Utah Water Conservancy District (did not attend field tour)

Summary

On 5 May 2003 those identified above met at the Central Utah Water Conservancy District Office in Duchesne. Prior to touring the diversion locations and structures in the lower Duchesne River, John Swasey provided an overview of water rights, duties, and distribution schedules associated with operating the Duchesne River below Starvation Reservoir. Gene Shawcroft also provided an overview of the importance of Starvation Reservoir for providing the storage that allows for exchanges necessary to operate the river and to make the Bonneville Unit of The Central Utah Project (CUP) function as it was intended. The following bulleted statements summarize key points brought up in the discussion:

- Water diverted below Myton Townsite Diversion is entirely made up of return flows during the irrigation season. This includes water diverted at Ouray School Diversion, Leland Ditch, and Jenkins Pump.
- Water is delivered based on crop reports that are submitted to the river commissioner on an annual basis. The acreage of crop production dictates the amount of water diverted.
- The Strawberry River above Starvation Reservoir and Currant Creek are not "regulated" because water comes back to the system as return flows.
- Water is delivered according to a "duty" or court distribution order which targets the delivery of 4 acre-feet of water per acre of cropland for the irrigation season (April 1 – October 15). The distribution schedule is based on the typical flow of the river in that early in the irrigation season flow deliveries are low (e.g. 1 cubic foot/second per 160 acres of cropland), at the typical time of peak run-off deliveries are highest (e.g. 1 cfs per 70 acres of cropland), and delivery rates taper off though the irrigation season to their lowest (e.g. 1 cfs per 250 acres of cropland). The delivery schedule for the Duchesne River for the irrigation season accounting for a distribution rate of 4.0 acre-feet of water per acre of cropland is attached (Attachment 1).
- A "duty" distribution schedule has been proposed in dry years since sometime in the 1930's.
- Starvation Reservoir
    - Constructed as part of CUP

    - A year-round water right allows CUP storage in Starvation Reservoir during the winter and when prior rights are being met
    - Storage includes water from the Strawberry River directly, and from the Duchesne River delivered to the reservoir from Knights Diversion (limited to 300 cfs of Duchesne River flow)
    - Storage capacity of Starvation Reservoir is 167,310 acre-feet, 21,400 acre-feet is the CUP yield for irrigation and 500 acre-feet is the CUP yield for Municipal and Industrial uses (M&I), the remainder is to satisfy exchanges for prior water rights
    - Starvation Reservoir is a "3-year carry-over reservoir" in that it has storage capacity to meet needs for 3 years.
    - Starvation Reservoir is a flood control feature and operates according to U.S. Army Corps of Engineers flood control guidelines. The safe channel capacity below Starvation Reservoir is 1100 cfs. Releases exceeding this amount result in flooding problems downstream.
    - Storage in Starvation Reservoir provides for irrigation deliveries downstream that allows for exchange to Strawberry Reservoir through the Strawberry Aqueduct Collection System (SACS) which collects water from the upper reaches of the Duchesne River and Currant Creek. Water stored in Strawberry Reservoir is delivered to Utah Lake through the Diamond Fork System. Stored water in Utah Lake allows for exchange to Jordanelle Reservoir. Jordanelle Reservoir water is delivered to the Wasatch Front as M&I water. A schematic representation of the Bonneville Unit of CUP and features of the lower Duchesne River is attached (Attachment 2).
- The Midview Reservoir (storage capacity is 5000 acre-feet) in addition to Starvation Reservoir has winter storage rights and receives water from the Duchesne River through the Duchesne Feeder Canal. Although it doesn't happen often, the Duchesne Feeder Canal can dry dam the river in winter (this occurred in the winter of 2002-2003)

<u>Field Tour and Description of River Features</u>

The purpose of this field tour was to gain an understanding of the operation of the lower Duchesne River and the logistics of delivering flows through the lower river to provide for endangered fish needs. As a reference, graphs of USGS gage data on the day of the field trip are attached for: 1) the Uinta River at Randlett (10-15 cfs), 2) the Duchesne River above the Uinta River near Randlett (20-30 cfs) and 3) the Duchesne River near Randlett (25-30 cfs) are attached (Attachment 3a, 3b, and 3c).

> <u>Knight Diversion</u> is located on the Duchesne River above the confluence with the Strawberry River and diverts up to 300 cfs for storage in Starvation Reservoir. This is a year-round storage right and diversion. Knight Diversion was not visited during this field tour.

Orchard Mesa Canal diverts water from the Duchesne River at Knight Diversion. Structural features for the Orchard Mesa Diversion are incorporated in Knight Diversion. As mentioned above, this diversion was not visited as part of this field tour.

Rocky Point Diversion is located on the Duchesne River below Knights Diversion and above the confluence with the Strawberry River. Water rights date back to 1905, 1908 and 1964. The river can be dry dammed at this diversion. Rocky Point Diversion was not visited during this field tour. This diversion was modified by the Utah Reclamation Mitigation and Conservation Commission to provide fish passage.

Duchesne Feeder Canal Diversion diverts water to lands north of the river and for storage in Midview Reservoir that has a storage capacity of about 5000 acre-feet. Water rights date back as far as 1861. This is the only diversion below Starvation Reservoir that has a right to divert water outside of the irrigation season. The river can be dry dammed at this diversion and this occurred in the winter of 2002-2003. The Duchesne Feeder Canal was not visited during this field tour.

NOTE: Lake Fork Creek, a tributary to the Duchesne River can be dry dammed above the siphon from Midview Reservoir. Lake Fork Creek converges with the Duchesne River between Myton Townsite Diversion and Ouray School Diversion, above the USGS gage at Myton.

Gray Mountain Diversion is the largest diversion on the Lower Duchesne River. Water rights date back to 1861. Approximately 14,250 acres of crop land are irrigated from this diversion. Water is diverted from the river down a canal about ½ mile before being measured and split (Figure 1). Excess water returns to the river via a small ditch. A concrete sill is present at the actual diversion, but was not in use during this field tour (Figure 2).

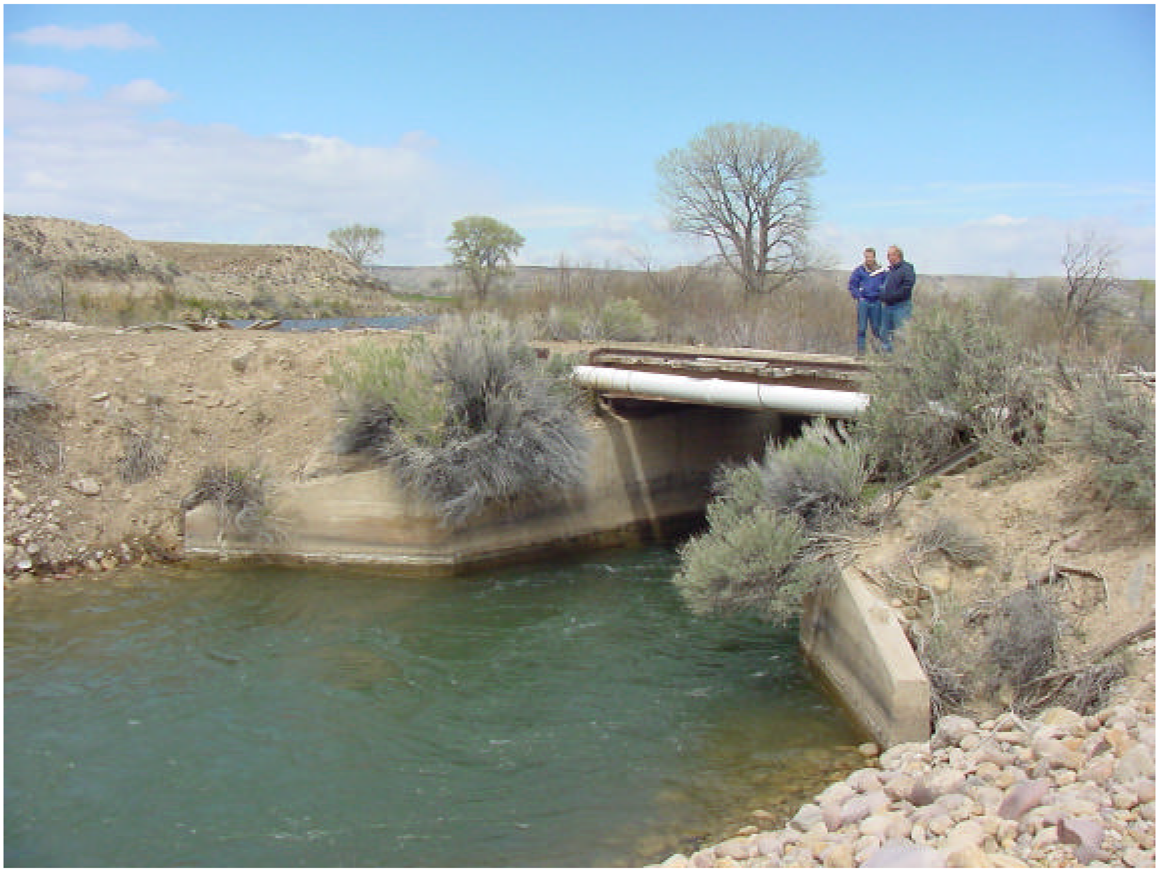

Figure 1. Gray Mountain Diversion Canal with Duchesne River in background.

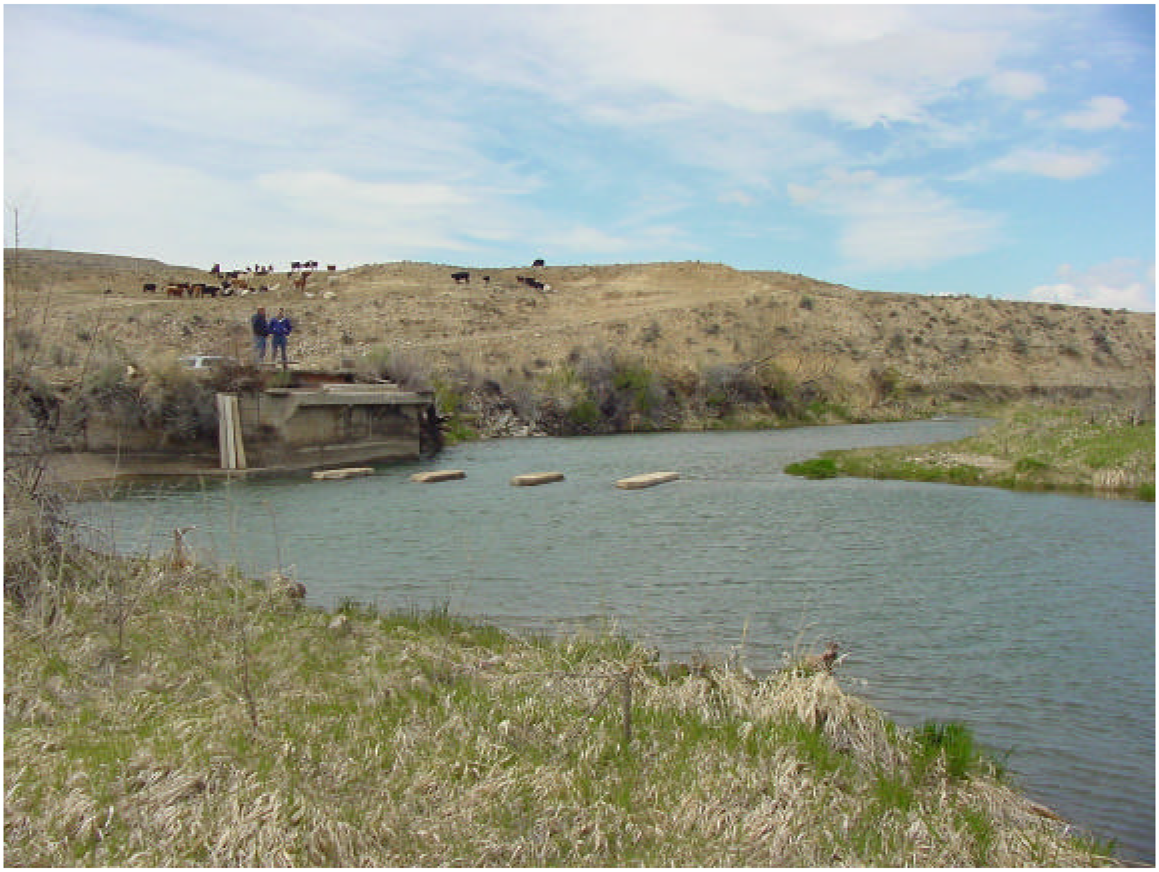

Figure 2. Duchesne River looking upstream at Gray Mountain Diversion.

Myton Townsite Diversion has water rights that date back to 1861. Every year since John Swasey has been river commissioner (since 1988) the river has been dry dammed at this diversion for the irrigation season. A concrete sill and dam crosses the river with the dam elevation about three feet above the water surface elevation on the downstream side (Figure 3). Diversions below this site are made up from irrigation return flows. During this field tour water was leaking through the diversion gate to the river downstream (Figure 3) and John Swasey called the ditch rider and informed him that they were losing water. Approximately 3700 acres of cropland are irrigated from this diversion (Figure 4).

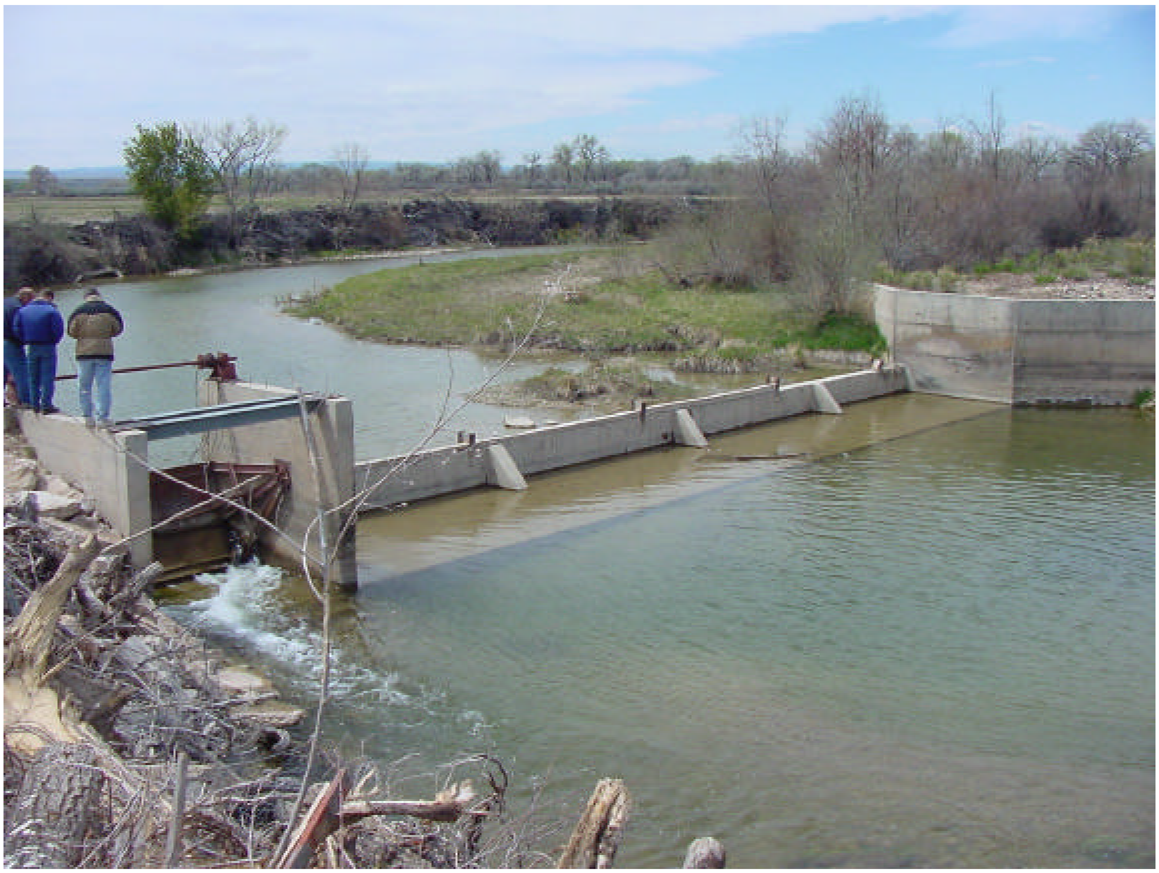

Figure 3. View looking upstream on Duchesne River at Myton Townsite Diversion.

Figure 4. View looking downstream on Duchesne River at Myton Townsite Diversion with diversion ditch to right of photo.

Dude Young Diversion historically diverted water for irrigation, but since the property fed by this diversion was acquired as mitigation, diversions have not been consistent. This diversion was not visited as part of this field tour.

Ouray School Diversion has water rights that date back to 1861. Water diverted here is usually made up of return flow from diversion off Lake Fork Creek. A gravel dam (pile of rocks) in the river directs water into an off-channel canal. Water flows down the canal about 600 yards and is measured and diverted to the irrigation canal (Figure 5). Extra water returns to the river via a small ditch. Approximately 2300 acres of cropland are irrigated from this diversion. This diversion can dry dam the river (Figure 6).

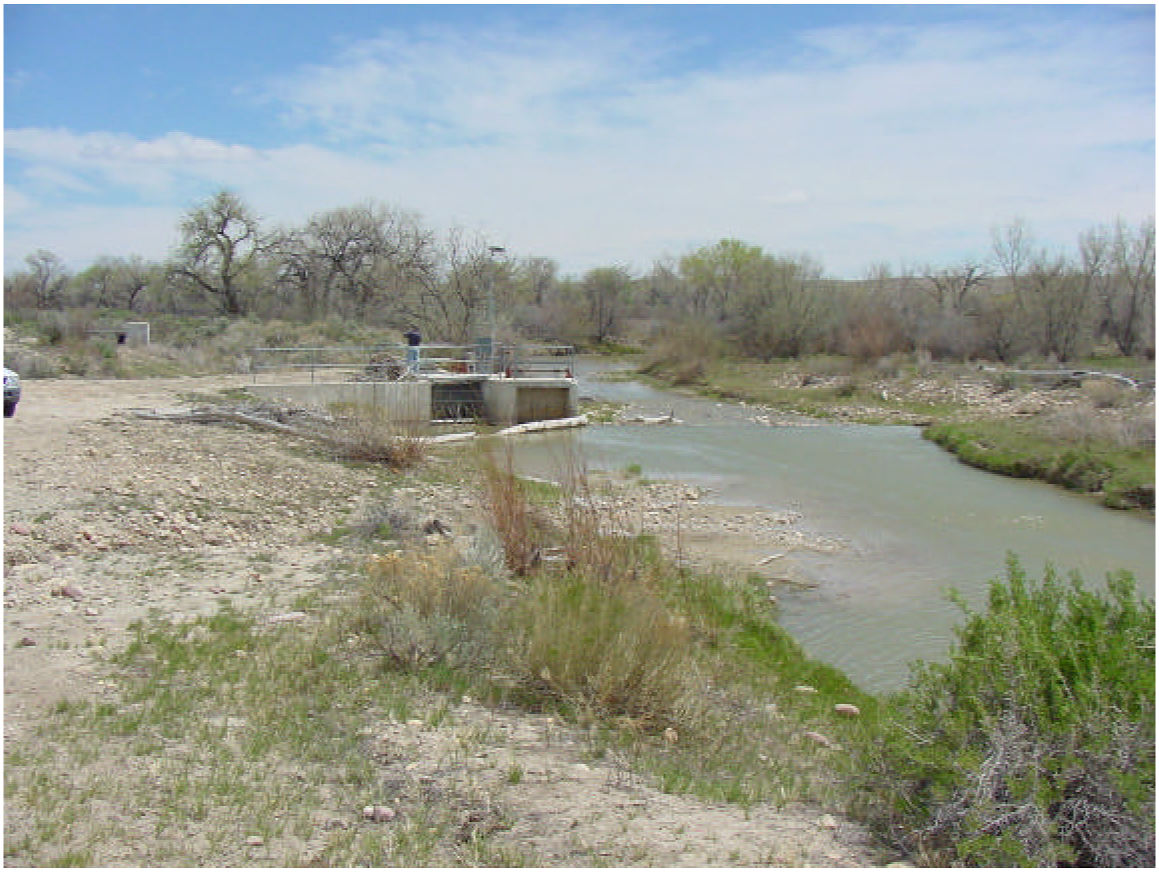

Figure 5. Irrigation Canal that receives water from Ouray School Diversion with measuring gate and overflow channel that goes back to the river.

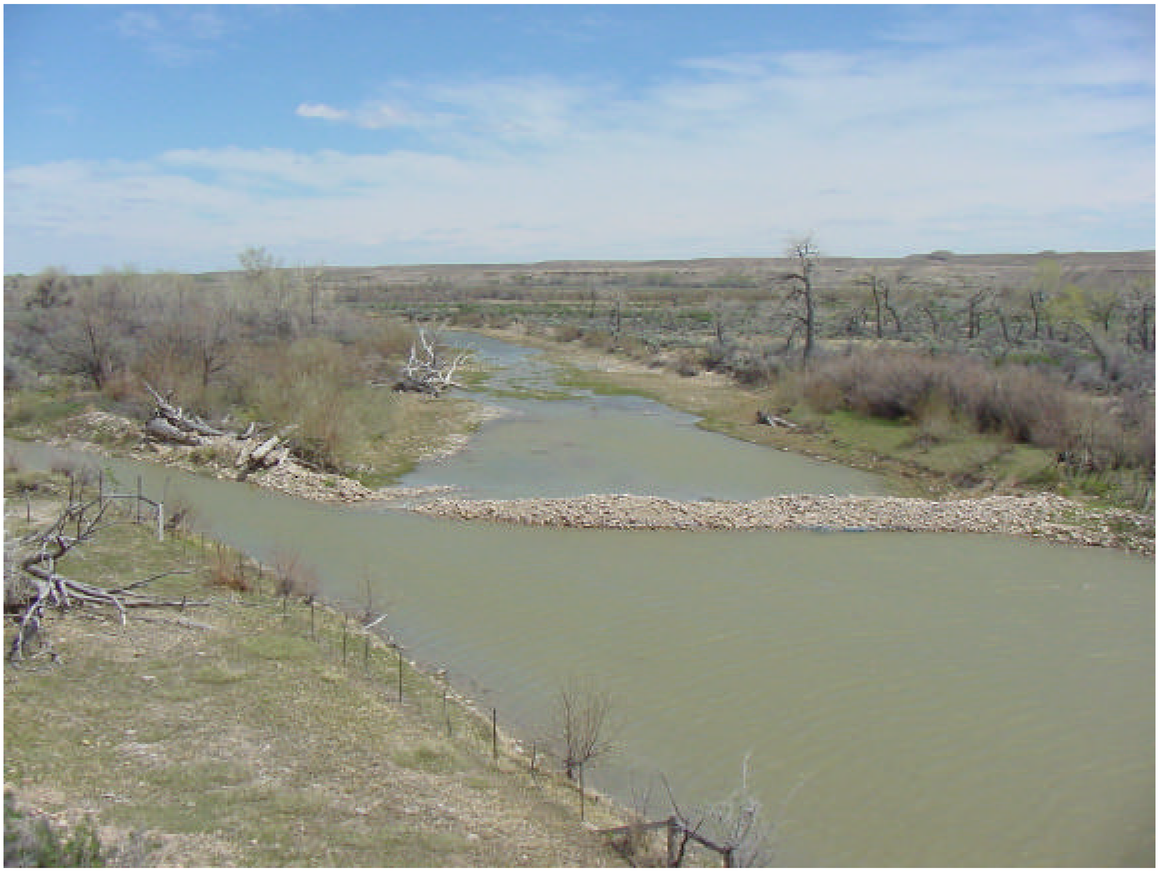

Figure 6. View looking downstream on Duchesne River at Ouray School Diversion with irrigation canal branching to the left on this photo, Duchesne River branching to the right.

Leland Ditch has water rights that date back to 1861. Approximately 450 acres of cropland are irrigated from this diversion. The diversion consists of a gravel pile which directs the river flow into an irrigation canal (Figure 7). Water flows about 400yards down the canal to a measuring and distribution gate. Overflow at the gate returns to the river via a ditch. This diversion can dry dam the river.

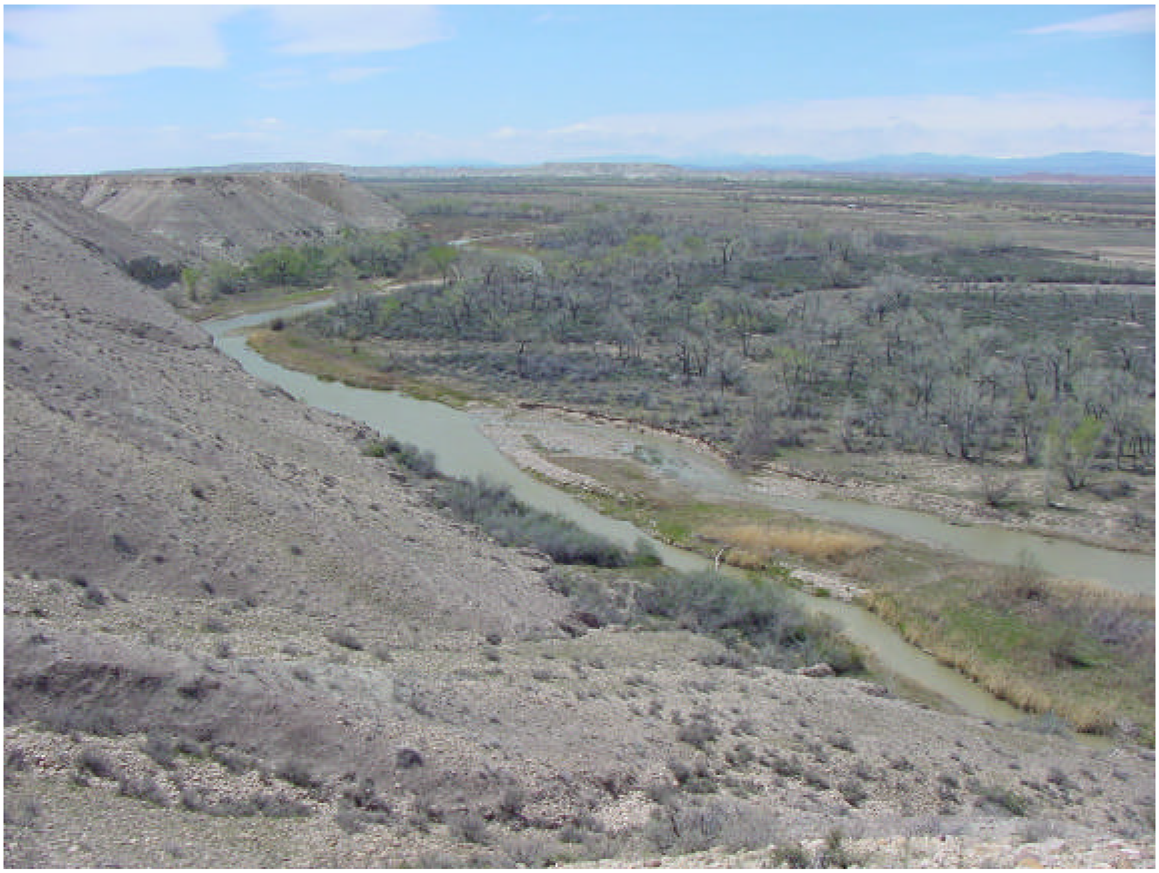

Figure 7. View from bench looking upstream on Duchesne River at Leland Ditch Diversion. The diversion canal forks to the right and is the closer channel in the photo.

NOTE: The Unita River converges with the Duchesne River below Leland Ditch and above the USGS gaging station at Randlette. The Uinta River is managed by a different river commissioner (not John Swasey). At the time of this field tour, the stage at the USGS gage on the lower Uinta River was being influenced by a beaver dam just downstream from the gage.

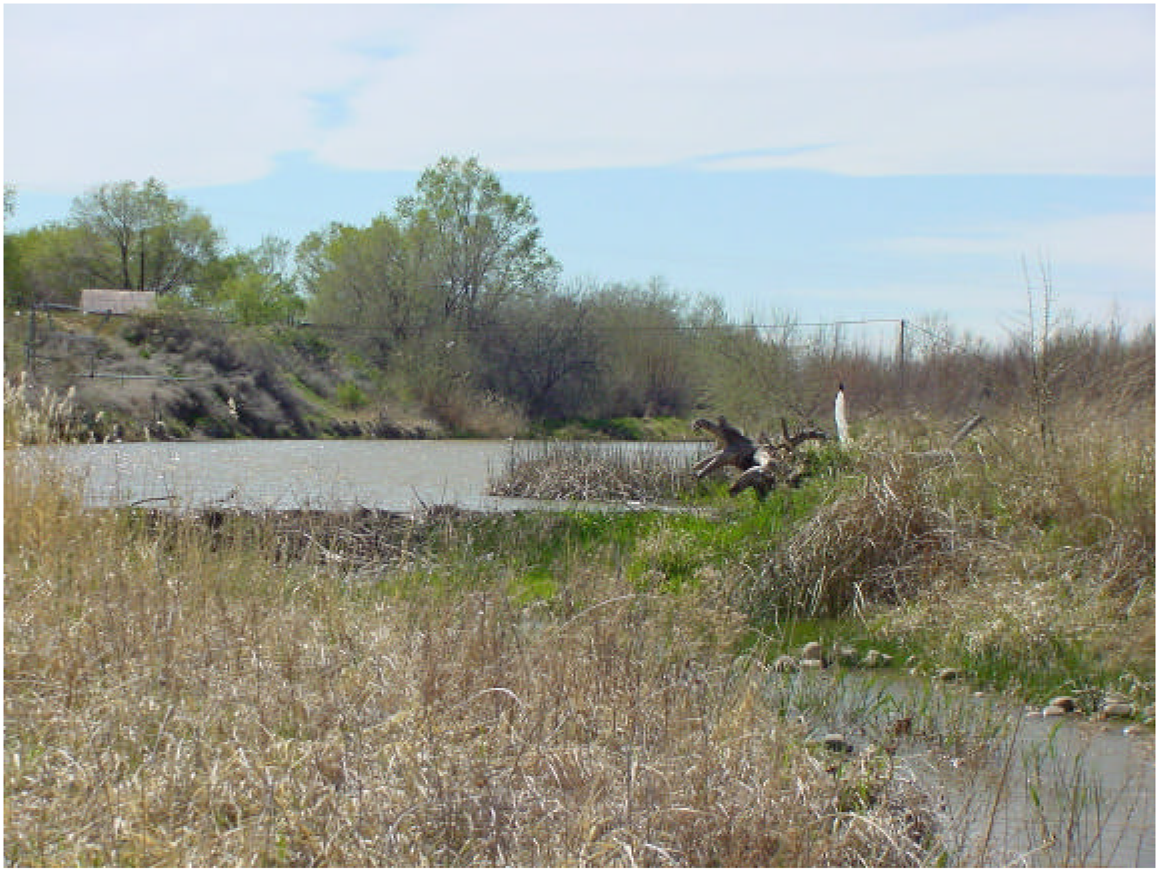

Figure 8. View looking upstream on Uinta River just above confluence with the Duchesne River. Cable in background is at gaging station where the stage of the river is being influenced by the beaver dam in the foreground.

NOTE: The field tour included a stop at the USGS gaging station at Randlett. There was a beaver dam upstream of the gage that was directing flow to the south side of the river (i.e. across from the gage house). Some of this flow remained on the south side of the river was not being measured by the USGS gage. This redirected flow joined the main channel just downstream from the USGS gage.

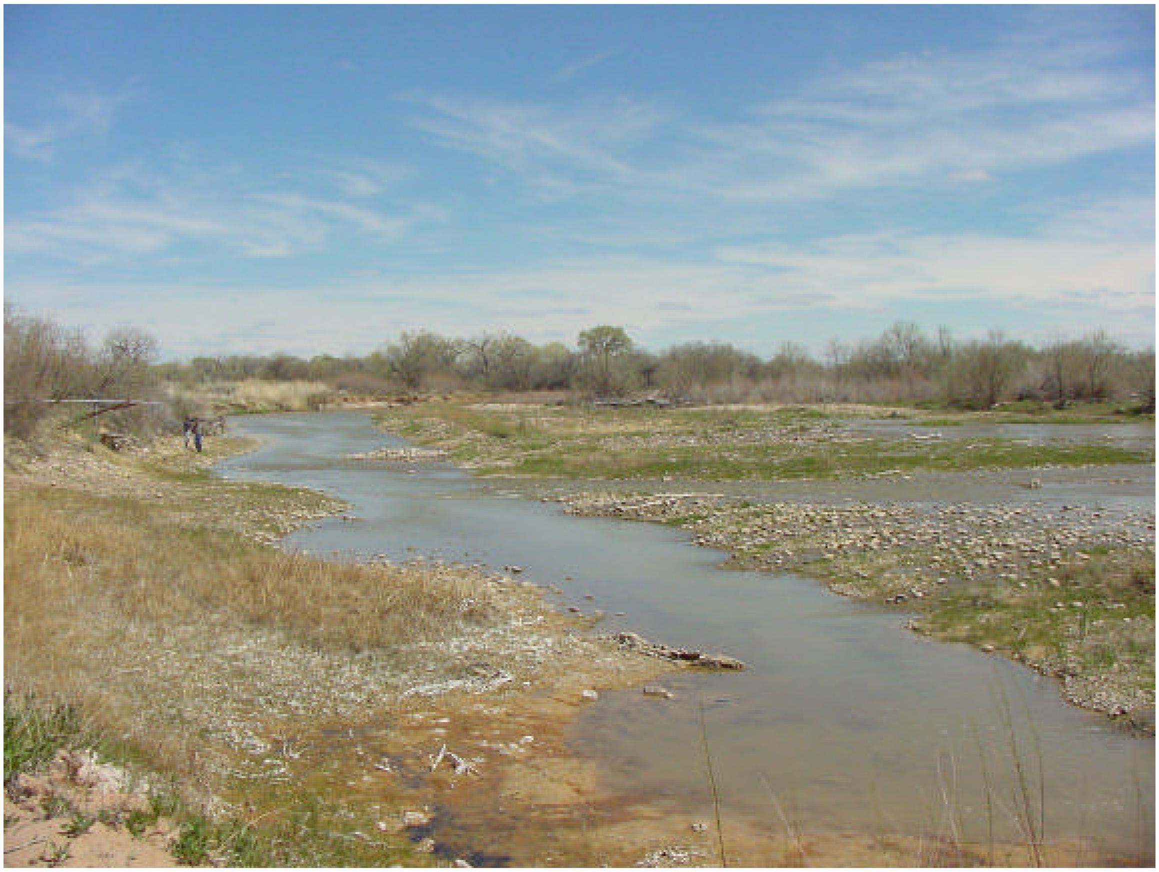

Figure 9. View looking downstream on Duchesne River towards USGS gaging station at Randlett showing braided channel.

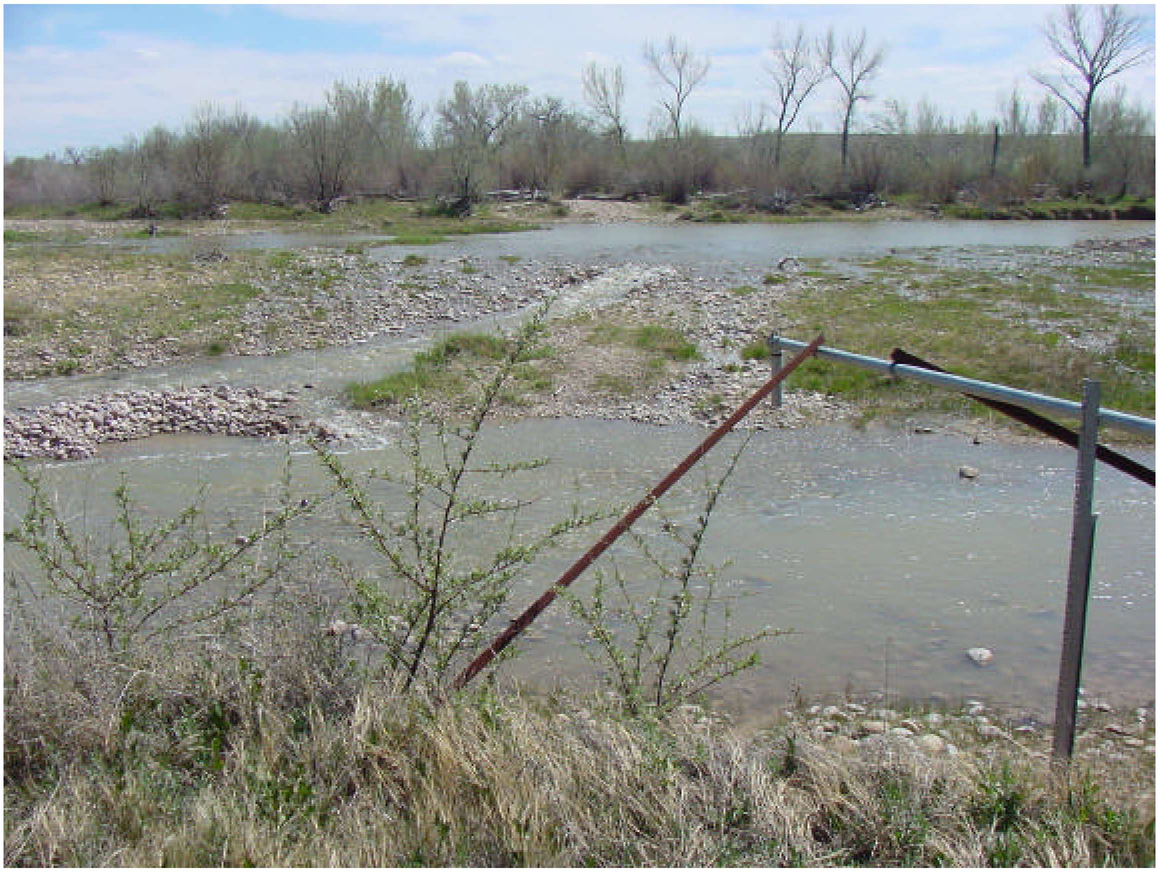

Figure 10. View of Duchesne River from USGS Randlett gage showing braided channel and stage differences across channel.

Jenkins Pump has water rights that date to 1962 and amount to about 7-8 cfs. About 600 acres of cropland are irrigated from this diversion. Water is diverted down a canal (Figure 11) into an off-channel pond (Figure 12) and then pumped uphill to another pond. From the second pond water is distributed into a sprinkler irrigation system.

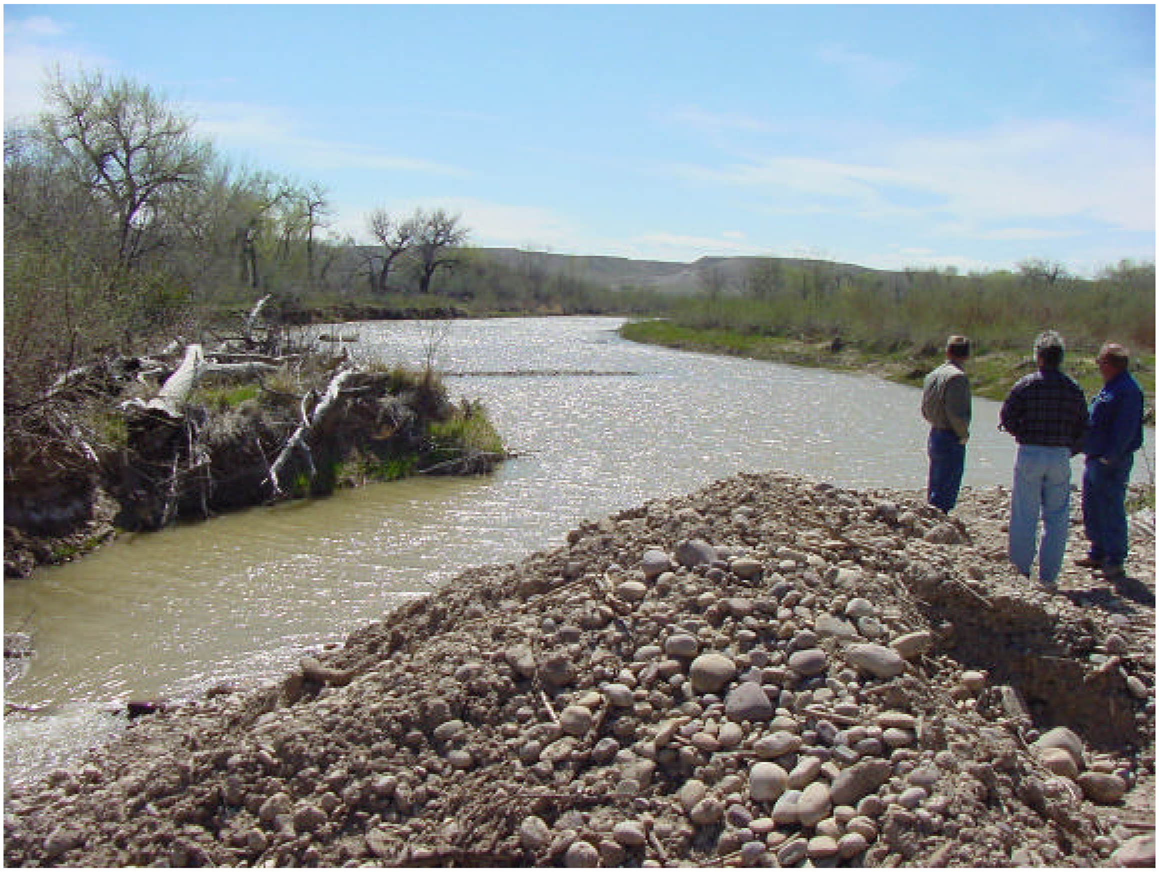

Figure 11. View of Duchesne River at Jenkins Pump Diversion looking downstream. The diversion canal branches off to the left on this photo and the river continues downstream into the background.

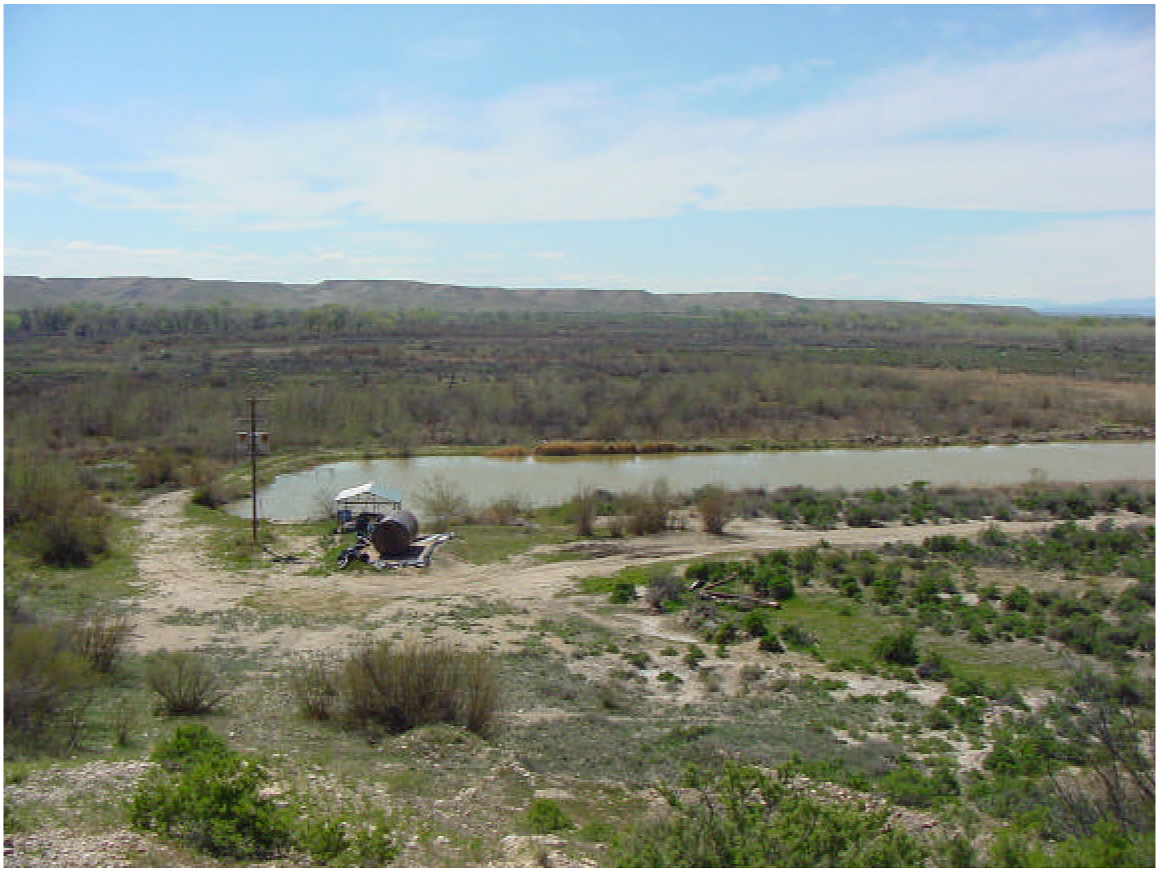

Figure 12. Off-channel pond fed by canal from Jenkins Pump Diversion. Ponded water is pumped uphill to another pond from where it is distributed via sprinkler irrigation.

Cover photo: Duchesne River

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