Lower Dolores River Implementation, Monitoring and Evaluation Plan for Native Fish

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I. INTRODUCTION: IMPLEMENTATION, MONITORING AND EVALUATION PLAN

Native fish have been a central part of ongoing discussions related to the Dolores River below McPhee Reservoir (lower Dolores River) since the inception of the Dolores River Dialogue (DRD) in 2004. In addition to that forum, in 2008 the DRD launched the Lower Dolores River Working Group, in cooperation with the Bureau of Land Management and United States Forest Service, to provide feedback on specific management questions related to the river corridor. As well as accomplishing that task, the Working Group reached consensus in early 2010 to pursue a legislative solution for the lower Dolores River with the goal of addressing concerns and priorities for the spectrum of stakeholders, thus launching yet another focused deliberation. Two important outcomes have resulted from all of these ongoing discussions. First, while there is great diversity in the interests of stakeholders invested in the lower Dolores, agreement was reached that the status of native fish needed to be addressed – for the sake of the fish themselves and for water rights protection. Second, then, was the realization of the need for deeper understanding of native fish below McPhee Reservoir and what types of management actions could benefit them.

An effort called *A Way Forward* (AWF) was created to gather information and identify opportunities for improvement in the management of native fish. The completion of *A Way Forward* led to the formation of an Implementation Team tasked with translating opportunities into management strategies. Development of this Implementation, Monitoring, and Evaluation Plan is the end result. As described in detail below, a foundation of this plan is the "Range-Wide Conservation Agreement and Strategy for Roundtail Chub *Gila Robusta*, Bluehead Sucker *Catostomus Discobolus*, and Flannelmouth Sucker *Catostomus Latipinnis*, " (Three Species Agreement) (http://ocs.fortlewis.edu/drd/implementationTeamReports.htm). Another important consideration in the development of this Plan has been existing obligations impacted by flows in the Lower Dolores. The Implementation Plan also is consistent with flow-related Dolores Project benefits and mitigation measures related to Dolores Project authorizations, specifically: (1) to create a quality sport fishery directly below McPhee Dam; and (2) to manage McPhee Reservoir spills[1] to optimize whitewater boating opportunities consistent with Project purposes.

All of the efforts related to the Implementation, Monitoring and Evaluation (IM&E) Plan are guided by the DRD purpose statement, which is ". . . to explore management opportunities, build support for and take action to improve the ecological conditions in the Dolores River downstream of McPhee Reservoir while honoring water rights, protecting agricultural and municipal supplies, and the continued enjoyment of boating and fishing." While the primary focus of the IM&E Plan is on the well-being of native fish in the Dolores River, the Plan also reflects the human needs and values that depend on the diversion of Dolores River water into the San Juan River basin for agricultural, municipal, industrial, and environmental uses. These include 70,000 acres of irrigated agriculture in the Montezuma Valley and the Ute Mountain Ute Tribe Farm and Ranch Enterprise. Without diversions from the Dolores River, the City of Cortez would not have developed and the growth and commercial expansion in the Tribal community of Towaoc[2], made possible by the Colorado Ute Indian Water Rights

[1] Note that the term *spill* as used in this document is synonymous with the term *managed release.*

[2] The Ute Mountain Ute Tribe holds allocations in the Dolores Project pursuant to a settlement of Tribal reserved water rights claims in the Colorado Ute Indian Water Rights Final Settlement Agreement of December 10, 1986, as authorized by Congress in the Colorado Ute Indian Water Rights Settlement Act of 1988, Pub. L. No. 100-585, and as amended by the Colorado Ute Settlement Act Amendments of 2000, Pub. L. No. 106-554 and Pub. L. No, 110-161 (2007); and the 1991

Settlement, would not have been possible. Continuing to support these community needs while protecting fisheries, riparian health and the quality of the boating experience below McPhee Reservoir are the challenges that the IM&E Plan is designed to address.

A. A Way Forward

Launched in 2010, the *A Way Forward* process was designed as a transparent scientific inquiry using all available existing data to help stakeholders better understand the status of the roundtail chub, the bluehead sucker, and the flannelmouth sucker in the lower Dolores River and to identify tools that could potentially help improve the status of each species. Three independent scientists with experience working on three-species issues were contracted to provide their own analyses of the biology and management issues affecting the fishery, and present ideas that might improve the status of each of the three species. Their final report[3] and resulting opportunities for population improvement became a foundation for this Implementation, Monitoring, and Evaluation Plan.

Three Species Agreement

The three native fish species, roundtail chub, bluehead sucker, and flannelmouth sucker, inhabit the Dolores River. Concerns about declines in the three species within the Colorado River Basin prompted resource agencies to draft and adopt a multi-state, multi-agency conservation agreement, the Three Species Agreement. Colorado and five other Colorado River Basin states that are part of the range-wide distribution of these species, along with the United States Forest Service (USFS), Bureau of Land Management (BLM), Bureau of Reclamation (BOR), and sovereign tribes, are signatories. In addition, the range-wide declines described in the conservation agreement speak to the species' potential for listing by the U. S. Fish and Wildlife Service as threatened or endangered under the Endangered Species Act of 1973, as amended. The U. S. Fish and Wildlife Service (USFWS) relies on the multi-state/agency/NGO conservation agreement to protect and conserve the three native warm-water species.

The Three Species Agreement articulates that within their jurisdictional authority, signatories are responsible for taking action to conserve native fish, coordinating status assessments, developing and maintaining data sets on occupancy and genetics, and documenting conservation measures taken on behalf of the three species. It encourages all signatories to cooperate on science, research, education and outreach to send a clear and consistent message about conservation of these species. The agreement is predicated on the concept that collectively, local, state, and federal agencies, and other willing partners can work together with the communities most affected by a potential listing to develop and implement voluntary actions that pre-empt the need for federal listing of any of these species under the Endangered Species Act (ESA).

Consent Decrees. The Tribal reserved rights allocations in the Dolores Project are subject to special protections and administration provisions, see Case No. W-1603-76H.

[3] Bestgen, K.R., P. Budy, and W.J. Miller, August 2011. Status and trends of Flannelmouth Sucker *Catostomus Latipinnis*, Bluehead Sucker *Catostomus Discobulus*, and Roundtail Chub *Gila Robusta*, in the Dolores River, Colorado, and Opportunities for Population Improvement: Phase II Report. Final report submitted to the Lower Dolores Working Group - Legislative Subcommittee. Larval Fish Laboratory Contribution 166 and Intermountain Center for River Rehabilitation and Restoration 2011(2): 1-55, + appendices.

All of the opportunities identified in the *A Way Forward* Report and this Implementation Plan align with the regional conservation strategies presented in the Three Species Agreement.

The *A Way Forward* Report

The final report from *A Way Forward* was completed in August 2011. It summarized the status and trends of the three species from McPhee Dam down to the confluence with the San Miguel River, discussed reasons for their decline, and presented recommendations that, if implemented, could lead to improvement of the native fish community. (http://ocs.fortlewis.edu/drd/pdf/DoloresRiverPhaseIIFinalAugust2011-appendices.pdf).

The scientists concluded that the strength of status and trend conclusions was high while the strength of conclusions regarding the exact mechanisms underlying population decline was less certain. According to the *A Way Forward* final report, there is currently no single factor that is most responsible for native fish declines. The most likely combined causal factors for declines in the three species' populations are reduced frequency, magnitude and duration and altered timing of peak flows (spills/managed release) compared to pre-impoundment times, as well as altered base flows compared to pre-diversion times and the presence of predatory non-native fishes (especially the smallmouth bass) that compete for habitat and prey on the offspring of the native fishes. These changes have had an adverse effect on the fishery.

The final report presented nine potential management opportunities that may assist with the improvement of the native fish community. Because no single factor was found to be responsible for the native fishes' decline, the three scientists recommended that all feasible opportunities be pursued in order to have the best chance to improve the status of native fish. This Implementation, Monitoring, and Evaluation Plan is constructed to specifically address these opportunities as they were presented in the *A Way Forward* scientists' final report. The list of opportunities presented by the scientists include:

- Spill Management
- Base Flow Management
- Geomorphic Processes - Sediment Flushing Flows
- Geomorphic Processes - Habitat Maintenance Flows
- Thermal Regime Modification
- Reduce Cold-water Invasive Effects - Discontinue Stocking
- Reduce Cold-water Invasive Effects - Reduce Brown Trout Reproductive Success
- Reduce Warm-water Invasive Effects - Disadvantage Smallmouth Bass Reproductive Success
- Supplement Adult Native Fish

B. Implementation Team

In June 2011, the Scientific Oversight Panel created specifically for the *A Way Forward* process ranked the nine opportunities based on urgency, necessity, and complexity of implementation. All of the opportunities except discontinuing the stocking of cold-water fish were ranked by the group as items that "we can and should work on now".

It was also thought that implementation of the opportunities identified by the *A Way Forward* scientists could and should be addressed independently of other ongoing collaborative discussions related to the lower Dolores River through a process that further described each opportunity identified, how implementation could proceed, and how to evaluate the effectiveness of actions taken. The formation of the Implementation Team and this Implementation, Monitoring and Evaluation Plan is the result of those efforts. The Implementation Team is a critical mechanism for successful management of native fish and flows in the Dolores River below McPhee Reservoir. Pursuit of many of the opportunities identified in *A Way Forward* requires cooperation from the multiple institutions and interests represented by the Implementation Team.

Through this Implementation, Monitoring, and Evaluation Plan, the Implementation Team and the federal, tribal,[4] and state entities represented on the team have sought to assess, implement, and evaluate the opportunities described by the scientists, and to adapt their management based on the success or failure of specific actions.

C. The Path Ahead

The Implementation Team and this Plan will support the long-term viability of native fish in the lower Dolores River through active adaptive management and monitoring, based on identified opportunities to improve the status of native fish. The Plan provides a framework for this by detailing specific management actions that Implementation Team partners can take. The Implementation Team partnership is based on the premise of shared responsibilities and, in keeping with the DRD purpose statement, will honor and respect existing water rights, water allocations, Dolores Project contracts, and other Project commitments, including the tailwater trout fishery and mitigations for whitewater boating. With that framework in mind, actions outlined in the Plan will be implemented when possible. It is understood by Implementation Team partners that conservation actions taken will be documented and modified over time based on monitoring and evaluation, and that there is no assurance that all native species will be viable in light of water availability, drought, climate change, or other unforeseeable factors that may negatively impact the native fishery.

It is the intent of the Implementation Team to continue to meet on a regular basis to identify appropriate management actions for a given year, process annual monitoring data, adjust management actions as needed, and continue discussions on long-term issues.

II. ASSESSING AND ENSURING NATIVE FISH VIABILITY

A. Native Fish Conservation Measures and Status in the Dolores River Below McPhee Dam

<u>Introduction</u>

The goal of this Implementation Plan is to maintain, protect, and enhance the native fish populations in the Dolores River. The Implementation Team recognizes that achieving native fish populations analogous to pre-water development times is not a realistic goal. It is not the intent of this Plan to achieve fish population densities and distributions observed in unaltered stream environments. Because sampling methodologies, habitat characteristics and suitability, and water quality all vary widely between sites, no one fishery or habitat metric will be applicable to the entire reach under consideration. Measurable progress occurs when multiple

[4] The Ute Mountain Ute Tribe has experience working with roundtail chub, bluehead sucker, and flannelmouth sucker populations in other tributaries of the San Juan River Basin (including extensive work with roundtail chub populations on the Mancos River).

indicators of species viability appear to show that native fish species' populations are being maintained or enhanced where appropriate habitat conditions exist. Further discussion of what constitutes a healthy fishery is included in Section B, 'Evaluation - Measurements of Fishery Health and Viability'. Section B describes how the collection of discrete and frequent data points will give managers critical information about specific indicators affecting the sustainability of the native fishery. Systematic evaluation of these data integrated over basin-wide and long-term scales while tracking management activities will allow fishery managers to focus on the causal factors that create positive shifts in the populations of each species and improved reproductive success. This approach will also help discern where populations of fish will be limited for reasons beyond the control or scope of this partnership.

The Implementation Plan details specific opportunities that can be implemented consistent with the Three Species Agreement, local communities' concerns about water supply, and collaborative efforts to conserve roundtail chub, flannelmouth sucker, and bluehead sucker. These actions should enable maintenance of existing populations of native fish observed in recent post-Dolores Project data between McPhee Dam and Bedrock, and should result in positive viability indicators for these species. Monitoring and evaluation of the measures of fishery viability is critical in order to determine the effectiveness of management actions taken in support of native fishery goals. These assessments will provide the basis for adjusting future actions under this adaptive management plan and, over time, will significantly add to the knowledge base pertinent to fishery management on the Dolores River.

The fish assemblage below McPhee Dam reflects a complex hydrologic history, which may be coarsely divided into four distinct phases: (1) pre-settlement conditions (pre-1886); (2) the 'MVI era' between 1886 and 1986, which ended when McPhee Dam construction was completed and the reservoir filled; (3) the early Project years, when major features of the Project were not yet completed (1986-1999); and (4) the full development period that exists today (2000-present). During the MVI era, the Montezuma Valley Irrigation Company diverted nearly all of the Dolores River after spring snowmelt subsided.[5] During early Project years, releases of undelivered but otherwise allocated water from McPhee Reservoir substantially augmented Dolores River base flows.[6] Therefore, water availability and use conditions during the full development period are the baseline hydrological conditions upon which this Plan is based.

Implementation of the conservation efforts described in the Plan recognizes the current hydrologic template that now exists, and these efforts must also be consistent with Colorado water law, and current Dolores Project contracts and allocations. Although the native fishery below McPhee Dam has persisted through intensive water development in the Dolores Basin, fishery managers also must recognize the limitations that current water supply and infrastructure impose on the prospects for a robust native fish assemblage (i.e., metrics for the Dolores below McPhee Dam such as fish numbers, size, biomass, or age structure may not resemble similar

[5] *See* Definite Plan Report at pp. 22-23 ("The river, which is now depleted in the late summer as a result of irrigation diversions, would be restored with the reservoir releases to its historic condition as a constantly flowing stream."); EIS at B-9 (stating that "during about 14 out of every 15 years, the river dries up at the dam site in the late summer or fall as a result of diversions upstream by the Montezuma Valley Irrigation Company"); DPR at p. 69 and EIS at p. B-13 (pre-Project photographs of Dolores River below MVIC diversions in late summer).

[6] In addition to historical Project operation records, *see* DPR at pp. 45 (stating that "[s]ome of the capacity of project features would remain unused after the initial delivery of project water but prior to the completion of project construction") and 54 (stating that "[a] 9-year development program would be needed for construction of all project features except for drains").

metrics from less-altered rivers). However, the recommendations made by the *A Way Forward* scientists should, if implemented, give native fish below the dam their best hope for long-term sustainability.

Life History and Status of Roundtail Chub, Bluehead Sucker and Flannelmouth Sucker in the Dolores River

A comprehensive discussion of the critical life-history stages, needs, and limiting factors of roundtail chub, bluehead sucker and flannelmouth sucker in the Dolores River, as they are currently understood, are found in the *A Way Forward* final report on pages 14-21 (Bestgen et al. 2011). Table 1 lists important milestones in each species' life history and the general habitat conditions needed to maintain viable populations of these species. Table 2 describes the Dolores River reaches that help stratify habitats, and how the life-stage habitat needs may or may not be met below McPhee Dam for roundtail chub, flannelmouth sucker, and bluehead sucker. The table also gives a general understanding of the current status of each native species by reach. Figure 1 provides an overview of the sampling sites and the reaches referred to in the tables and narrative below.

	SPAWN	FRY- EMERGENCE	YOUNG OF YEAR JUVENILE	ADULT
Roundtail Chub	Need relatively clean cobbles/ interstitial space for eggs to settle; can be runs and glides; temps 16-22° C	Structure/ complexity to avoid immediate predation	Quiet shallow channel margins, backwaters	Deeper water/ slow-velocity eddies with access to good flow/ runs. In-channel structure. Omnivorous, opportunistic feeders
Flannelmouth Sucker	Spawn over gravel and cobble; eggs adhere or fall into interstitial spaces. Need clean substrate and flowing water to aerate eggs. 10-18° C.	Near-shore, slow-velocity habitats with cover	Utilize wider variety of habitat types; deep runs, riffles and pools	Utilize multiple habitat types; feed in riffles and deep runs on detritus, algae, invertebrates; have been known to move long distances (documented to ~150 miles)
Bluehead Sucker	Shallow areas with clean cobbles and interstitial space for egg incubation; 14-20° C	Near-shore, slow-velocity habitats and trending toward deeper water and higher velocity with age	Extend habitat used into faster-moving water; begin feeding exclusively in riffles and deep runs	Swifter velocity, higher-gradient riffles and runs; scraper of detritus, algae, and macro-invertebrates from substrate

Table 1. General description of life-stage needs for the roundtail chub, flannelmouth sucker, and bluehead sucker.

Reach	General Description	Roundtail Chub	Flannelmouth Sucker	Bluehead Sucker	Non-Native Fishes
Reach 1 (McPhee Dam to Bradfield)	Cold-water release precludes use by native warm-water species	Unoccupied; no potential	Unoccupied; no potential	Unoccupied; no potential	Brown trout abundant; rainbow trout common. 80% brown trout; 20% rainbow; brown trout self-sustaining; combined trout biomass is about 43% of a typical Rocky Mtn. stream. Green sunfish rare.
Reach 2 (Ponderosa Gorge)	Cold- to cool-water habitat. Thermally transitional waters. Use by all warm-water native fish documented during Ponderosa Canyon surveys in 1993; FMS/BHS not documented in 2005 or 2007 surveys. RTC present.	Relatively low abundance; difficult to assess; habitat suitability ebbs and flows with water discharge.	Status unknown but may be extirpated from reach; limited potential or seasonal occupation only	Status unknown; based on juveniles found downstream, at least seasonal occupation during spawning season	Brown trout relatively low abundance (less than 50 adults/mi); fire and drought (warm water) limit population. Green sunfish status unknown.
Reach 3 (Dove Ck Pumps to Pyramid)	Good habitat (structure and instream cover, riffle-pool-run complexity). Sedimentation from tributaries, lack of sediment mobility may affect habitat availability.	Abundant. Adults show small body size relative to downstream/ other river populations.	FMS rare; absent from most DCP surveys. 1 juvenile in 2013 survey. No FMS in seine samples.	BHS rare; absent from most DCP surveys. 8 juvenile BHS captured in 2013. No BHS in seine samples.	Brown trout rare to common near DC pumps (<50 fish/mi) and decreasing to rare near Pyramid. Smallmouth bass (SMB) rare to common at DC pumps and common at Pyramid. Green sunfish common. Channel catfish rare.

Table 2. Current habitat suitability and status of fish for designated reaches of the Dolores River below McPhee Dam

Reach	General Description	Roundtail Chub	Flannelmouth Sucker	Bluehead Sucker	Non-Native Fishes
Reach 4 (Pyramid to Big Gyp Valley Bridge)	Pyramid to Disappointment (good structure and instream cover, riffle-pool-run complexity) – similar to Reach 3; Disappointment to Big Gyp Valley – heavy sedimentation, lack of structure, turbid water. Reach above Disappointment Ck. has abundant clean cobble used by FMS for spawning.	Smallmouth bass occupy reach above Disappointment Ck. Roundtail chub rare but slightly larger than in Reach 3.	Flannelmouth sucker uncommon but need more data on utilization of Pyramid reach; may be important for spawning. SMB above Disappointment Ck. 2012 seine survey found a few young FMS; dead FMS picked up after 2013 Disappointment Ck flash flood	Bluehead sucker uncommon; no juveniles in 2012 seine surveys. Several large adults captured above Disappointment Ck in 2007.	Brown trout rare to absent. Smallmouth bass common to abundant down to Disappointment Creek confluence. SMB rare below Disappointment Creek. Heavy sediment and flash flooding may limit SMB population expansion downstream of Disappointment Ck. Green sunfish common. Black bullhead common. Channel catfish rare.
Reach 5 (Slickrock Canyon)	Good structure; riffle-run-pool complexes; turbid water. Native fish made up 79% of catch in 2007 survey. Importance of tributaries/ inlets as refugia and/or spawning unknown.	Few fish (2 caught per mile) but larger when caught. Spawning or fry use may be linked to tributaries.	Few fish (2-3 caught per mile) but larger adults than upstream populations.	Extremely rare (1 fish caught per 5 miles of canyon) but larger adults when caught.	Smallmouth bass, channel catfish, green sunfish, and common carp are rare. Black bullhead status unknown. Status somewhat uncertain because only 1 survey was completed in the past 10 years.
Reach 6 (Paradox Valley - Bedrock to San Miguel confluence)	Salty, channelized, hot. Need to investigate potential for fish to move through this reach from below San Miguel confluence into upper reaches – seasons, frequency, water discharge are of interest. Question: Is Reach 6 an impediment to colonization from downstream?	NO DATA	NO DATA	NO DATA	NO DATA

Table 2. Current habitat suitability and status of fish for designated reaches of the Dolores River below McPhee Dam

Reach	General Description	Roundtail Chub	Flannelmouth Sucker	Bluehead Sucker	Non-Native Fishes
Dolores River below San Miguel confluence	Good canyon habitats w/ structure, riffle-pool-run complex, with hydrograph (river process) more intact by San Miguel inflows. Native fish 51% of catch in 2007 survey; 76-93% natives in 2010 surveys on 3 reaches.	Uncommon in surveys. (2-10 fish/mile); smaller size class river miles)	Uncommon (~7-10 fish/mile); good age structure amongst sampled fish.	Uncommon (3-10 fish/mile); good age structure amongst sampled fish.	Channel catfish and carp are common (20-30% of fish captures). Status of green sunfish, black bullhead, white sucker, uncertain.
OVERALL – Dolores River below McPhee Dam	Habitat intact, mostly contiguous, and lacking hybridization with white sucker; regional 3-species recovery priority. Flow management/out of basin diversions remain significant challenge for reach between Dove Creek pumps and SM confluence (~70 miles)	Abundant in reaches 3 & 4 but small; better age structure but less abundant below Disappointment or San Miguel River.	Gone or nearly gone from reaches 1-3; Reach 4 may be important spawn area. Juveniles in reach 4. Good age structure below San Miguel River confluence.	Gone from Reach 1 and Reach 2 (?); some evidence of reproduction in Reach 3, less so in 4 and 5; part of intact native fish assemblage below San Miguel confluence.	Brown trout most abundant in first 12 miles, then absent by ~40 miles downstream of McPhee. Smallmouth bass common in about 20 miles from DC pumps to Disappointment Ck. Channel catfish and carp most common non-native species below San Miguel.

Table 2. Current habitat suitability and status of fish for designated reaches of the Dolores River below McPhee Dam

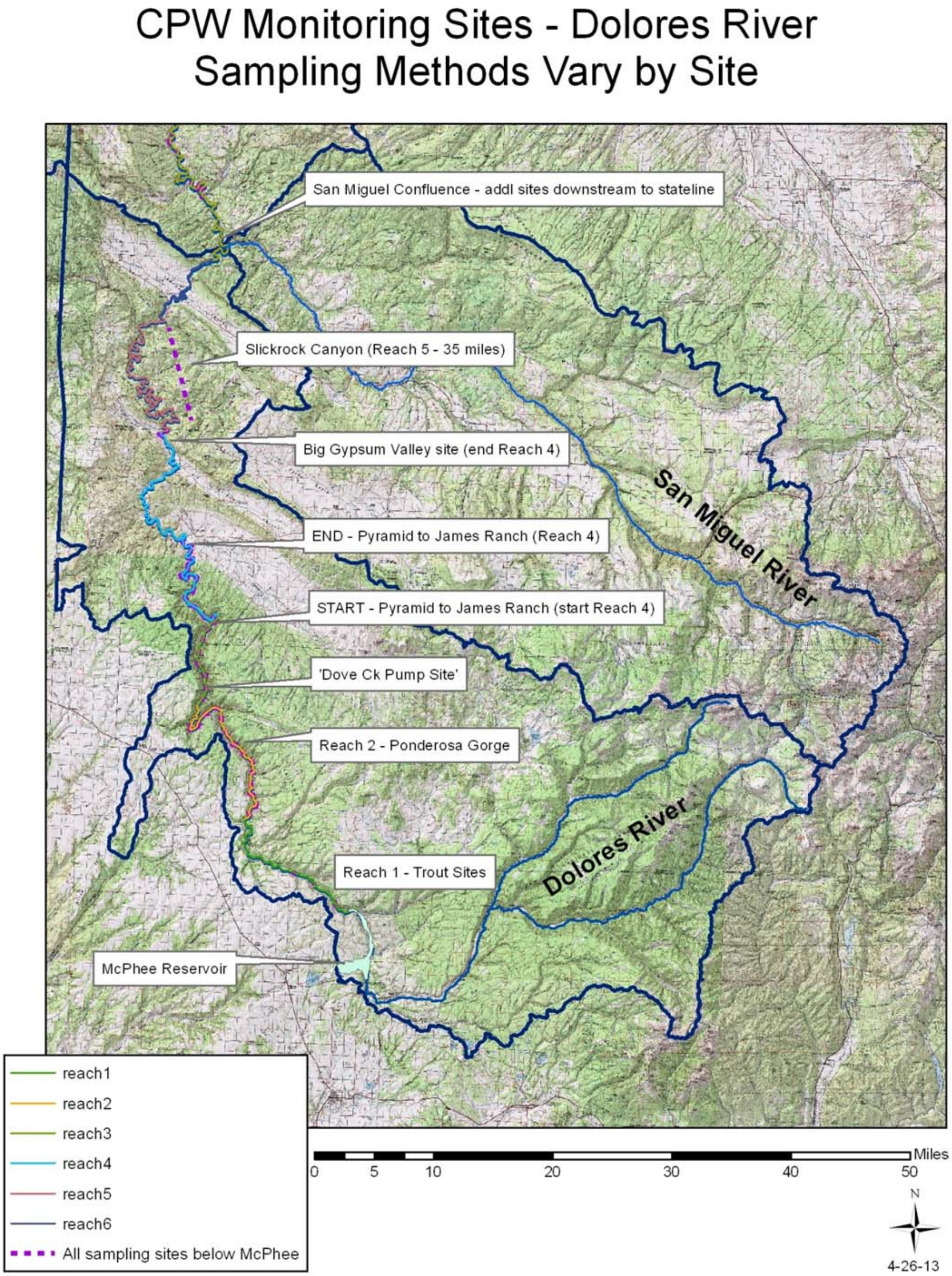


Figure 1. Detailed map including sampling reaches. Sampling methods and intent of effort vary between sites.

The status of roundtail chub and the two native suckers in the Dolores River varies from Reach 1-5 (McPhee Dam to Bedrock) and below the San Miguel River confluence. Bestgen et al. (2011) present a detailed account of native fishes within the Dolores River based on the history of sampling data; however, a brief synopsis may be instructive as the objectives, potential, and status for species by reach are different. This reach summary encapsulates the suite of available information about fish occupancy in each reach, describes the desired condition of the fishery within each (hinting at the potential of each reach to provide a meaningful contribution to the health of the fishery), and details current monitoring efforts.

Reach 1: McPhee Dam to Bradfield Bridge; 12 miles

CURRENT CONDITION: Native warm-water fish, including roundtail chub, are currently extirpated from Reach 1 because of coldwater releases from McPhee Dam and the introduction of non-native salmonids. Colorado Parks and Wildlife (CPW) manages this reach as a coldwater trout fishery with special regulations. The mottled sculpin, a native cold-water species, remains abundant in this reach. Low-level releases from outlet level 3 have been an important management strategy to minimize the potential for escapement of warm-water non-native fish from McPhee Reservoir, including smallmouth bass and white sucker.

DESIRED CONDITION: Reach 1 has been and will continue to be managed as a coldwater sport fishery, and serves as an important 'buffer' between non-native fish in the reservoir and downstream warm-water native species that are potentially impacted by release of non-native fish. Rainbow trout and/or native cutthroat trout fingerling are stocked on a near-annual basis; in recent years, Hofer strains of rainbow trout that research indicates are more resistant to whirling disease have been stocked in this reach. Biomass of trout in this reach correlate closely with the volume of total release from McPhee Dam.

MONITORING: Because establishment of a quality cold-water fishery was an important objective for the Dolores Project, Reach 1 has been routinely monitored since 1988. Three long-term 1000-foot walk-shock sites allow CPW aquatic biologists to monitor population, biomass, and measures of 'quality' (e.g., fish over 14") and have been critical in assessing the effects of whirling disease, habitat, and flow on the sport fishery. A fourth site was added in 2004 to assess the effects of a habitat improvement project implemented on CPW property upstream of the Ferris Creek campground.

Reach 2: Bradfield Bridge to Dove Creek Pumps, aka 'Ponderosa Gorge'; 19 miles

CURRENT CONDITION: Reach 2 may support small numbers of all three native species at times but is considered transitional and, functionally, may be abandoned by native suckers. Native suckers persisted in this reach in low numbers after McPhee Dam was closed and before Dolores Project distribution-facility construction was completed and deliveries reached full allocation, but no suckers were captured in longitudinal surveys in 2005 or 2007. Bluehead sucker may occupy the low end of Reach 2 as evidenced by the presence of the occasional juvenile and young-of-the-year fish captured in surveys at the 'Dove Creek Pump' sampling station, located 1.3 miles below the Dove Creek Pumps (in Reach 3). Because roundtail chub are relatively abundant at the Dove Creek Pump site but do not occur upstream at Bradfield Bridge, this reach is transitional for roundtail chub and perhaps a small number of bluehead suckers. Native fish may alter their use of Reach 2 seasonally to adapt to changing flow and temperature conditions. Data from surveys in 2012 and 2013 at the Dove Creek Pump station (top of Reach 3) indicate that a fire and subsequent sedimentation in 2010 originating in Narraguinnep Canyon significantly impacted the coldwater fishery. Reduced pressure from trout in this reach may offer an opportunity for re-population with native species through stocking, reproduction, or migration. CPW manages this reach, as well as the remaining reaches to the Utah Stateline, as native fish conservation water. Reach 2 may act as a barometer of expanding native fish abundance and distribution in the Dolores River but is not considered critical for improving the status of native fishes.

DESIRED CONDITION: Reach 2 serves as an important transition between cold-, cool-, and warm-water habitats and is likely occupied by trout, native, and non-native warm-water species seasonally and inter-annually, depending on hydrologic conditions. Spills would tend to drive warm-water species downstream, and as the spill recedes, warm-water natives may follow warming temperatures and lower flows upstream into Ponderosa Gorge for spawning. The upper portions of Reach 2 have historically been identified as excellent cold-water sport fish habitat, specifically for brown trout. The reaches near the northerly (lower) end of this canyon may be occupied seasonally by roundtail chub and bluehead suckers, and could potentially serve as important spawning for bluehead suckers in habitat not occupied by bass or green sunfish. In 2013, CPW lifted bag limits on brown trout through this reach to encourage angler take.

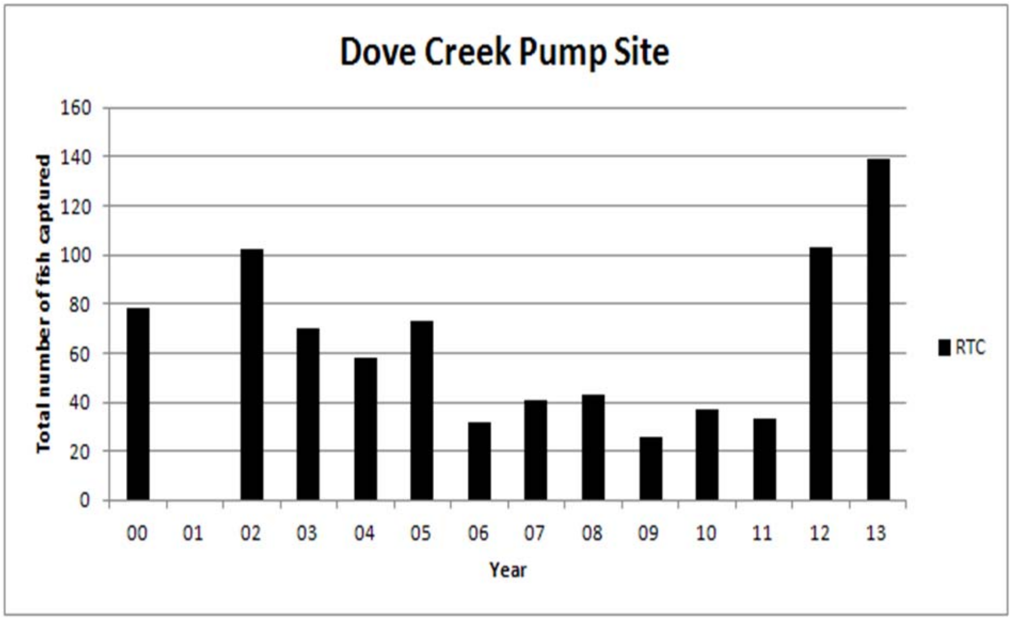
MONITORING: Periodic longitudinal surveys may occur during the managed spill, preferably at flows between 400 and 800 cfs. Two-pass mark-recapture surveys that allow for population estimates have been performed three times in 1993, 2005 and 2007, initially to detect escapement of fish from McPhee Reservoir during a managed release over the spillway while gates were under repair. No surveys have been done since 2007. The purpose of subsequent surveys will be to assess expansion of native fish occupancy and abundance, to assess (and potentially to suppress) brown trout numbers, and to detect the presence/absence of fish escapement from the reservoir in this transitional reach of the Dolores River. Data collected in 1993, 2005, and 2007 show declining abundance and distribution of both native warm-water species and trout. One pass catch-per-unit effort (CPUE) would be more realistic than the two-pass mark-recapture surveys completed in prior years, though replication of earlier methodologies that allow quantification and comparison of population metrics (fish/acre; lbs/acre; by species) are valuable if opportunities permit.

Reach 3: Dove Creek pumps to Joe Davis Hill just east of the 'Pyramid Peak'; 9 miles

The Dove Creek pump sampling site (about 1.3 miles below the actual pump location) is near the head of this reach and provides the best long-term data for native fish below the dam.

CURRENT CONDITION: This reach contains relatively steep-gradient riffles punctuated with deep boulder-strewn pools. Roundtail chub are the most abundant fish in this reach and although their abundance varies considerably from year to year, the population is relatively stable, with annual evidence of reproduction and multiple age classes (Figure 2). Though relatively abundant, sexually mature roundtail chub are much smaller through this reach than in many Western Slope rivers, indicating that roundtails may be adapting to limited habitat and low productivity in this reach of the Dolores. Bluehead and flannelmouth suckers are present in this reach but in low abundance and variable distribution. Low numbers of brown trout are historically found in this reach and diminish downstream, but smallmouth bass and green sunfish become more abundant near the downstream end. Recent sampling (2012-2013) at the Dove Creek pumps and larval fish sampling sites between the Dove Creek pumps and the Pyramid Reach indicate increasing numbers of warm-water non-native fish.

DESIRED CONDITION: Maintaining the roundtail chub population in this reach, especially evidence of successful spawning, is a high priority. Evidence of use by bluehead suckers and flannelmouth suckers would also be expected through this reach, given available habitats for these species. Occupation by brown trout near the upstream end and smallmouth bass and/or green sunfish near the lower end of the reach would hopefully diminish, which would indicate more favorable conditions for native species and selection against non-native fish propagation and recruitment. Representation of all age classes for all three native species is a desired condition, with a tendency toward more bluehead suckers, as they have a greater cool-water tolerance than flannelmouth suckers. In addition, larger adults of all species would be more resilient to stress from competition and predation by other species. While monitoring has substantiated viable populations of roundtail chub, the capability of Reach 3 to support all age classes of bluehead suckers and flannelmouth suckers is unknown at this time and will be evaluated by ongoing monitoring. The Dove Creek pump sampling site will remain critical in order to document changing species composition at a point near the upstream end of occupied native fish habitat.



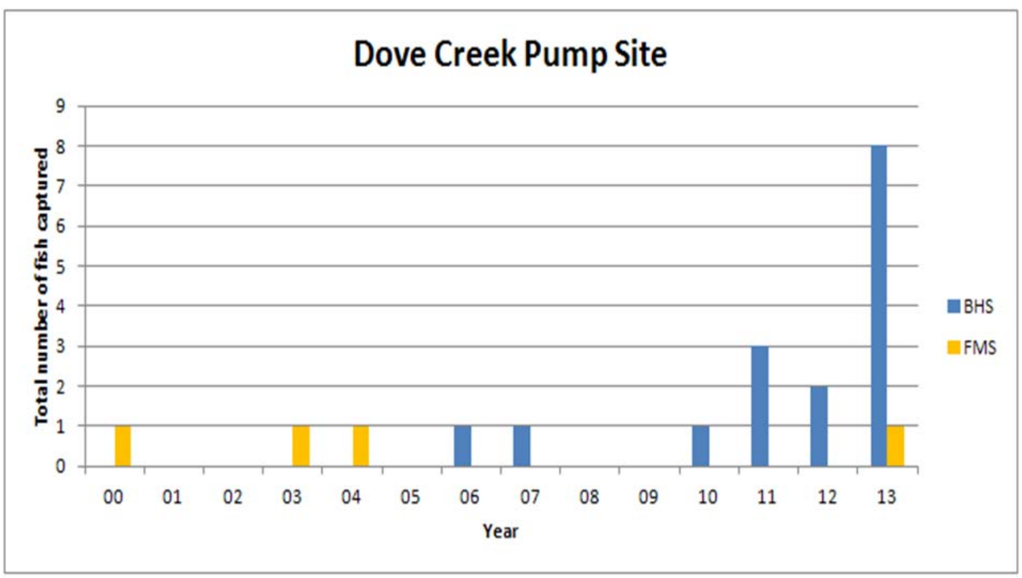


Figure 2. Relative abundance of roundtail chub (top) and native suckers (bottom) in the 1,000-foot section of stream surveyed 1.3 miles below the Dove Creek pump station. (Note: Scale on Y axis of graphs is different.)

MONITORING: As noted, the 1000-foot Dove Creek pump site is the most complete long-term dataset that exists in the lower Dolores, and the data enable detection of population trends of warm-water native fish species and other species occupying that reach. This site will remain a high priority in order to maintain continuity of this data and to detect how the species assemblage shifts in response to both management actions and unplanned stochastic events (e.g., droughts, floods, fires). Below the Dove Creek pump sampling site, some limited sampling has occurred the past few years (2012 and 2013) by walk-shock, backpack shockers, and seining to detect young-of-year or larval fish, and to understand how species composition changes longitudinally down the river. However, pools are generally too deep to wade, and abundant structure (e.g., Snaggletooth rapid) makes boat-shocking through this reach particularly challenging. When conditions are appropriate, it may be worth investing the resources to try to raft-shock to obtain species assemblage and 'catch-per-unit-effort' (CPUE) data. It is also hoped that Reach 3 will continue to be periodically sampled for the presence of larval fish in edgewater and backwater habitat to detect the spatial extent of spawning by each species.

Reach 4: Joe Davis Hill (Pyramid Peak) to the start of Slickrock Canyon; 38 miles

The first 14 miles of the reach is primarily confined and boulder-strewn with deep pools connected by clean riffles, but the reach also includes sub-reaches where the canyon widens to allow for modest alluvial processes to influence habitat. Reach 4 changes in character below the confluence with Disappointment Creek due to the high sediment inputs from this drainage, and again below Summit Canyon (~Slickrock) when the valley widens and alluvial processes dominate habitat characteristics.

Monitoring the relative abundance of smallmouth bass and native fish species in this reach is critical, and affords one small opportunity for smallmouth bass suppression by removing any fish caught. Also, because of the occasional presence of spawning flannelmouth suckers, maintenance of spawning habitat connectivity between upstream and downstream reaches is an important objective in this section of Reach 4.

CURRENT CONDITIONS: All three species of native fish are found in the Big Gypsum Valley site (Figure 4). Most of the data show that roundtail chub and young flannelmouth suckers are relatively common compared to other fishes but by 2004 (the last year of a prolonged non-spill and drought cycle), black bullhead comprised 45 percent of all fish caught. Figure 5 shows relative abundance of native and non-native species caught in sampling through an eight-year period (missing data in 2002 and 2003), and indicates how populations shift toward non-native species during prolonged low-flow periods(e.g., 2004), when native species made up less than 50 percent of the total fish caught. After a prolonged spill event in 2005, flannelmouth sucker and roundtail chub were 59 percent and 25 percent of the total fish caught, respectively. Bluehead sucker are rare.

DESIRED CONDITIONS: Objectives for the portion of Reach 4 above Disappointment Creek focus on reversing the observed population trends of sucker species and smallmouth bass, i.e., significantly reducing the presence of smallmouth bass in this reach and observing improvements in numbers and distribution, both size classes and spatial distribution, for sucker species, particularly flannelmouth. Improving the age class structure and numbers of roundtail chub through this reach are also important objectives, as habitat conditions that are similar to Reach 3 suggest that larger numbers of roundtail than what are observed in sampling would be the desired condition.

Further downstream below Disappointment Creek, positive changes in base flow and spill management may result in maintenance of a species composition that, overall, favors native fish over non-natives. However, drought-induced flow shortages should be anticipated, and during these periods increases in the non-native composition of species will persist. Wet years will continue to present the best opportunities to manage for recruitment of native fish, and fishery data from the Big Gypsum site showing robust distribution of age classes for all three species would indicate that new fish are being recruited into the population, ensuring a higher degree of resiliency to drought than what is currently observed.

MONITORING: Monitoring of the first 14 miles occurs via raft-shocking during managed spills, at flow levels of 400-500 cfs. These surveys first occurred in 2007, and were critical in determining the extent to which smallmouth bass had colonized and began to dominate the species assemblage in this reach. In 2012, fishery biologists began seining for larval and age 1+ fish to determine whether a successful spawn or recruitment had occurred, and also to discern which habitats are utilized by young fish. The Big Gypsum sampling site (a 2-mile section of Big Gypsum Valley between the BLM recreation site and the bridge immediately above Slickrock Canyon – see Figure 3) has been repeatedly sampled since 2000 by raft-shocking and in 2012 and 2013, seining for larval fish. No recent data have been collected between Disappointment Creek and the start of Big Gypsum Valley; however, habitat conditions upstream to Disappointment Creek are somewhat similar and comparable to the Big Gypsum sampling site, so this site is considered somewhat representative of sites upstream to Disappointment Creek.

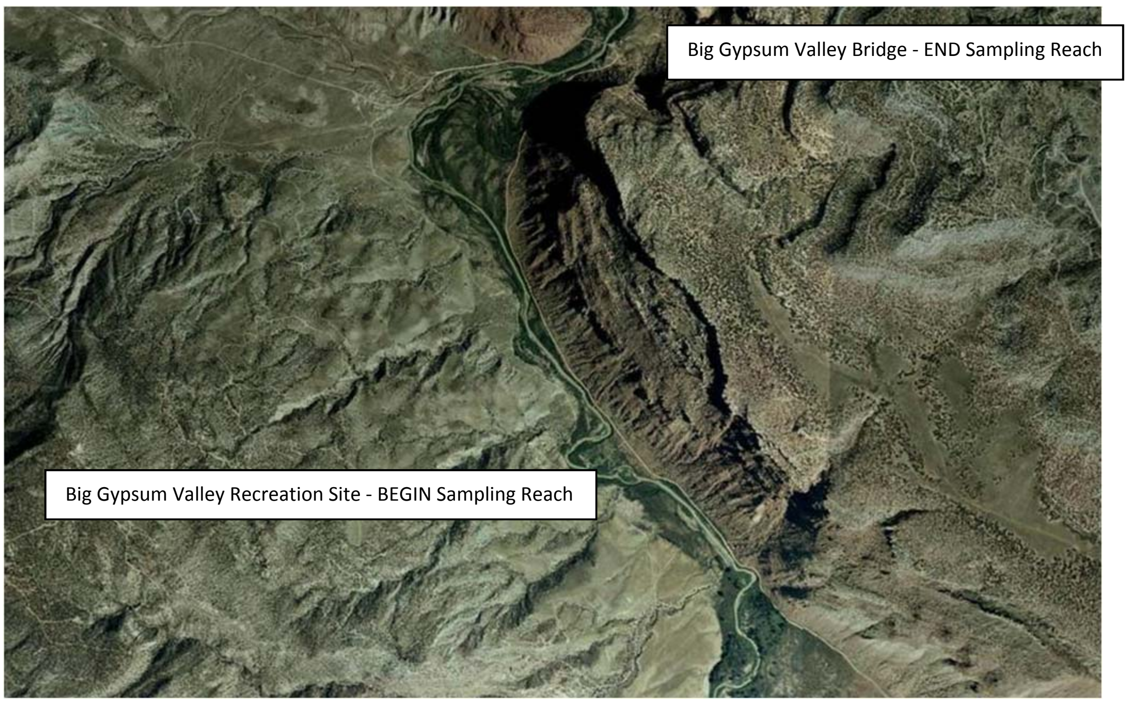


Figure 3. Big Gypsum Valley sampling reach. This reach was intensively sampled during a research effort (2000-2005) and remains a key sampling site immediately above Slickrock Canyon.

Monitoring the species composition at the Big Gypsum site will remain a priority because it appears that the native fish assemblage may be particularly sensitive to low-flow conditions or other environmental factors. The Big Gypsum site is also located such that repeated sampling over time should allow for the early detection of an expanding smallmouth bass population downstream. Monitoring for the presence/ absence of early life stages of roundtail chub and native sucker species is important in this reach, since there is some evidence that flannelmouth may be spawning upstream near the Pyramid. It would be desirable, given resources and appropriate flows, to sample from Slickrock to Big Gypsum Valley to determine whether good age classes for native fish exist, and to discern the downstream extent of smallmouth bass. Understanding how Disappointment Creek affects channel morphology and species composition will be an important topic of inquiry in coming years.

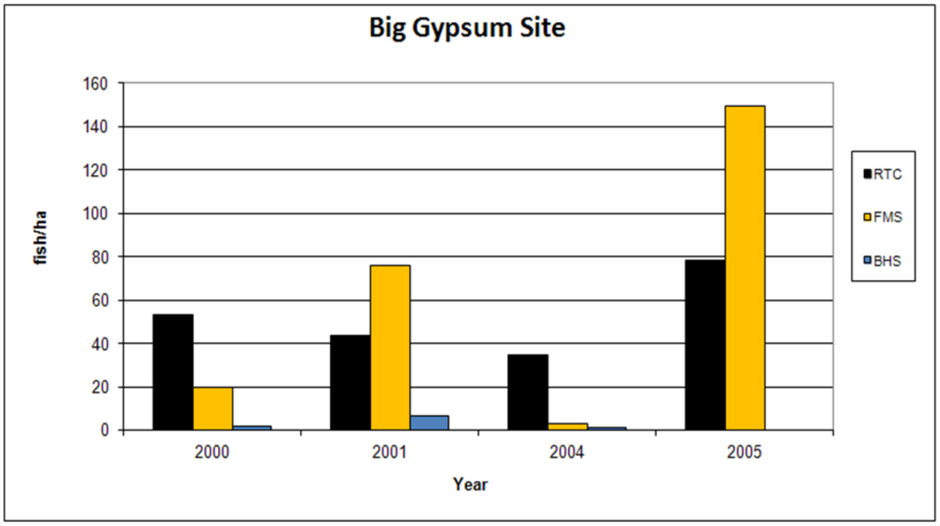


Figure 4. Density (# fish per hectare) of roundtail chub, flannelmouth sucker and bluehead sucker in a 2-mile section of Big Gypsum Valley (Anderson and Stewart 2007).

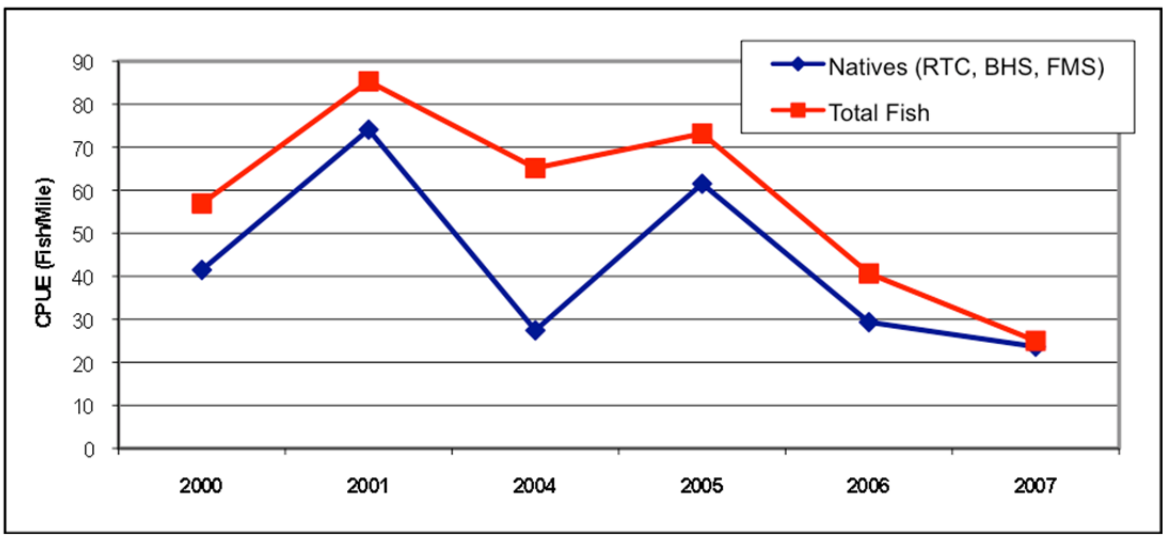


Figure 5. Comparison of overall native and non-native fish trends between 2000 and 2007 at the Big Gypsum site. Note that the units are different between Figure 4 and Figure 5.

In April 2013, a PIT-tag array was installed across the river just above the Disappointment Creek confluence on the James Ranch. PIT (Passive Integrated Transponder) technology allows for individual fish that have been implanted with rice grain-sized microchips to be detected as they move upstream or downstream across the array. The array can detect the direction of the fish, and transmits instantaneous movement data specific to the individual fish to a designated data-retrieval site via satellite. Though only a few fish have been tagged within the Dolores, the data already acquired is suggesting that native fish, particularly flannelmouth suckers, move regularly up and down river. The cost of an array approaches $75,000 with labor, so this array represents a significant investment in understanding the timing and magnitude of fish migration. At this time, native fish and smallmouth bass have been targeted for implants, though very few bass will receive implants since it is at least as important to keep bass that are caught out of the river completely.

Reach 5: Big Gypsum Valley Bridge to Bedrock (Slickrock Canyon); 32 miles

CURRENT CONDITIONS: All three species are found in this reach but in low abundance. Few non-natives were detected in one of the only recent fish surveys (2007), with those mostly consisting of channel catfish and common carp. Most of the fish captured were adults but it is not known if there are important rearing habitats within the canyon for young life stages of native fish. A relatively large number of small young-of-year native fish were found near the mouth of Coyote Wash, suggesting that tributary drainages may play an important role as refugia or rearing habitat for young fish.

DESIRED CONDITIONS: Slickrock Canyon should be maintained as a nearly-intact native fish assemblage. Non-native stressors are currently less problematic than at many upstream sites because channel catfish and carp are not aggressive predators. However, due to the logistical problems of routine sampling in this reach, it is not known how populations may shift during drought or seasonally or to what extent non-natives are impacting the ability of native fish to thrive. Maintaining a good age class structure for all native species is a desired condition. Increasing the numbers of native fish (abundance) may improve the resiliency of the fishery to periods of low flow.

MONITORING: Monitoring early life stages of roundtail chub and native sucker species is important in this reach as well as the detection of an expanding smallmouth bass population downstream or shifting populations of other non-native competitors. Sampling the canyon can only occur when flows are ~800 cfs, and because catch rates are so low (typically only a few fish per mile), sampling realistically can only determine species composition and rough measure of CPUE as the reach is sampled. PIT-tag data from upstream may encourage fishery researchers to look more closely at fish movement through the canyon or from downstream of the San Miguel confluence (i.e., installation of an array near Bedrock), since upstream movement may provide the best chance for native suckers to re-colonize upstream reaches if habitat conditions improve.

Reach 6: Bedrock to the San Miguel River confluence; 12 miles

CURRENT STATUS: Unknown. Reach 6 is highly affected by natural salt loading through Paradox Valley, even with significant mitigation by BOR, and flow depletions during the late summer and fall.

DESIRED CONDITION: Salinity, flow, and habitat conditions through Paradox Valley should continue to be mitigated to minimize barriers to movement of native fish between the Dolores River below the San Miguel confluence and Slickrock Canyon.

MONITORING: Currently, no monitoring is done in the Paradox Valley or immediately above the San Miguel River confluence. One important question to answer is how high salinity concentrations may impact opportunities for fish movement between the Dolores River below the San Miguel River and the Dolores above Bedrock. As mentioned above, a second PIT-tag array may be considered at a site near Bedrock or closer to the San Miguel confluence in order to help understand how fish move seasonally. In addition, a Clean Water Act Section 319 Watershed Plan has been prepared by the Dolores River Dialogue, and salinity has been identified as a constituent of concern that may be affecting the vitality of the native fishery. Measures to mitigate this natural source of salt loading, including an active Bureau of Reclamation mitigation program, are described in that document, and if a study design conforms to the goals and objectives outlined in the plan, funding may be available to study how salt loading affects the native fishery.

B. Evaluation - Measurements of Fishery Health and Viability

The earliest fish surveys on the Dolores River were conducted in the mid-1950s using a variety of techniques and in locations relatively easy to reach. The first longitudinal ichthyofaunal surveys were done by Holden and Stalnaker (1971) and Valdez (1981, 1992). The purpose of these early longitudinal surveys was to determine the presence/absence, distribution, and abundance of rare fish, and in the 1981 and 1992 surveys, to specifically look for federally endangered fishes in the Dolores River (Colorado pikeminnow, humpback chub, razorback sucker, bonytail chub). These surveys did not focus on roundtail chub, flannelmouth sucker or bluehead sucker and though these three species were not ignored, their abundance was often described qualitatively (i.e., 'rare', 'common' or 'abundant') or sampling methods were slightly different than more recent surveys, which makes quantitative comparisons using current data sets difficult. The sampling techniques used in the early studies included a variety of techniques; primarily seining, electrofishing, and use of haul nets. They were also conducted during a period when the hydrology of the lower Dolores River differed markedly, as outlined in the introduction and section IIa.

As described by reach in the prior section of this document, Colorado Parks and Wildlife has developed several long-term or intensively sampled data sets at locations that provide quantitative population estimates at specific locations and/or for a specific time period. CPW's 1000-foot 'walk-shock' sites in Reach 1 (four sites) and Reach 3 (one site) provide a glimpse of how species composition and densities of fish have changed over time at these sites, but only one is located where the roundtail or sucker species now occur (Reach 3). Two rigorous data sets were also developed by Nehring (Ponderosa Gorge in 1993, 2005 and 2007) and Anderson (Big Gypsum Valley between 2001 and 2007), under research efforts designed to answer specific questions about the fishery or their habitats. As described in more detail below, CPW continues to monitor the five long-term sites, Anderson's research site in the Big Gypsum Valley, and when flows allow, opportunistically samples more remote canyon sites (Ponderosa Gorge, Pyramid to James Ranch, Slickrock Canyon) and reaches below the San Miguel River confluence. In addition, CPW has developed a fish-sampling protocol to assess early life stages of the three species, and in 2012 implemented the first season of this effort on six sites in reaches 3 and 4; data was again collected in summer 2013 but was affected by both extremely dry conditions and flash flooding. In April 2013, a PIT-tag array was installed on the James Ranch (within Reach 3) to detect movement of native fish and smallmouth bass that have been implanted with microchips.

Monitoring fish populations in the Dolores River is a difficult prospect given the unpredictability of suitable fish-sampling flows below the dam and the remote and inaccessible nature of the canyons during low water conditions. In addition, CPW has finite resources with respect to time, personnel, equipment, and dollars, and many of the sampling efforts requiring specific raftable flows are intermittent and difficult to plan. The array of historic methodologies used to sample fish is indicative of the complexity of monitoring the fishery on the Dolores.

Each set of data allows fishery biologists to examine certain aspects of the fishery to address questions of population dynamics, abundance, or distribution of species. Repeated sampling of many of these sites is the only means of detecting how or if fish populations are responding to management or other environmental factors. One important consideration that applies to all the data sets gathered by CPW or others is the effect of random, stochastic events that change the dynamics in the fishery, such as landslides, fires, disease, new species introductions, or drought. In addition, though the walk-shock sites are cherished for the repeatability of the data, nearly all other sampled locations are sampled opportunistically at different times of year under slightly differing flow conditions that may affect the ability to directly compare data collected across different years.

Thus the ultimate analysis of 'fishery health' often emerges from the consensus of fishery professionals with experience working in many different fisheries over the course of their careers.

Population Viability

As defined in the Three Species Agreement "population viability is a function of population demographics (size and age structure), population redundancy (number and distribution), habitat carrying capacity (resource limitations), and genetic stability (inbreeding and genetic diversity; Franklin 1983; Soulé 1980; Shaffer 1987; Allen et al. 1992). Viable, self-sustaining populations are characterized as having a negligible chance of extinction over century time scales, are large enough to be sustained through historical environmental variation, are large enough to maintain genetic diversity, and maintain positive recruitment." (Three Species Agreement, p.37).

The Three Species Agreement identifies the following population viability factors that may be considered, although other appropriate factors may be added to this list in the future:

- Known and potential threats
- Available habitat(s)
- Habitat stability
- Genetic stability
- Metapopulation connectivity and stability
- Reproductive opportunity and potential, including recruitment into the effective population
- Potential to expand population sizes and distribution

The State of Colorado through the Department of Natural Resources and Colorado Parks and Wildlife is currently developing a state-specific strategy that describes how Colorado is implementing management actions that will help conserve these species. The Implementation Team is nesting its monitoring program within the statewide approach. The table below will be used to assess not only the presence or absence of native fish in the river, but also to answer the important questions about range, recruitment, and trends in populations' abundance and threats. These data sheets will be filled out for each sampling effort to provide a summary of how fishery managers perceive the many aspects that collectively help them understand whether a particular fishery is in relatively good shape. This table is a sample shown for the year-end assessment of the native fishery health over time, given the results from a specific monitoring effort.

Water Quality Monitoring

In spring 2012 a real-time monitoring station for air/water temperature and relative humidity was installed above Disappointment Creek. The purpose of monitoring air and water temperature at this location is to manage releases to the lower Dolores River in advance of managed spills to suppress warming of the water in early spring so that spawning does not occur prior to the release. Real-time data will be available to biologists and water managers; CPW will house the long-term temperature database from this site. There also is more information about 'thermal regime modification' presented in Section III of this plan.

In addition, the Dolores River Dialogue has completed a Section 319 (Clean Water Act) Watershed Plan that in addition to a modified thermal regime has identified certain constituents of concern (primarily sediment and salinity) that potentially pose a threat to existing uses of the water, including habitat for native fish. That plan presents voluntary measures that citizens, industry, agencies, or other motivated groups working in the lower Dolores watershed can collaborate on to improve existing conditions for fish relative to these parameters. Sediment flux is addressed in this plan, and the naturally occurring salinity load to the river through the Paradox

Valley has been well documented elsewhere. The BOR's salinity-control unit continues to actively decrease salt loading to the river and the BOR remains committed to reducing salt loading through this reach.

Table 3. Annual summary table of fishery measures intended to allow detection of trends in the health of the native fish species in the Dolores River.

Native Species	**Prior Trend**	**Fishery Measure**	**YES (+)**	**NO (-)**	**Trend Analysis (moving in a positive or negative direction)**
RTC		Fishery abundance (quantifiable metric where possible - fish/mi CPUE; lbs/ac)			
FMS					
BHS					
RTC		Young of Year or larval fish present			
FMS					
BHS					
RTC		Age class structure – presence of multiple age classes of fish, including juveniles and adults			
FMS					
BHS					
RTC		Expanded distribution of fish			
FMS					
BHS					
Non-native Invasives		Reduction in smallmouth bass, brown trout, or other invasive predator/ competitor species (sunfish, carp, bullhead, catfish)			
HYDROLOGIC NOTES		Describe conditions of flow that are relevant to the data summary			
TEMPERATURE NOTES		Describe thermal conditions that are relevant to the data summary			
GEOMORPHIC NOTES		Describe geomorphic conditions relevant to data summary (e.g., flash flood; debris flow event affecting sample...)			

RTC - Roundtail Chub
FMS - Flannelmouth Sucker
BHS - Bluehead Sucker

III. SPILL MANAGEMENT and SYNERGIES WITH THERMAL AND SEDIMENT FLUSHING OPPORTUNITIES

Spill management will continue to be a critical component of mitigating Dolores Project impacts to whitewater boating. Spill management also provides a significant opportunity to improve the Dolores River fishery and downstream environment.

Current Spill Hydrology and Operations

By design, McPhee Reservoir stores much, if not all, of the Dolores River annual spring runoff and exports much of this storage to the Montezuma Valley (San Juan River basin), thereby reducing the amount of stream flow available for uses below McPhee Reservoir. Project hydrological studies[7] projected that in low to medium runoff years, McPhee Reservoir would capture the entire spring peak in order to provide perennial flows later in the year. The studies also determined that the reservoir would capture some, but not the entirety, of the spring peak in high runoff years.

Specifically, under Project conditions outlined in the Definite Plan Report (DPR) and the 1977 Final Environmental Impact Statement (FEIS) issued by the Bureau of Reclamation, Dolores River inflows resulting in excess water above the storage capacity of the reservoir would be released downstream. Mitigation required under the Dolores Project FEIS states: "By providing the best boating conditions consistent with project purposes and announcing the occurrence of those conditions to boaters in advance, the Bureau would encourage the most efficient use of the river"[8].

The Definite Plan Report details how surplus snowmelt runoff, expected to average 66,000 AF, could be released in anticipation of spills to meet boating objectives. In order to minimize the adverse impacts to whitewater boating from construction of the Project, the BOR's operating criteria were to maximize the use of forecasted releases for boating below McPhee Dam. Spills would be on a scheduled basis from mid-April to the end of June to provide whitewater boating opportunities below the dam, to be scheduled in five or more consecutive days with sufficient water and announced in advance in order to optimize opportunities for whitewater boaters[9].

The draft DRD Correlation Report (2006) presented the results of an updated, post-Project revamping of the original Definite Plan Report flow modeling done for the Dolores Project (1977), which consisted of 77 years of modeled flow, based on the historic record, with all Dolores River depletions, including modeled Dolores Project demand figured into the calculations. These findings identified two important trends in Dolores Project history:

1. Approximately 45 percent of years are 'no-spill' years, with only one year of modeled shortage;
2. Of the spill years (55 percent of total years), the average spill magnitude is approximately 187,000 AF, with two-thirds of those spills falling between 64,000 AF and 310,000 AF.

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[7] Definite Plan Report (DPR) for the Dolores Project, Bureau of Reclamation, 1977.

[8] Dolores Project Colorado Final Environmental Impact Statement (FEIS), U.S. Dept. of the Interior, Bureau of Reclamation, May 9, 1977, at p. D-4.

[9] Ibid; DPR at p. 69.

These modeled hydrologies provide the best available information upon which to make predictions of future hydrologic expectations for flows below McPhee. However, since 2000, there have been multiple Project shortages (2002, 2003, 2013) and only two spills larger than 100,000 AF (2005, 2008); thus it will be important to re-visit hydrologic and climatic data to assist in understanding future hydrologic conditions associated with reservoir releases. Current forecasting efforts focus on the period from 2000 into the future.

Pursuant to the 2000 Operating Agreement, the Bureau of Reclamation and the Dolores Water Conservancy District jointly develop an Annual Operating Plan to optimize the use of available water supplies for Project purposes while assuring the integrity of Project facilities. The Annual Operating Plan is informed by Project users, Project documents and purposes, and forecasted conditions. Seasonal changes to the Operating Plan may be made to adapt to changing hydrologic conditions and are posted regularly on DWCD's web site, doloreswater.com.

Spill management was identified by the AWF scientists as a key factor in several management opportunities that could provide multiple benefits to the downstream native fishery: thermal regime management; sediment flushing and habitat maintenance; and more flexible management of the base pool water budget (see also Section IV.2 in the Base Flow Management section that describes in more detail the relation between spills and the base flow 'clock'). As spill volume and duration increase, the opportunities to manage McPhee spills for water temperatures most suitable for timely spawns, maintain important sediment-transport processes, and conserve base flows for later in the year also increase - all of which benefit the native fishery. It is the intent of the Plan to maintain the whitewater boating values consistent with those outlined in Dolores Project authorizations and documents, while maximizing benefits to the native fishery. This section of the Implementation Plan articulates ways to maximize fishery and whitewater boating benefits for spills of all sizes.

1. OBJECTIVES

The objectives for spill management under all hydrologic scenarios are to fill McPhee Reservoir while also scheduling releases that support and encourage native fish reproduction and survival, and provide for whitewater boating experiences. Because every year's hydrologic scenario is different, the Implementation Plan outlines spill volumes of different magnitudes (25K AF, 50K AF, 66K AF, 100K AF, and 200K AF – (Appendix A, http://ocs.fortlewis.edu/drd/implementationTeamReports.htm.). Each scenario also includes specific objectives, release volumes and timelines for making critical decisions. These timelines are informed by forecasts made by the Colorado Basin River Forecast Center to create the best opportunity for native fish spawning success while minimizing risks to other Dolores Project water users. The development of these hypothetical hydrographs that optimize native fish and whitewater boating benefits are presented in more detail in Section III.2, below.

A. Thermal Regime Modification

Filling McPhee Reservoir and then spilling water once storage is full or near full is commonly called 'fill and spill' operations. This risk-management strategy is used primarily when forecasted surplus inflows are less than 50K AF and filling the reservoir is less certain. Performing fill-and-spill operations may limit native fishes' ability to use water temperature as an appropriate spawning cue. Native fishes typically spawn in spring and early summer in response to changes from an increased photoperiod and warmer water temperatures, most near the peak or on the descending limb of a snowmelt runoff hydrograph. Temperature data from various sites below McPhee Dam show that prior to the beginning of a managed spill in the spring, water temperatures begin to increase to the point that native fishes may initiate spawning activity. In years with a small forecasted spill (fill–and-spill years), spawning may occur prior to large, cold-water releases. This inadvertent and poorly timed spawn has been observed by CPW biologists on multiple occasions since 2006. During these times, release of spill water abruptly cools the river and if native fish spawning occurs prior to a spill release, incubating eggs or hatched fry are particularly susceptible to mortality.

One example of the complexities of managing temperature and flows can be seen in the releases during the spring of 2009 (Figure 6). The hydrograph below illustrates how an abrupt increase in regional air temperature can result in rapid decreases in water temperatures below McPhee Dam. Water temperature data from 2009 at Bedrock show temperature increases until early May and then an abrupt 7-degree C (12.6°F) drop in temperature. Spring 2009 was characterized by multiple wind events resulting in a series of major dust-on-snow layers. These conditions were compounded by an early May air temperature spike in the southwest. Rapid temperature increases accelerated snowmelt well beyond normal rates, and Project operators had no choice but to start managed releases or risk an unmanaged spill over the spillway. As a result, the managed spill release reflected inflows into McPhee, less irrigation demand, in order to fill but not "overfill" McPhee.

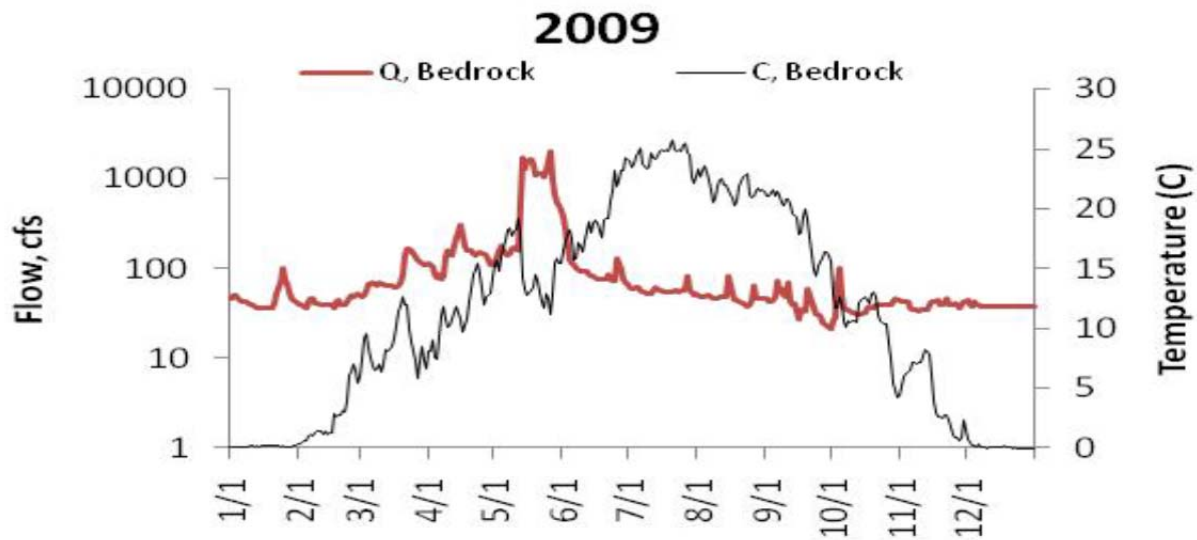

Figure 6. Temperature data from 2009 showing the inverse correlation of water temperature and streamflow during a spring spill event.

The *A Way Forward* scientists emphasized that there are management opportunities that could address and alleviate this problem. Spills may be managed to mitigate thermal shock to developing fish embryos or recently hatched larval fish. During spring runoff, the temperature of the water at downstream sites is inversely correlated with the volume of water being released; thus the AWF scientists suggested that early release of some quantity of forecasted spill water during the spring (March-May, depending on the year) would more closely mimic natural runoff patterns and suppress water temperatures enough to delay spawning until after peak releases. The challenges associated with this management opportunity are threefold:

1. Any release of the 'anticipated spill' water prior to filling the reservoir increases the risk that the reservoir may not fill.

2. It is not known precisely how much water would be needed to suppress water temperatures such that 'spawn delay' is successful. A coarse water temperature model (SSTEMP) indicated that flow volumes of 125 - 200 cfs on May 1st may be necessary to keep temperatures below 15°C at the Dove Creek pumps, and more water may be necessary further downstream to keep temperatures low enough to delay spawning activity. There is now a real-

time air and water temperature gauge at the James Ranch that will enable actual real-time correlation and adjustment of flows for water temperature suppression and allow verification and refinement of the temperature model.

3. The controlled releases are to be scheduled in advance and grouped together in periods of five or more consecutive days consistent with Project purposes, with prior notice of these intended releases given so that whitewater boaters can benefit from the spills and a high use of the limited resource be attained.[10]

The reservoir release hydrographs included in the Implementation Plan (see Section III.2, below, and Appendix A) as well as current hydrologic conditions and downstream temperature data are resources to assist Project management in optimizing benefits to native fish and whitewater boating.

B. Sediment Transport

AWF scientists noted that coordination of managed spills to meet specific sediment transport objectives would be beneficial to sediment transport and habitat maintenance. Generally, they suggested that increases in the magnitude and frequency of spill events below McPhee would benefit transport capacity and habitats downstream, but they also realized the inherent uncertainty and lack of control in planning for these events. Managed spills should be coordinated, when possible, with peak flows in other tributaries downstream of McPhee in order to attempt to meet desired sediment transport objectives. It is recognized that any sediment transport capacity in the river below McPhee is dependent on the size, frequency, and duration of the managed spill, and the operational flexibility any particular spill might present. Additional research into the role of tributary inputs of sediment and water is encouraged. These inputs can be significant and in general are highly variable (e.g., fire runoff, debris flows, instantaneous rainfall peaks), but may also need to be factored into spill management decisions.

Two specific sediment transport targets have been identified by AWF scientists: (1) those flows necessary to scour algae or mobilize finer particles that tend to adhere to spawning gravels and cobbles, fill interstitial spaces between these particles, and settle in pools ('flushing flows'); and (2) flows large enough to mobilize significant quantities of riffle materials themselves at the D50 or D84[11] size classes ('habitat maintenance flows') that have the capacity to re-set channel geometry by lateral erosion, floodplain inundation, and nutrient exchange with floodplains. Flushing flows are important to prepare spawning areas and improve oxygenated flow around deposited eggs and for invertebrate production in riffles; habitat maintenance flows are critical to provide the diversity of instream habitats necessary to meet the needs of various life stages of native fish. Flushing flows and habitat maintenance flows have been estimated for different reaches of the Dolores River, and range from 400-800 cfs for flushing needs to between 2000 and 3400 cfs for habitat maintenance flows for periods longer than 24 hours. Larger flows and longer durations provide proportionately more opportunities to perform work on the channel and for more extensive floodplain exchange. An array of spill sizes and durations also creates a more diverse and valued set of whitewater boating experiences.

[10] Dolores Project Colorado Definite Plan Report, April 1977 at Appendix B, pp. 38-38c; Final Environmental Impact Statement, May 9, 1977 at A-6, D-4

[11] D_{50} and D_{84} refer to the particle size classes observed in the active stream channel or more specifically for habitat maintenance flows, in riffles. D_{50} indicates the median particle size in the sample (50% of the particles are smaller); D_{84} is a larger class size indicating that 84% - approximately two standard deviations above the median in a normally distributed sample – are smaller.

Neither flushing flows nor habitat maintenance flows are possible without a spill; thus there is a nexus between spill opportunities and sediment transport opportunities, and it is clear that whenever a spill occurs, there will be incidental benefits for sediment transport. Managing for flushing flows requires the release of relatively large amounts of water, and may not meet minimal whitewater boating flow targets (minimal flows are ~700 - 900 cfs, depending on craft type), so 'boatable flow days' may be reduced. The Implementation Plan recognizes that sediment flushing targets – the smaller end of the sediment transport regime – may be an important objective whenever a spill opportunity is available since spawning success of native fish is a pre-requisite if native fish are to persist below the dam. Flushing flow targets of 400-800 cfs also present the best opportunity for monitoring native fish in remote sites (Pyramid to Disappointment ~ 500 cfs; Slickrock Canyon ~ 800 cfs), which cannot be shocked using wade-shocking techniques. While minimal monitoring flows do not meet most whitewater boating needs, they may meet minimum requirements for small crafts such as canoes or inflatable kayaks. Given monitoring needs, the hydrographs have been constructed to make the most use of historic ramping criteria at the end of a spill. Designing the descending limb of the spill around ramping rate criteria to allow for monitoring of native fish may be the best way to improve the chances that successful data collection will occur.

The following ramping criteria are used to assist Project managers in transitioning from non-spill operations to a spill and back to regular Project operations that serve a suite of consumptive and non-consumptive users. The ramping criteria were developed to ensure fish and boaters were not stranded as water levels dropped and ensure safety for river users and keep fish from being displaced as releases are ramped up.

<u>Downstream Ramping Criteria</u>

- Ramping up from 0 to 1,200 cfs, do not exceed 400 cfs per day.
- Ramping up from 1,200 to 5,000 cfs, do not exceed 1,200 cfs per day.
- Ramping down from 5,000 to 1,200 cfs, do not exceed 800 cfs per day.
- Ramping down from 1,200 to 800 cfs, do not exceed 400 cfs per day.
- Ramping down from 800 to base flows –
    - 200 cfs ramp down, hold at 600 cfs for 2 days (alerts boaters that McPhee releases are being ramped down).
    - 200 cfs ramp down, hold at 400 cfs for 2 days
    - 200 cfs ramp down, hold at 200 cfs for 2 days
    - Decrease releases to reach desired base flows supplied by the fish pool
- In an emergency it is acceptable to exceed ramping criteria to avoid undesirable conditions.

The use of Project ramping criteria provides for sufficient water and time to complete monitoring work. Reservoir releases will signal Colorado Parks and Wildlife that there will be an opportunity to monitor native fish and other aquatic species. Taking advantage of monitoring opportunities will be an important activity that will assist in the future management of native fish.

2. RANGE OF VARIABILITY – OPPORTUNITIES, CONSTRAINTS, and DEVELOPMENT OF SPILL HYDROGRAPHS

Ironically, extreme flow variability within the Dolores River drainage is perhaps the most predictable hydrologic variable. Elevations of over 14,000 feet in the southwestern San Juan Mountains create a snowmelt-driven runoff pattern, but its southerly latitude also brings with it a unique blend of hydrologic effects and monsoonal-driven storm events. As a result, the Dolores River experiences some of the greatest natural flow variability amongst Colorado rivers. Warm-water native fish in the basin evolved and adapted to hydrologic variability characteristic of desert rivers in the American Southwest through reproductive strategies, general longevity, and phenology. The Implementation Plan focuses on what is feasible given available water supplies and highly variable climatic factors.

Recognizing the diversity of hydrologic conditions that exist in the Dolores basin, the development of scenarios for managed spills is critical to meet multiple objectives. A subcommittee of Implementation Team membership was formed to develop a suite of managed spill scenarios that optimize releases to meet Project operations and ramping criteria while providing for whitewater boating and native fish. These hydrographs integrate management objectives from IT members resulting in a shared vision of how to meet Project purposes while improving managed spills to maximize whitewater boating opportunities as well as to benefit native fish. As noted in Section III.1 above, spill management opportunities were stratified by magnitude of the downstream release: 25K, 50K, etc.

Prior to the development of managed-release objectives, American Whitewater (AW) presented a report titled 'Defining Recreational Flow Needs in the Lower Dolores River: Stream Flow Evaluations for Whitewater Boating' which identified flow preferences for whitewater boating on different reaches of the Dolores below McPhee. AW developed 'acceptability curves' that graphically illustrate flow preferences and detailed by reach and by craft type 'minimum acceptable' and 'optimal' flows (as well as other recreational-user definitions) that collectively provide an excellent picture of current recreational-user flow preferences on the Dolores River. Based on the results of these surveys, AW then presented hydrographs for five hypothetical spill scenarios. Additional criteria provided by BOR, DWCD, CPW, and Trout Unlimited were incorporated into these spill scenarios, resulting in objectives for how reservoir releases may be managed to benefit native fish for each spill scenario based on specific ecological or physical parameters that were both science-based and deemed feasible. Native fish assumptions for all spill scenarios were as follows:

• Priority objective was to improve ascending spring flows beginning April 1 that ramp sufficiently to minimize pre-spill water warm-up that triggers pre-spill spawn.

• Provide flushing flows to prepare spawning bed (~400-800 cfs).

• Attempt to mimic natural pattern of flows during a spill at times most critical to native fish.

• Recession limb of 200 cfs decrease over two days can be used to provide monitoring conditions and assist boaters. This can provide sufficient three-day period of 400-500 cfs to monitor.

The hydrograph below (Figure 7) illustrates how ~50,000 AF of water (51,373 AF in this example) could be managed to maximize benefits to native fish while meeting Project purposes and maximizing whitewater boating opportunities. The shaded blue pyramid represents how spill management can be implemented to accomplish many of the criteria detailed above: increase flows modestly after April 1st to suppress premature temperature increases below the dam; provide flushing flows to prepare spawning grounds; mimic natural spring runoff patterns and follow ramping objectives to assist boaters and monitoring. Meeting these targets is likely to assist productive native fish spawn and provide a more diverse boating experience that includes a peak in the reservoir release.

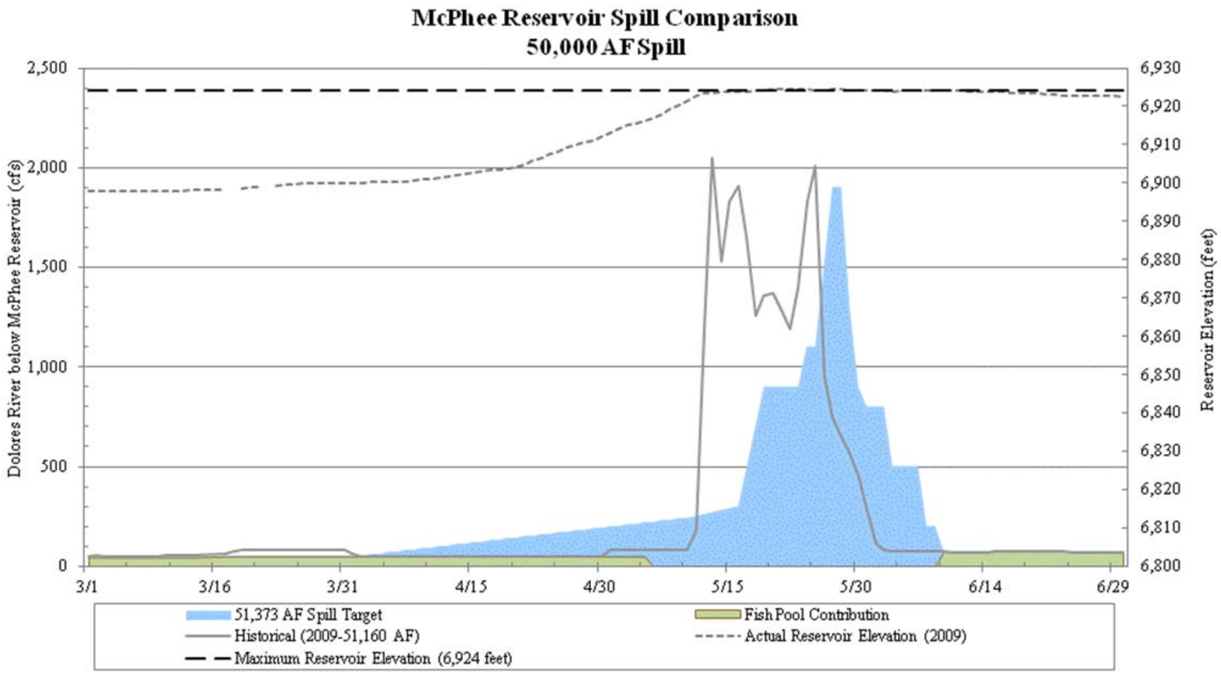

Figure 7. Hydrograph of a hypothetical managed spill of 51,373 AF, graphing the dam release and reservoir elevation that occurred with the 2009 spill. An early temperature spike brought the reservoir elevation to full before it was anticipated, forcing the early release of downstream water without prior notification to boaters. None of the hydrographs or criteria will supersede the need to operate the Dolores Project safely. Appendix A at http://ocs.fortlewis.edu/drd/implementationTeamReports.htm includes other hydrographs of 25,000, 66,000, 100,000, and 200,000 AF.

In addition to these hydrologic models, the Implementation Plan highlights the following objectives for when runoff conditions are in excess of reservoir storage capabilities. Table 4 identifies the benefits expected to accrue through different spill volumes and indicates how monitoring might detect whether release objectives for native fish were met.

Table 4. Flow hypotheses, native fish habitat objectives, and measurable indicators that will assist the Implementation Team in determining whether proposed flows to meet native fish objectives will support sediment transport objectives. Durations and recurrence intervals will vary based on current water supplies, antecedent conditions, desired outcomes, and adaptive management.

Flow Hypothesis	Habitat Objective	Measurable Benchmark
Flushing Flow 400-800 cfs to scour fine sediment	Maintain quality spawning habitat at times appropriate for spawning to occur	Quantify percentage of fines (<2mm) in spawning beds (cobbles) pre- and post-flow event; percentage of fines measured should be reduced, with specific attention paid to aligning flushing flows relative to the timing of native fish spawning.
Flushing Flow 800-2000 cfs to initiate mobilization of the median-size particle	Maintenance of riffle and pool vertical relief	D_{50} should coarsen in riffles; annual accumulation of fine sediment should be scoured from pools. Pool-riffle profile should be maintained.
	Maintain benthic macro-invertebrate productivity	Taxa measurements for benthic macro-invertebrate species in riffles (quantitative/ qualitative measures?) should reflect productive instream environment.
Habitat Maintenance Flow 2000 - 3400 cfs for 7+ days (bankfull flows)	Maintain pattern and profile appropriate for the reach	Monitor changes in cross-section and profile dimensions; channel aggradation, degradation or entrenchment should be assessed; over a reach, over time, gradient and pool-riffle spacing should be consistent. Assess plan-view changes, such as stabilization of mid-channel bars or bar extension; vegetative encroachment on point bars; medial bar expansion.
	Scour pools	Maintenance of pool depth (see above re: pool depths).
	Mobilize majority of riffle materials	Monitor mobile fraction of channel bed in riffle; tracers or direct bedload transport measurements; hydraulic modeling.
	Initiation of significant interaction with floodplains in alluvial reaches.	Cottonwood recruitment (or at least some indication of seed-bed preparation and germination); maintenance of other riparian indicators (e.g., minimize encroachment of xeric/mesic species onto floodplains). Validate Q_{bkf} hypotheses by reach.

Habitat maintenance Flow Peak flows of >3400 cfs at a frequency of ~7-10 years	Mobilize and re-set riffle habitats; create and maintain instream habitat diversity (pool scour; backwaters; secondary channels)	Document movement of D_{84} in riffles; assess instream habitat complexity. Assess cross section and longitudinal changes.
	Maintain floodplain exchange and robust riparian vegetative community	Monitor riparian vegetation diversity and density; cottonwood germination and recruitment (NOTE - Riparian monitoring will be an important indicator of whether large flows are providing the exchange benefits to instream resources).
	Energy and nutrient exchange between channel and floodplains	Validate Q_{bkf} hypotheses by reach. Floodplain inundation depths; measure exchange of material between channel and floodplain (e.g., painted patches; floodplain transect monitoring).
	Maintenance of alluvial aquifer	Groundwater monitoring in floodplain.

Small projected surpluses represent the biggest challenge for Project managers to operate the Project to meet multiple objectives. Filling McPhee Reservoir is the first priority for Project operators, but even small surplus water projections in March or April should cue operators that adaptive on-the-fly management opportunities to suppress water temperatures or manage for flushing flows may be available should subsequent forecasts continue to indicate surplus water is available. Comprehensive spill management that integrates real-time supply data and water-supply forecasts with downstream flow and temperature data will continue to provide the best opportunity for releases that meet the needs of native fish without detriment to other Project users.

3. RIPARIAN NEEDS AND THE MAGNITUDE AND FREQUENCY OF HISTORIC SPILLS

The frequency of flow events is an important concept in riparian and geomorphic literature that is not addressed in detail in this Plan.

A note regarding riparian conditions along the Dolores River: This Implementation Plan is focused on opportunities presented by the *A Way Forward* scientific panel that could be implemented to improve the success for native fish populations below McPhee Dam. As indicated elsewhere in this section, large spills afford the opportunity to manage spills for habitat maintenance, including 'overbank flows' that improve nutrient exchange with the floodplain along with other high-flow benefits for instream habitat. Overbank flows and exchange between a river and its floodplain also benefit riparian ('stream-influenced') plant communities, which are not specifically addressed in this plan. However, the Dolores River Restoration Partnership (DRRP) has developed long-term Dolores River treatment and monitoring protocols for their work on the entire corridor (McPhee dam to the confluence with the Colorado River). For monitoring purposes, coordination of Implementation Plan efforts with the DRRP will leverage available resources and information pertinent to the downstream ecologic condition of the Dolores River, specifically to discern how releases affect riparian conditions downstream. Additional work may need to be performed to benefit riparian areas while continuing to meet the Project's whitewater boating mitigation and native fish needs.

Investigations into the role woody debris play in riparian conditions and native fish habitat is an area of interest to ecologists and aquatic biologists. McPhee Dam likely filters the recruitment of woody debris from the headwaters and much of the wood marooned by historic high flows is now cut off from the river channel. Investigations into how native and non-native fish and invertebrates benefit from the presence or absence of woody debris may give managers some important tools for manipulating habitat features in the Dolores River.

4. MONITORING SPILLS – HOW CAN WE LEARN FROM OUR EXPERIENCE?

A critical component to improving the management of reservoir spills is reflecting on how well spills helped meet our shared goals while still meeting Project purposes. In the wake of spill years, the Implementation Team and participating organizations will meet and consider questions such as:

- Did early releases effectively suppress temperatures, delay spawn and lead to a successful spawn of native fish? How much water was required to keep temperatures below X degrees?
- Did early releases adversely affect the number of or quality of whitewater boating opportunities? If so, in what way and how many days? Representatives from the boating community will collect and disseminate boater surveys.
- What are other questions for future consideration to help assist Project management?

In addition to evaluating the risks and opportunities of early releases, the success of spill management for a given water year will depend on an evaluation of how well operators were able to meet targeted objectives for spills of a given size. These objectives are presented below in Table 5 in a simplified 'checklist' format to determine whether the specific objectives for spills of a given magnitude were met. This evaluation form will complement the findings from the early release responses and will be presented to interested forums. These lessons learned will provide an opportunity to evaluate and articulate the process of spill management for the year, identify possible ecological benefits, and articulate lessons learned for future management decisions.

Table 5. Sample table indicating whether specific spill management targets were met during a given water year.

	Thermal Target* (<15°C prior to peak release)	Flushing Flow Target (~400+ cfs to flush fines from cobbles)	Habitat Targets (complexity, diversity encouraged by 2000+ cfs)	Base Flow Target (reserve of base pool during spill to maximize summer growth opportunity)	Boating Flow Targets (certainty of boatable days; optimized flows, etc.)
25,000 AF	✓	✓	NA	✓	✓
50,000 AF	✓	✓	NA	✓	✓
100,000 AF	✓	✓	✓	✓	✓
200,000 AF	✓	✓	✓	✓	✓
WY 2012 (full supply, no spill)	NA	NA	NA	NA	NA
WY 2013 (~70% shortage)	NA	NA	NA	NA	NA
WY 2014 (?)	?	?	?	?	?

* May also include target that minimizes rate of change of temp to keep daily change less than 0.3-0.5 °C/d during pre-spill period.

Adjusting spill management consistent with Project purposes to provide suitable spawning conditions and monitoring the response is one of the best opportunities to utilize a science-based adaptive management approach. Experiments with the early release of water to delay spawning are being strengthened by cooperation among the Implementation Team partners resulting in:

- The installation of real-time thermal monitoring in the "Pyramid" area combined with temperature monitoring at the Slickrock gauge to calibrate thermal modeling with actual responses to the release of specific amounts of water for thermal suppression purposes.
- The purchase of a PIT-tag array, along with efforts to PIT-tag captured fish to better understand the movement of native fish under various spill and flow conditions.
- The development of a Watershed Plan that identifies options for beginning to address water quality considerations including sediment and salinity.

As spill management experiments and monitoring advance, additional tools and practices will be pursued and tested by the partners.

IV. BASE FLOW MANAGEMENT

1. History of Base Flow Management Since Dolores Project Implementation

Base flows provide habitat for basic life functions such as nursery areas for young fishes, food production areas (riffles), feeding lanes and runs for fishes, and resting habitats for summer and winter use, as well as cover from predators. Summer base flow periods that maintain riffle productivity result in warmer water, which maximizes food production and growth of fishes. Growth is important for survival because bigger fish can escape predators more easily, and move larger distances to find food, cover, and mates. Better fish growth during summer also improves the opportunity to survive over winter and to develop a higher quality and quantity of eggs the following spring, thereby increasing fishes' future reproductive potential. All of these factors promote the carrying capacity of a stream for fishes and increase their resilience to environmental stressors like drought, predation, competition, and sedimentation.

Base flow in the context of the Dolores Project is the water released from McPhee Reservoir to the Dolores River except during periods of a managed spill. Base flow recommendations are developed by the Dolores River Biology Committee (Biology Committee). The Biology Committee consists of members from Colorado Parks and Wildlife (CPW), the U.S. Forest Service (USFS), U.S. Fish and Wildlife Service (USFWS), Bureau of Reclamation (BOR), and Trout Unlimited (TU). The Biology Committee uses the best scientific information available on fish/flow relationships to make flow recommendations to the BOR for the Dolores River below McPhee Reservoir.

Change from Indexed Releases to Managed Fishery Pool Releases from McPhee Reservoir:

During the early years of Project operations, pursuant to the Project's DPR and EIS, year-round releases from McPhee Reservoir were to be based on an annual March 1 assessment of projected Dolores River runoff and reservoir storage, with releases of 20, 50, or 78 cfs specified by a 'dry', 'normal', or 'wet' year determination, respectively. The Project allocation made for such downstream fishery releases was 25,400 AF, thought to be the average annual amount of Project water required to be released from storage to provide for these flows.[12] In March 1990 the first 'dry' determination was made. When stakeholders realized that 20 cfs releases throughout the year might not sustain the fishery that had developed below the dam in the early years of Project operation, DWCD voluntarily agreed to release an additional 6,000 AF of water, improving flows in late June to 50 cfs. The BOR initiated an effort to develop a different means of addressing McPhee releases. Between 1990 and 1996, negotiations and fishery studies were conducted to develop an improved fishery release policy. The BOR determined that the 25,400 AF Project allocation for fishery releases to meet flow regime demands was not sufficient for that purpose, and that an additional 3,900 AF would need to be acquired from DWCD for the downstream fishery release to be consistent with the original Project planning parameters. In addition, participants in this process raised a concern that even if the Increment I water were re-allocated to the fishery, the resulting volume allocated for downstream fishery release still might not be adequate to support the downstream fishery in all years. This resulted in identifying additional increments of water that could also be acquired for downstream releases, which would be considered a voluntary goal that the stakeholders would pursue.

[12] 1996 EA at p. 2.

In 1996 the BOR completed an Environmental Assessment (EA) with a Finding of No Significant Impact (FONSI) and a Record of Decision (ROD) to change from an indexed release to a 'managed pool' release scenario. The purpose of the 'flow to pool' EA was "to establish the size of, and management parameters for, the fish and wildlife pool" (i.e., the "Fishery Pool"). Specifically, the Proposed Action evaluated in the EA was to "modify the release criteria of McPhee Reservoir and to acquire additional water to increase the volume of project water reserved by the United States for downstream fish and wildlife purposes"[13]. The proposed action evaluated in the EA and adopted in the FONSI and ROD included (1) acquiring additional water for fish and wildlife purposes; (2) changing the water year for Fishery Pool purposes to April 1 to March 31; (3) directing that the water released during managed spills not count against the Fishery Pool (i.e., the "fish clock"), and (4) directing that the Project Fishery Pool share shortages with other Project water users during declared water shortage years.

Additions to the Project Fishery Pool

In June of 1997, the BOR purchased 3,900 AF of "Increment I" water from DWCD to increase the Fishery Pool to 29,300 AF. The acquisition of this water resolved a discrepancy in the original Project operation study regarding the average annual volume of Project water required from storage to fulfill the 1977 DPR and FEIS downstream water release criteria. The purchase of the Increment I water was completed with the execution of a contract between the BOR and DWCD and brought contents of the Dolores Project fish and wildlife pool water ('Fishery Pool') to 29,300 AF.[14] The addition of non-Project water to meet senior downstream needs temporarily resulted in a total base flow pool of 33,200 AF.

Since 1996, a base flow pool target of 36,500 AF, approximately equivalent to 50 cfs for 365 days has been recognized as a biological and water supply goal. The BOR determined in the EA that the acquisition of 3,300 AF of 'Increment II water' to bring the total managed pool, when combined with non-Project water to meet downstream senior water rights, to 36,500 AF was recommended as a suitable goal by several resource management agencies and Trout Unlimited. However, specific provision to acquire the 'Increment II Water' was made on an interim basis. Beginning in July of 1996 with funding provided by the BOR, the Ute Mountain Ute Tribe agreed to temporarily lease 3,300 AF of water annually for up to five years, to increase the Project Fishery Pool from 29,300 AF to 32,600 AF.[15] From 1997 to 2000, the additional release from McPhee Reservoir of up to 3,900 AF to meet senior downstream water rights effectively resulted in a total base flow pool to be used for downstream purposes of 36,500 AF. Once the Ute Mountain Ute Farm and Ranch Enterprise needed its full irrigation supply from the Project, the Tribe's short-term lease of 3,300 AF to the Fishery Pool ended and the size of the Fishery Pool reverted to 29,300 AF.

The 1996 Flow to Pool EA addressed the replacement of the 3,300 AF to be leased from the Tribe, stating in footnote 1 on page 8:

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[13] "Environmental Assessment and Finding of No Significant Impact Proposal to Modify Operation of McPhee Reservoir and Acquire Additional Water for Fish and Wildlife Purposes, Dept. of Interior, BOR, 1996, aka, '1996 Flow to Pool EA'

[14] Grant Agreement No. 6-FG-40-18960, April 10, 1996.

[15] The temporary 3,300 AF Project Fish Pool lease occurred during the development of the Tribe's 7,600-acre, high-efficiency Farm and Ranch Enterprise, which now operates at full capacity. The Tribe uses its other allocations in the Dolores Project to provide treated water to the Towaoc community and to all the governmental and commercial enterprises on the Ute Mountain Ute Reservation.

> "Water to make up 3,300 AF of the fish and wildlife pool does not now exist. To acquire, lease, or otherwise obtain an additional 3,300 AF of water for the 32,600 AF fish and wildlife pool, the cooperative effort of federal, state, and local parties is needed. The acquisition of this additional 3,300 AF does not have acquisition priority over water to meet other Dolores Project purposes. The acquisition and management of this additional water for the fish and wildlife pool requires: the identification and involvement of interested parties, the structuring of the parties' efforts, the identification and analysis of potential water sources, contribution and management efforts of the participants."

In addition, the McPhee Dam and Reservoir Operating Agreement signed by BOR and DWCD in April of 2000 states on page 5:

> The District and Reclamation will continue, as part of a coalition including Federal and State entities and private interests to explore the permanent acquisition of 3,300 acre-feet of additional water for downstream fish and wildlife purposes.[16]

BOR provided $371,000 to establish a trust account for the future acquisition of water. However, permanent acquisition or development of additional water requires cost-sharing and participation by entities other than BOR. Other entities wishing to participate in water acquisition can make deposits to the trust account, which now has an approximate balance of $400,000. To date (2014) no additional deposits have been made in this account and no water has been acquired using these funds.

Current Contents of the Base Flow Pool of 31,798 Acre Feet

The drought in 2001-2004 led to a re-examination of the amount of water needed to meet downstream water rights senior to those of the Project. A use-based quantification determined that 1,274 AF would adequately meet the water demands of downstream senior water rights. Water released to augment stream depletions from deep brine injections at the BOR's Paradox Salinity Unit was set at 700 AF through negotiations among DWCD, BOR, and the Colorado Water Conservation Board.[17] Of the up to 3,900 AF set aside to meet downstream senior water rights, the remaining 1,926 AF (i.e., 3,900 – [700 +1,274]) was made available for re-allocation to Project uses. In February of 2007, the DWCD Board passed its first interim resolution addressing McPhee releases for downstream senior water rights and Paradox salinity depletion augmentation, allocating the remaining 1,926 AF proportionate to Dolores Project uses including: the Fishery Pool (524 AF), the Ute Mountain Ute Tribe (417 AF) and full service Project lands (985 AF). These interim allocations, made permanent by DWCD in 2013, are summarized below per the DWCD resolution:

AF

- **3,900** DPR estimate of downstream senior water rights' requirements
- (1,274) District estimate of downstream senior water rights' requirements
- (700) Paradox Salinity Unit augmentation

[16] McPhee Dam and Reservoir Operating Agreement between the United States of America and the Dolores Water Conservancy District, Contract No. 99-WC-40-R6100, April 25, 2000.

[17] The Augmentation Plan, District Court, Water Division 7, Case No. 83CW14; BOR Agreement with CWCB, Water Division 4, Case No. 83CW45, allows variable amount McPhee Releases to augment the Salinity Unit instead of a set amount.

- **1,926** Balance to be distributed to other Project uses
- (985) Distribute to the District for use on Project full service lands
- (524) Distribute to the downstream fishery managed pool
- <u>(417)</u> Distribute to the Ute Mountain Ute Tribe irrigated lands.
- **= 2,498 AF** for downstream uses (1274 AF + 700 AF + 524 AF)

524 AF was added to the Fishery Pool of 29,300 AF, resulting in the current Fishery Pool of 29,824 AF. The total Base Flow Pool currently available for downstream uses, including senior irrigation water and Paradox augmentation, is 31,798 AF (i.e., 29,824 + 1,274 + 700). Given a full-supply water year, this amount of water is used by the Biology Committee and BOR to schedule McPhee releases for the downstream fishery. This means that achieving the base pool goal of 36,500 AF would require the acquisition of an additional 4,702 AF or more. Senior irrigators downstream of McPhee use water from this release schedule during the irrigation season but under full supply scenarios, only minimally affect flows in the river.

2. Current Management of the Base Flow Pool

Operating Rules

During negotiations to change McPhee indexed releases to a managed Fishery Pool release, new management parameters were defined so that all parties understand how the Fishery Pool is to be operated relative to the hydrologic variability typical of the Dolores River basin. In addition to enabling a more variable hydrograph, these parameters were designed to enhance the benefit of available Project allocations through aligning water-year accounting with spill management and not deducting water released during a spill from the managed pool by creating a 'fish clock' (see below) whereby releases while a spill is occurring are not debited from the base flow pool. The following summarizes the management parameters developed for short-supply years, non-spill, full-allocation years, and excess-supply, 'spill' years.

<u>Short-Supply Years – Shortages Shared by Fishery Pool:</u> In years when there is less than a full McPhee allocation available to the various Project uses, the allocated water in the Fishery Pool is shorted in the same proportion as the water supply to the Ute Mountain Ute Tribe's irrigated lands, the MVIC supplemental irrigation supply, and the Dolores Project full-service irrigators' supply. Only the 29,824 AF of Project water included in the Fishery Pool is shorted, not managed pool water originally utilized as M&I water and other originally non-shorted water. Downstream irrigation water rights may be shorted by standard water rights priority administration.

<u>Non-Spill, Full-Allocation Years:</u> Full-allocation years that do not occur in conjunction with a managed spill from McPhee require the Biology Committee to manage a water 'budget' based on the existing components of the managed pool described above (31,798 AF). Thus Project and fishery managers work with the BOR during February and March to describe daily releases over the forthcoming water year, which for the Fishery Pool accounting begins April 1 and ends March 31 the following year. How the Base Flow Pool is managed to benefit the downstream fishery is further described below. In general, flows are elevated during the summer months to maximize the opportunity for fish growth and minimized during the winter with about two-thirds of the Fishery Pool used from April - October. Seasonal transitions during spring and fall result in flows of 35-50 cfs. BOR will occasionally adjust recommended flows to take advantage of the power plant's 25 cfs incremental turbine capabilities (i.e., flows of 25 during winter and 50 or 75 cfs during transition or summer months are often the result of both optimizing power production and seasonal fishery needs).

<u>Excess-Supply – 'Spill' Years:</u> 'Spills' or 'managed spills' are managed releases of water that McPhee Reservoir has no room to store. Such excess water, insofar as it is consistent with Project purposes, is to be released

downstream to support recreational and commercial boating. During managed-spill releases, the Fishery Pool is not debited. Therefore, water released from the managed pool (31,798 AF) can be utilized in less than a full year, which allows for higher releases to benefit the fishery based on the flow recommendations by the Biology Committee. The rules for such 'fish clock' adjustments are presented in the following section.

<u>Fish Clock Rules During Managed-Spill Years</u>: BOR develops an Annual Operating Plan (AOP) for McPhee Reservoir in consultation with DWCD and updates it as necessary. DWCD is responsible for implementation of the AOP and day-to-day McPhee Reservoir operations in consultation with BOR.

Because the Fishery Pool is not to be debited during a managed spill, many factors, including the following, must be considered in determining when a managed spill will begin and debits to the Fishery Pool will stop: volume of forecasted spill; reservoir elevations; weather and runoff forecasts; actual runoff; user demand and timing of demand; boating release patterns; facility conditions and limitations; dam safety; public safety. Filling McPhee Reservoir is the highest priority of Project operators. Reclamation in consultation with the DWCD evaluates these factors and determines a beginning date that is reasonable and fair to all parties and best fits the year's situation.

The spill effectively ends when McPhee Reservoir inflow is equal to outflow. Due to the inherent variability of runoff timing, including multiple peak upward spikes followed by ebbs, this matching of inflow to outflow is difficult to predict. Ramping down a spill at prescribed rates over more than four days must also be considered in the inflow-to-outflow equation. Generally, the reservoir is almost full when downstream releases are ramping down to the Biology Committee's recommended base flow. Many times the spill will end and a weather event increases inflow or decreases diversions; if the reservoir and other Project facilities (canals, ditches, and ancillary storage) are full, this additional water must be passed downstream. When this happens, the spill continues and debits to the Fishery Pool continue to be suspended.

Fishery biologists have recommended the release of small amounts of water beginning in March and prior to the spill for temperature suppression. (See Section III.1.A, Thermal Regime Modification, for a more complete description of the need and procedure for releasing projected surplus water earlier in spring, prior to the declaration of a managed spill.) Up until a managed spill is declared, the Fishery Pool is being debited. When such temperature-suppression water from the projected surplus is released, the Fishery Pool is debited only for the base flow component of the volume released. At the conclusion of the spill, the volume of water released for temperature suppression is totaled and divided by 1,785 AF (acre feet required for one boating day at 900 CFS). The product of this equation is rounded to the nearest day and that number of days is added to the length of the spill. Example: the amount of water released for temperature suppression is 6,750 acre-feet, 6,750 AF/1785 AF = 3.8 days, rounded to four days. The spill duration is lengthened by four days. Temperature suppression flows are incrementally raised from the March 31 base flow releases up to 200 cfs over approximately 45 days into mid-May when peak inflow approaches and reservoir operations require release of surplus inflow.

Complexity of Pool Releases from McPhee Reservoir
During the planning, construction and early years of operation of the Dolores Project, the primary expectation was the establishment of a cold-water trout fishery below McPhee Dam. As described at the beginning of this chapter the McPhee Reservoir release regime was changed to a 'managed pool' scenario, which was formalized in the 1996 EA. The driver of this change was the preference for a variable hydrograph to address the inability of rainbow trout populations to survive when indexed flows were set at 20 cfs in accordance with a "dry year" index determination, as required by the DPR and FEIS. After the 1996 EA was completed, more attention began to be paid to the three native fish species that are the focus of this Implementation Plan. Focus on these native

species was formalized in the Three Species Agreement signed in 2004 by Colorado, Utah, Wyoming, Nevada, New Mexico, and Arizona and later by the United States (BOR, BLM, USFS, NPS, USFWS), as well as some Native American tribes within the Colorado River basin.

With the increasing focus on managing in accordance with the Three Species Agreement, it is also critical to address the commitment to maximize opportunities for boaters, consistent with Project purposes, in "excess supply" or "spill" years. Adaptive management measures to help the native fish must be carefully coordinated with the Dolores Project commitment to optimize boating opportunities during a managed spill. The boating community has actively cooperated in evaluating early releases to meet thermal targets to benefit native fish spawning and, when possible, high peak releases to provide channel and floodplain maintenance flows. The boating community has embraced the ecological health of the river as critical to a quality boating experience, as well as flow variation, for its ecological benefits and the recreational opportunities resulting from the variation. This nexus of cooperation between the boating experience and care of native fish populations will continue to be key to the success of this Implementation Plan.

Meeting demands for downstream uses of the Dolores River consistent with Project purposes is complex and it is not always possible to meet all objectives every year. The degree to which these objectives are compatible over the long term can only be determined based on carefully considered adaptive management experiments that conform to the sideboards presented by the size of the managed pool and Dolores Project operating rules.

Hydrologic Variability, Drought and Allocation Shortages

The other complexities that will need to be addressed in the adaptive management process are the inevitable drought and shortage cycles. In the 12 years since 2002 there have been three painful shortage years. All Project allocation holders except users of M&I water share shortages. Table 6 below summarizes shortages in 2002 and 2003, along with projected shortages in 2013.

Table 6

	MVIC (1)(2)	Full Service Farmers (2)	Ute Farm and Ranch	Downstream Fishery (3)(4)
Project Water Allocation + Decreed Water (MVIC)	150,400 AF	55,282 AF	23,300 AF	33,200 AF (31,798 AF)
2002 Total Use	75,490 AF (50% of Avg.)	16,978 AF (31%)	6,290 AF (27%)	11,678 AF (35%)
2003 Total Use	118,362 AF (79% of Avg.)	27,953 AF (51%)	12,588 AF (54%)	16,321 AF (42%)
2013 Water Availability - September DP Allocation	110,000 AF (73 %)	16,400 AF (30 %)	6,600 AF (28 %)	8,713 AF (27 %)

(1) MVIC owns decrees for 795 cfs of direct flow water (707.7 cfs absolute, 89.7 cfs conditional) that equate to a maximum 150,400 AF of Project water under various contracts, plus 3,000 AF of livestock and domestic water. Average MVIC diversions of decreed water rights and Project allocations have been approximately 136,000 AF per year.

(2) 6,000 AF of MVIC's decreed water right is committed by contract to DWCD in the form of Class B Stock, which in shortage years is shorted in the same proportion as full-service Dolores Project irrigators.

(3) The Fishery Pool year runs April 1 to March 31. The table shows traditional water year accounting year (November 1 to October 31) for MVIC, Full Service Irrigators, and the Ute Mountain Ute Tribe and a 'Fishery Pool Water Year' of April 1 - March 31.

(4) In 2002 & 2003 the Fishery Pool included the full "up to 3900 AF," estimated as need by downstream senior water rights, so the denominator for "% Allocation" was 33,200 AF. Following the interim, now permanent, re-allocation of the 'up to 3900 AF of senior downstream water rights,' the denominator used for 2013 'Projected Water Availability' was 31,798 AF.

Because of the Project shortage, managed pool release rates for the 2013-14 managed pool water year ranged from 23 cfs down to 8 cfs. By comparison, full Project allocations without a spill, as occurred in the 2012-13 Fishery Pool water year, provided release rates of 70 cfs to 25 cfs. During the last big spill year, in 2008, when the spill did not end until June 25, Fishery Pool release rates ranged from 33 cfs to 132 cfs.

Project allocations, based on various contracts and McPhee Reservoir water rights, add up to 270,000 AF per year. The Dolores River provides most of this water, 82% on average, and a higher percentage on dry years. Over the 101-year record at the Dolores Gauge, 42 individual years do not produce the required yield for annual diversions. A two-year rolling quantity produces 30 shortfalls and a three-year rolling quantity produces 22 shortages. The fact that actual diversions can be less than allowed, the timing of inflows, irrigation season precipitation, and other climatic or operational considerations can all influence Project supplies and the magnitude of shortages. A more detailed operation study would give a more detailed look, but the takeaway message is that shortages occur regularly. Historical hydrologic studies, such as paleo tree ring studies, indicate many more and longer droughts than the 20th century record that most water managers generally use. These data reinforce the need to acknowledge and plan for shortages as a regular operational practice.

3. Management of Native Fish Species Under Conditions of Hydrologic Variability

The extreme hydrologic variability depicted above raises some key questions that need to be addressed by an adaptive management and monitoring program that evaluates how the Base Flow Pool may be best utilized for native fish needs.

With regard to drought and shortage periods, the following evaluation questions need to be addressed from a management and monitoring perspective:

1. How do the limited Base Flow Pool releases during drought and shortage periods affect each life stage of roundtail chub, flannelmouth sucker, and bluehead sucker?

2. How do the limited Base Flow Pool releases during drought and shortage periods affect trout (rainbow, brown, cutthroat) and smallmouth bass populations?

3. How can the recommendations of the *A Way Forward* native fish scientists regarding reducing populations of predatory and competitor fish species be implemented during shortage periods?

4. How can the answers to questions 1-3 above be integrated into adaptive management strategies that contribute to the ongoing viability of the three native species?

5. How can monitoring be structured during and after these drought periods to better understand how native fish are affected by drought? How effectively does monitoring detect the effects of management measures taken during drought conditions?

6. Given the influence of a relatively unmodified flow regime from the San Miguel River, are there opportunities below the Dolores River/San Miguel River confluence to overcome constraints in the Dolores River resulting from drought and shortage-impacted McPhee releases?

7. What are the long-term opportunities on specific reaches of the Dolores River, above and below the confluence with the San Miguel River, given the cycle of hydrologic variations?

The upside in hydrologic variability on the Dolores comes in significant spill years such as 2008. For example, based on the "Fish Clock" rules described above, releases from the Base Flow Pool in 2008 were made in only nine months. Instead of average releases of 50-75 cfs, there were 65 days of flows ranging from 80-132 cfs after 90 days of spill above 200 cfs. In addition, 2008 presented an opportunity to begin ramping up flows in March (adding surplus water on top of the prior year's Base Flow Pool water), mimicking in pattern those flows seen upstream of McPhee Reservoir at the Dolores gauge. Some potential evaluation questions concerning higher-flow hydrologic periods include the following:

1. What can be done with higher base flows after a managed spill ends to improve the status of the roundtail chub, and the flannelmouth and bluehead suckers?
2. How does the use of these higher base flows to help the three native species affect the trout populations and smallmouth bass?
3. How can monitoring be structured before, during and after these higher base flow opportunities to better understand how native fishes benefit, and how can monitoring measure the effectiveness of any management measures taken in conjunction with higher flow conditions?

A series of evaluation questions also need to be formulated for small-spill and no-spill years as intermediate to drought and large spill periods. The monitoring protocols described in Section IIB under 'Native Fish Conservation Measures and Status in the Dolores River Below McPhee Dam' will annually examine which of these questions can be best assessed during that year's monitoring efforts, in response to specific management actions taken to benefit native fish. CPW is responsible for managing and conserving native species from the Bradfield Bridge to the Utah state line, and will continue to collate existing datasets with annual Dolores River monitoring needs as adaptive actions are taken by Project operators. Where CPW staff commitments are not able to keep up with the need to evaluate management actions, the Dolores River monitoring and evaluation program may also benefit from contractors or university researchers that obtain grants to study specific opportunities emerging from water management, such as spiking flows to disrupt spawning bass, determining the fate of larval fish, or running pre-spill water to flush fines or suppress water temperatures.

Monitoring data will continue to inform Project managers and biologists about the current status of the downstream fishery. Data sheets for monitoring sites will also contain information that should enable detection of trends in important population metrics such as presence of young-of-year or juvenile fish, non-native predators, recent geographic distribution, or general notes about the age class structure at a site. These data, collected over multiple years with different hydrologies, will build the knowledge base of how the fishery downstream of McPhee Dam responds to specific Dolores Project operations and will give biologists and managers a better understanding of the most effective actions to be taken for a given hydrologic scenario.

Current Management of the Base Flow Pool by the Biology Committee

The questions asked annually by the Biology Committee are, 'How much water is available to release from McPhee?' and 'When should it be released?'. The answer to the former question is a matter of supply; the answer to the latter is driven by the seasonal needs of the fish. As general guidance, the Biology Committee currently recommends the following flow-release scenarios, which vary based on the water year (e.g., small or large spill year; full allocation, no spill; shortage).

Spring Flows: Flow recommendations for March/April are generally in the 50 cfs range, a little higher than winter flows, to allow better connectivity between habitats for reproductive needs and to help 'dampen' the effects of large springtime ambient air temperature fluctuations. Spring spawning fish use cues like rising stream discharges associated with the onset of spring melt, increasing photoperiods and water temperatures, and increasing turbidity associated with scouring of fine sediments for maturation of gonads, reproductive site selection, and gamete release. In the absence of a managed spill from McPhee Reservoir, it may not be possible to mimic these processes with the existing or even an enhanced Base Flow Pool.

Summer Flows: As with any temperate animal, summer is a time of growth and prosperity for fishes. Riffle areas with clean cobble promote the abundance and diversity of aquatic bugs and algae consumed by the various fish species in the Dolores River. Terrestrial invertebrates (i.e., beetles, grasshoppers, ants, etc.) that drop into the water are important food items for roundtail chub. The proximity of the flowing water to shoreline vegetation and woody debris piles entrains more invertebrates than dry or shallow riffles. Depressions along the shoreline or connected side channels create shallow warm-water habitats or "nurseries" for young fishes along the river channel. The quantity and quality of nursery areas shrink and expand depending on water availability. The Biology Committee recommends flows that are maximized during the summer to provide such conditions. These flows generally range between 60 and 120 cfs from June-August. During shared shortage years, flows have ranged between 8 and 39 cfs, which limits the availability of both food production areas and refugia for fish. Significant channel losses between the point of base flow releases at McPhee and much of the downstream river (as a percent of the volume released) further reduces the habitat value during shortage.

Fall Flows: Fall brings cooler temperatures, and flows need to be sufficient to avoid extreme temperature fluctuations and to allow fish passage to overwintering sites. Base Flow Pool releases between 60 cfs down to 40 cfs and tapering to between 25 and 35 cfs for overwintering are recommended.

Winter Flows: Fishes need adequate water depth and cover from harsh freezing conditions (e.g., anchor and frazzle ice formation in the water). Flows need to be stable and consistent; otherwise fish can move into sub-optimal habitats that either dry or freeze. Nehring (1993) recommended minimum winter flows between 25 and 35 cfs. Once a flow is determined by water availability, the main consideration is to not deviate from it. Winter flows do not allow for fish movement between overwintering habitats (pools) because riffle depths are too shallow. Once a fish chooses a place to winter in, it is stuck in that location. Higher overwintering flows would allow fish to move from sub- to more optimal habitats, plus an increase in the volume of water helps protect fishes from wide temperature swings and freezing. However, winter flows generally receive a very limited portion of Fishery Pool releases because of fish water needs of the other three seasons.

The effective Base Flow Pool can shrink or grow depending on the water year, Figure 8. As described above under 'Operating Rules', water from the Base Flow Pool is not used when a managed spill is declared by the BOR. The set of hydrographs below depicts how the Fishery Pool was used under four recent hydrologic conditions that occurred since 2000: shared shortage (2003); full allocation w/out a spill (2006); a small spill (2007); and a large spill 2008).

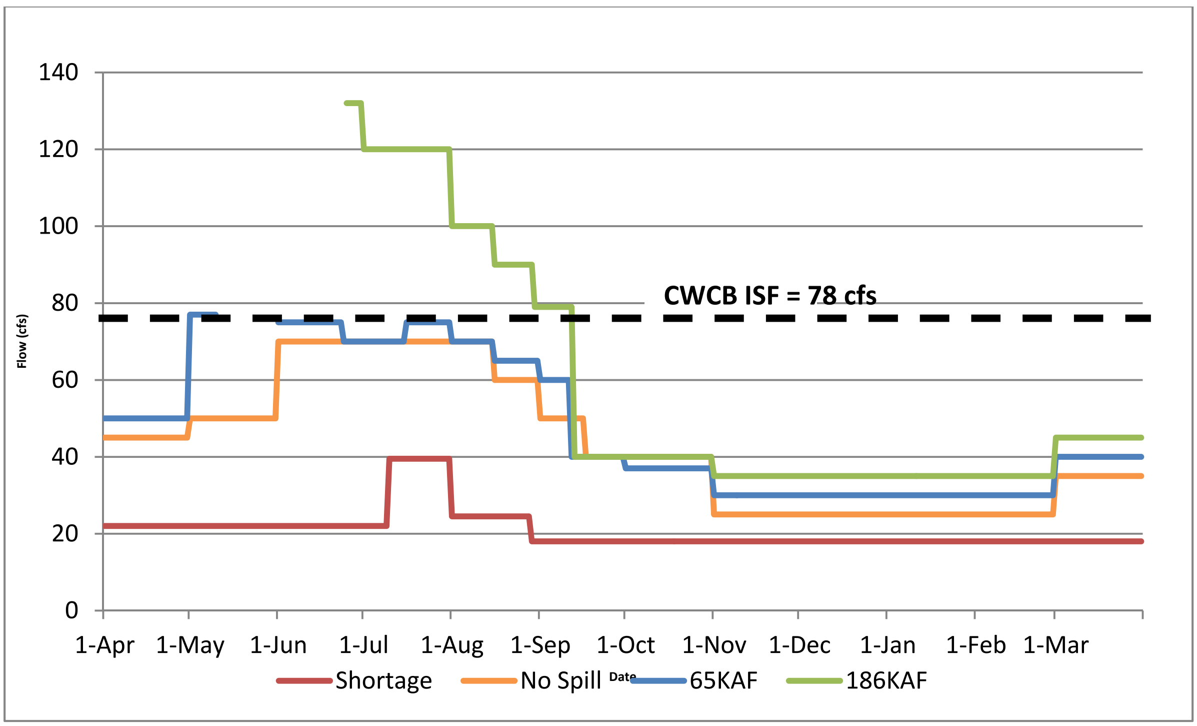


Figure 8. Base flow hydrographs depicting scenarios ranging from shortage years (48%, e.g., 2003), full allocation without spill years (2006), and spill years showing 65K AF and 186K AF (2007, 2008). Gaps in the hydrographs for spill years show where the Base Flow Pool is not debited, allowing for greater flows during critical summer months and better winter flow conditions. Note also that the 'water year' for Base Flow Pool management begins April 1.

Trout and Native Fish Management: Are They Compatible? Water from McPhee Reservoir is released at the deepest outlet possible to prevent non-native fishes in the reservoir from escaping. The deep-water releases are cold and create habitat for trout in the first 12 miles of river below the dam (approximately to Bradfield Bridge), but are inhospitable to warm-water fish that might be released from the dam. As has been mentioned elsewhere in this section, the creation of a quality trout fishery is also a Dolores Project benefit that is part of the Project authorization.

The quantity and timing of water releases from the Base Flow Pool are aimed primarily at keeping base flows high during the most productive part of the trout's growing season, late June to early Sept. High base flows during this time period also benefit native warm-water species in the same manner by creating the best possible forage and foraging conditions for adult, juvenile, and young fishes. That is because both trout and native fish young hatch in the spring and depend on good base flows to provide food for the young fish in the shallow riffle areas of the stream. The only real difference between trout needs and native fishes' needs is their relative tolerance of water temperature.

"*Won't delivering more cold water downstream just expand the trout habitat?*" This is a natural question to ask when the focus of recent efforts downstream of the reservoir has been on native warm-water fish management. Water temperature data have been collected at various points along the Dolores River below McPhee for about 25 years, and span both relatively high and low Base Flow Pool release years. The reach between Bradfield Bridge and the Dove Creek pumps is transitional, with cold-water habitat expanding or contracting seasonally and inter-annually based on different hydrologic circumstances. During the summer base flow period, the cold-water habitat (70ºF or less) may expand downstream of Bradfield Bridge on high base flow years, but it is only by a few miles and well within the thermal tolerance of warmwater native species. On most years the water exceeds the 70ºF temperature threshold by Bradfield Bridge, and ambient temperatures (where air temperature becomes the dominant factor affecting water temperature) are reached during base flow conditions in the vicinity of Bradfield Bridge. Thus available data indicate that the additional release of relatively small amounts of base flow does not significantly expand cold-water habitat downstream.

Severe Drought Periods Resulting in Shared Shortages: Dry years significantly affect the ability of the Base Flow Pool to meet any of the objectives outlined above, especially when there is a lack of carryover storage from a prior drought year(s). Water year 2013 is the most recent and severe dry year and it was compounded by a drought year 2012 that left little carryover storage to begin the year. Given Project water supplies of approximately 25 percent of the full allocation, the Biology Committee recommended flows of 12 cfs for summer and 9 cfs for winter. In early July 2013, the Dolores River was dry at the Slickrock gauge (0 flow), and a mid-summer upward adjustment to a 16 cfs Base Flow Pool release was made to avert complete drying/ drainage into river alluvium of what water was left in pools. The combination of the minor increase in release and the advent of monsoonal rains occurring upstream of the gauge increased flow to between 5 and 10 cfs at the Slickrock gauge (see Figures 9a and 9b). Later in August another example of severe hydrological variability and conditions occurred. During larval fish monitoring efforts, storms over the Disappointment Valley drainage resulted in a mud and debris torrent in the Dolores. Fishery biologists observed many fish dying in the muddy water in the Dolores River near the Big Gypsum Valley recreation site, including both native and non-native fish. It is hypothesized that these fish suffocated by smothering of gills with sediment.

Figure 9a and 9b. Left photo (9a) at 12 cfs out of McPhee Dam and without flow (standing water only) in the vicinity of Slickrock. Right photo (9b) shows improved flow conditions resulting from a combination of increasing the Base Flow Pool release to 16 cfs from McPhee Dam and tributary contributions from monsoon rain events (40 cfs was measured at the Slickrock gauge one day prior to this photo).

The Dolores at low flows, including under full-allocation base flow conditions, is unable to dilute incoming tributary flash floods or debris flows, and shared shortage flows may reduce the overall resiliency of the river to absorb shocks released from tributaries. Since 2010, three events have been observed where large numbers of fish have died due to tributary debris flows: in 2010, the Narraguinnep Canyon fire scar ran ash and sediment into the Ponderosa Gorge, killing many of the trout in this reach; in 2012, summer monsoons near the Snaggletooth rapid resulted in a debris flow into the river and killed or displaced many of the small mouth bass that occupy that reach to Disappointment Creek; and in 2013, flash flooding from Disappointment Creek will be evaluated, based on available monitoring data, for the impact on the native and predator fish that occupied the reach below the Disappointment-Dolores River confluence.

Shared shortages during a severe drought have implications for riffle productivity during summer, which will limit growth of all fishes. Since riffles and side channel/ depression nursery areas are effectively eliminated as functional habitats, all fish are concentrated in existing pools and as a result, competitive stress increases between and within species. Greater stress, more predation, and limited growth all serve to minimize fishes' ability to overwinter. Ongoing monitoring and adaptive management will provide a basis for better understanding of how severe drought affects each of the three native species.

Full Allocation, No Spill: Full-allocation years without a spill are an improvement over years with shortage flows imposed on the Base Flow Pool, but despite some improvements, many of the objectives for native fish may still not be met. Some of the basic questions that still need to be addressed during a 'base flow-only' year include:

- what is the timing of spawning for native fish?
- do fry emerge, and what is their fate?
- how do low flows affect mobility of native fish?
- what is the relative importance of local snowmelt runoff, and to what degree does 'low snow' (snowmelt runoff from the Glade or Dolores Rim) or adequate monsoon moisture mitigate the effects of low base flow conditions?
- how are sediment processes of delivery and re-distribution affected?

- what benefits could base flow augmentation provide to mitigate the effects of sedimentation, poor temperature regimes, reduced fish mobility, or over-competition and predation?

Base Flow Management During Spills: Wet years with extended managed spills to the Dolores River downstream of McPhee Dam conserve water in the Base Flow Pool because it is not debited during a managed spill. This 'conserved water' is typically used to enhance base flows during the summer months and to provide better-than-average overwintering flows for both native fish and non-native salmonid species; the benefits for both summer and winter flows may be proportional to the number of days of a managed spill. Small-spill years may provide an opportunity for some pre-spawn flushing flows and thermal regime 'correction' so that native fish spawn at the appropriate times rather than just prior to a spill release. Thermal regime modification will be aided by having access to real-time temperature data from just above Disappointment Creek and the stream gauge at Slickrock to assess the benefits from tributary inflows during spring. Some Base Flow Pool water may be used in combination with an 'early release' of projected spill water ('projected surplus') to maximize the flow benefits of a small spill event for native species.

Larger spills such as occurred in 2005 or 2008 afford opportunities to the benefit of native fish. Some of the potential benefits include:

- more appropriate thermal cues;
- higher summer, fall, and over-winter flows;
- potential opportunity to utilize 'conserved water' (i.e., Project surplus water) for driving bass from summer nests;
- significant sediment flux (cleaning of riffles and scouring of pools);
- overbank flows (nutrient exchange);
- creation or maintenance of habitat diversity in the river, necessary to support all life stages of native fish.

One important research question under a 'large spill' scenario is to determine how large spills may serve to limit the growth or propagation of smallmouth bass, as they are not riverine species and do poorly in flowing, cool-water environments. Both large and small spills also afford the opportunities for raft shocking (longitudinal monitoring) of remote canyon reaches (Ponderosa Gorge, Pyramid to James Ranch, Slickrock Canyon, and below the San Miguel confluence) that non-spill years cannot provide. However, smaller spill create greater uncertainty about the timing or availability of the necessary shocking flows and the more difficult scheduling and logistics become.

4. Base Flow Augmentation

As described in earlier sections, 'Increment II' water refers to water that the BOR and the stakeholders who were negotiating the change from an indexed-release regime to a managed-pool regime described as necessary to increase the Base Flow Pool to a total of 36,500 AF. Currently, the total Base Flow Pool is 31,798 AF, so Increment II water is technically 4,702 AF short of the recommended goals set out in the 1996 Record of Decision and Environmental Assessment, and affirmed by the Operating Agreement between BOR and DWCD in 2000. Acquiring Increment II water has always been described as a partnership undertaking, recognizing existing allocations and water rights, and conceptualized as a 'willing buyer - willing seller' transaction, and as noted, partially funded with seed money by BOR, with approximately $400,000 in the account exclusively for this purpose.

If Increment II Water is acquired to Increase the Base Flow Pool to 36,500 AF, How would the Base Flow Pool Be Managed to Improve the Status of Native Fish?

The *A Way Forward* scientists suggested a number of possible benefits from augmented base flows:

- There is a strong positive correlation between summer base flow conditions and native fish populations;
- Current base flows are held constant for long periods of time and are below recommended flows for improved native fish populations;
- Higher base flows would provide more habitat for native fish and invertebrates;
- Higher base flows would provide more escape cover and more diverse habitat, decreasing competition and predation between native and non-native fish;
- Higher base flows have the potential to improve water quality, including thermal buffering against extreme daytime temperatures.
- An increment of Base Flow Pool water could be used to provide a short flushing flow to improve spawning conditions for native fish.

If additional Base Flow Pool water supplies were acquired, the Biology Committee would have more flexibility to recommend flows to achieve a number of objectives, including:

- Reduce smallmouth bass reproduction by targeting newly hatched young on the nest with a short-duration flood in excess of 1000 cfs (2 days). Targeted flooding displaces vulnerable young fish into the main channel where they are susceptible to predation, pushes them into flooded vegetation that is quickly dewatered with flow reductions, and into high-sediment areas with limited visibility. Flows at this level would have the added benefit of cleaning the spawning substrate for roundtail chub, which spawn typically later in June and, if noticed early, provide reliable boating flows sufficient to float from Bradfield Bridge to Slickrock.
- Promote native fish movement into suitable spawning habitats from downstream areas during no-spill years. Movement of flannelmouth sucker and roundtail chub has been documented in the Dolores River during early May. Additional water would allow Project managers to run flows in excess of 150 cfs during the first couple of weeks of May, intended to promote the movement of native fishes through shallow riffle areas and into areas with suitable spawning habitat such as in and around the Pyramid reach. Flows at these levels would also suppress water temperatures and may delay the onset of smallmouth bass spawning. Delaying smallmouth bass spawning (and other warm-water non-native fishes) is important because there is less time for them to grow before the onset of winter, when a lot of smaller fish perish if they don't have sufficient fat reserves.
- Improve the production of food in riffle areas for fishes in no-spill and shortage years. During no-spill years, flows from May to August would see improvement of 14% to 44% of current water deliveries. On a shortage year (using 2013 as an example) overwinter flows could be improved by 38% (8 to 11 cfs) but there would still be little flexibility to provide any meaningful summer base flows aimed at food production in riffle areas.
- Improve the size and availability of pool habitat in shortage years for roundtail chub. An additional increment of water would allow managers to keep more pool habitat area, and connections between pools, available to roundtail chub even with a shared-shortage situation. Figures 9a and 9b show a dramatic improvement in pool condition below Slickrock after modest flooding from monsoonal rains filled the pool and primed the river channel. The river flows at the Slickrock gauge went from 0 to 40 cfs with a couple of rain events, but with the combined rain and increased releases of water from 12 to 16 cfs, that was enough to re-establish flow between the pools (albeit well below normal flow conditions).

The emergency releases made during the summer of 2013 will come at the expense of over-wintering flows, which were reduced from 10 cfs to 8 cfs for 182 days (50% of the year). Over-winter flows could be maintained at 11 cfs in 2013 if Increment II water was added, pro-rated to a 27% shortage as indicated in Table 7.

- Provide the flexibility to monitor smallmouth bass removal efforts after flood experiments in addition to more frequent and predictable assessments of management activities and the biological response of fishes. Four days at 400 cfs would consume about 68% of the 4,702 AF of water needed to reach a total fish pool of 36,500 AF. But in a small-spill year, this water could be used to monitor ongoing management actions without significantly impacting existing habitat conditions under the current Base Flow Pool allocation. Ancillary benefits include some limited scouring of fine sediments and a predictable low-flow recreational opportunity for the boating community.

These objectives will need to be prioritized based on the various hydrologic scenarios and resulting limitations.

Supply Limitations to Base Flow Pool Expansion

As discussed above, the 1996 EA contemplates a total managed Base Flow of 36,500 with cost-sharing participation by others (DOW, USFWS, BLM, USFS, TU). BOR provided $371,000 to establish a trust account for the acquisition of water, and other entities wishing to participate in water acquisition can make deposits to this account. This account has an approximate balance of $400,000, but no water has been acquired using these funds. Table 7 inventories all known water rights or allocations associated with McPhee Reservoir. The fact that all of these water supplies are allocated/obligated, coupled with the impact of shortage periods, complicates the search for the increment of water needed to reach the 36,500 AF.

Table 7. Physical Water Sources in and Through McPhee Reservoir

Water Rights & Allocations	Quantity AF	Approvals	Concurrence
DP-DWCD M&I	5,120	DWCD, BOR	DWR
DP-DWCD / Full Service Irrigation	56,267	DWCD, BOR	DWR
DP-UMUT SJ F&W	800	UMUT, BOR	DWCD, DWR
DP-UMUT Irrigation	23,717	UMUT, BOR	DWCD, DWR
DP- Cortez M&I	2,300	Cortez, BOR	DWCD, DWR
DP-Dove Creek M&I	280	Dove Creek, BOR	DWCD, DWR
DP- UMUT M&I	1,000	UMUT, BOR	DWCD, DWR
DP-BOR SJ F&W	800	BOR	DWCD, DWR
DP - Fish Pool	31,798	CPW, BOR	DWCD, DWR
DWCD Plateau Reservoir (proposed): Fishery, Recreation, M&I	+/- 20,000 (conditional)	DWCD, CPW, USFS, BOR	DWR
Totten Exchange: Irrigation, Domestic, Augmentation, Exchange	3,000	DWCD, BOR	MVIC, UMUT, DWR
DP-MVIC Irrigation Project Water	0-60,000	MVIC, BOR	DWCD, DWR
MVIC Direct Flow Irrigation	150,400	MVIC, DWR	BOR, DWCD
MVIC Livestock Water	3,000	MVIC, DWR	BOR, DWCD
Cortez Direct Flow	4.2 CFS	Cortez, DWR	BOR, DWCD

Montezuma Water Company	13.2 CFS	MWC, DWR	BOR, DWCD
Other private upstream water rights	Unknown	Private Party, DWR	

V. MANAGING AGAINST NON-NATIVES AND CONSIDERATION OF STOCKING

Introduction and Background

Non-native fishes such as smallmouth bass, brown trout, green sunfish, black bullhead, channel catfish, and white sucker pose varying degrees of threat to native fishes below McPhee Reservoir. The primary threat to native fishes by non-natives is predation on the young or small size classes, but competition for food and habitat between the species at different life stages occurs as well. Hybridization between native and non-native white sucker may compromise the genetic integrity of native sucker populations; however, no white suckers have been documented in the Dolores River despite their relatively high abundance in McPhee Reservoir.

The distribution and abundance of non-native fishes in the Dolores River varies by reach. Brown trout were stocked in the mid-1980s after the closure of McPhee Dam and are now self-sustaining in the first 12 miles of the Dolores River. Smallmouth bass probably escaped the reservoir in 1993 during the only surface spill in its history. Smallmouth bass primarily occupy Reaches 3 and 4 (Dove Creek to Big Gypsum Valley) and are self-sustaining in Reach 3. Other non-natives were present before the Project and widely distributed in all warm-water reaches in relatively low abundance.

The focus on non-native removal efforts will primarily be on brown trout and smallmouth bass. Although green sunfish, black bullhead, and channel catfish can (and do) prey on native fishes and/or their eggs, their numbers in the Dolores River are relatively low and they generally don't obtain an adult size large enough to prey on all life stages of native fishes, but they will continue to be monitored. During non-native fish control efforts, all non-natives below Bradfield Bridge will be removed and we anticipate other management activities directed at brown trout and smallmouth bass will have negative impacts on other non-native fishes as well.

Crayfish are not native to the Colorado River Basin or the Dolores River. Crayfish are often thought of as detritovours or scavengers. This is not an accurate portrayal. Crayfish seek out and consume high protein and caloric food sources such as bottom-dwelling insects and fish eggs in addition to algae and detritus. Biomass (weight of organisms over an area) of crayfish in the Dolores River was estimated at 490 kg/ha in 1990 (Beck 1990)[18]. In contrast, the biomass of a recent invasion of the same species of crayfish in the Yampa River was estimated at 122 kg/ha (Martinez 2011), which was 2 kg/ha more than all of the other macroinvertebrates and fish combined for the river. Crayfish in the Dolores River are most abundant in Reach 3. Beck (1990) speculated that relatively clear water conditions and warmer temperatures found in this reach might be optimal for crayfish growth and reproduction.

Crayfish complicate the management of non-native species in the Dolores River. They can be a predator of native fish eggs, a competitor for food resources and habitat, and they are an excellent food source for otters and smallmouth bass.

[18] Jim White to footnote all of the references in Section V

Brown trout are the most abundant large-bodied fish in the first 12 miles of the Dolores River below the dam. Their abundance declines rapidly below Bradfield Bridge from densities of about 145 fish per mile above Bradfield to less than 50 per mile downstream of Bradfield. Brown trout prefer summer water temperatures below 66ºF but can tolerate temperatures above 70ºF. Temperatures above 80ºF are lethal. The optimal cold-water habitat for brown trout diminishes greatly downstream of Bradfield Bridge (Figure 10) with summertime temperatures commonly exceeding 70ºF at the Dove Creek pump station site.

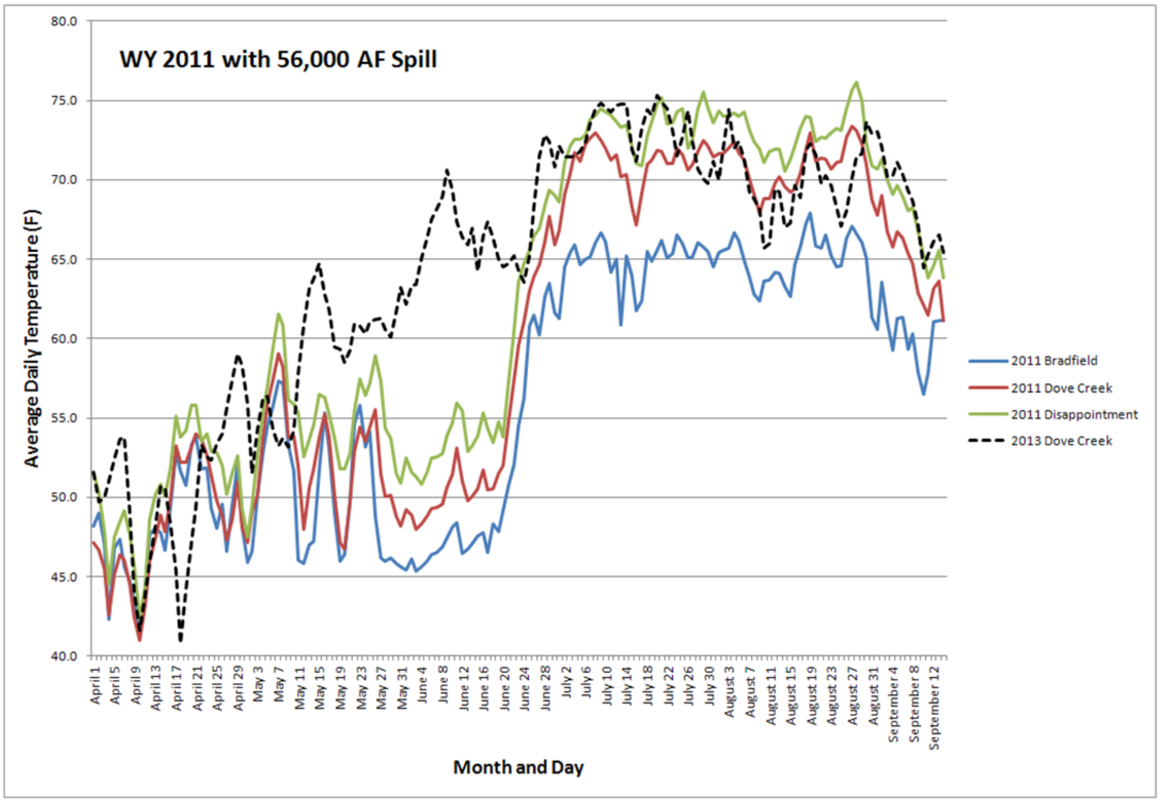


Figure 10. Average daily water temperatures at three different sites downstream of McPhee Reservoir. Bradfield Bridge is 12 miles, Dove Creek 32 miles, and Disappointment 54 miles below the dam.

Large numbers of smallmouth bass were discovered in 2007 in Reach 3 (between Dove Creek pumps and Disappointment Creek). These fish are well established with multiple age classes present (Figure 11), suggesting conditions are suitable for spawning during multiple years and under various flow conditions. Smallmouth bass populations appear to thrive under drought conditions in western streams with healthy crayfish populations (Johnson et al. 2008; Martinez 2011). Drought conditions typically result in slow velocity pools and earlier warming of water temperatures (Figure 10), allowing for earlier spawning and a longer stable period of growth. Smallmouth bass reproduction and growth is disrupted by moderate flooding when water velocities are greater than 0.3 to 1 ft/sec over the nest and temperatures remain below 60ºF for an extended period (Winemiller and Taylor 1982; Johnson et al. 2008). Smallmouth bass are relatively confined and isolated in the Dolores River.

Figure 11. Multiple age classes of smallmouth bass on the lower Dolores River, May 2011

Opportunities and Constraints

This plan addresses the need to diminish the impacts of non-native predatory fishes on native fishes in the Dolores River. The management strategy mainly revolves around three categories of opportunities (see Table 8 for list of all possible management actions):

- **Prevention** of existing and/or new non-native introductions through the use of physical or thermal barriers, removal of source populations, or removal thorough regulatory mechanisms.
- **Removal** of non-native populations either directly or through habitat manipulations.
- **Exclusion** of non-native fishes from preying upon or otherwise interfering with native fish though active management, particularly in nursery areas including, but not limited to, installation of barriers during rearing periods.

An additional but very new technique involves the genetic manipulation of the sex chromosomes of the source population. Much more research needs to be done in the field before attempting to impose a biological or genetic control on the smallmouth bass population.

Prevention

There are a number of management opportunities that are currently used to prevent the escapement of non-native warm-water fishes from McPhee Reservoir and the introduction and spread of nuisance species. These are:

- Avoid using the spillway at McPhee Dam. Surface spills result in non-native escapement.
- Use the lowest reservoir outlet (jet valve and/or 3rd SLOW) during managed releases to avoid entraining non-native fishes such as white sucker, smallmouth bass, and walleye. The upper SLOWs was built to

address temperature and dissolved-oxygen issues and could improve temperature conditions for native fish in Reach 1, but these potentials will go unexplored until the risk of non-native escapement can be satisfactorily addressed.

- Prevent the introduction of potential upstream threats such as invasive species and new diseases. Boat inspection stations are now in place to prevent the introduction of zebra and quagga mussel and other aquatic nuisance species and diseases such as rusty crayfish, nuisance fish species, viral hemorrhagic septicemia (VHS) disease, and nuisance plants.
- Prevent establishment of non-natives within the drainage below McPhee. All warmwater fish stocking on private land must be approved through a permitting process. All non-native, warmwater stocking done by the state is regulated by a Non-Native Stocking Procedures Protocol – an agreement between the states and the USFWS.
- Prevent the transportation of crayfish to new drainages. CPW regulations require all crayfish be killed before transporting.

Prevention of additional non-native introductions is constrained by a number of factors, including emergency surface spillway releases from McPhee Reservoir and illegal fish introductions into the reservoir or Dolores River by anglers. Removing existing populations of non-native fishes in McPhee Reservoir is daunting. Smallmouth bass, white sucker, and walleye are widespread and abundant in the reservoir and represent a possible escapement risk. Smallmouth bass and catfish stocking has not occurred since the early 1980s and is currently not permitted under the Non-Native Stocking Procedures, an agreement between the State of Colorado and the USFWS to limit/exclude certain stocking practices. Adding physical screens to the outlets of McPhee Dam to prevent non-native escapement would be expensive and difficult. However, deep cold-water releases appear to be an effective management strategy that prevents additional escapement from the reservoir. For 28 years CPW has annually collected fishes from three different electrofishing stations below McPhee Dam and only a few fish with reservoir origins have ever been captured. Periodic electrofishing and netting in the stilling basin at the outlet of the reservoir resulted in the capture of only a few deep-water-dwelling reservoir fishes such as kokanee salmon and yellow perch escaping from the reservoir.

Removal of non-native warmwater fishes in McPhee Reservoir through chemical means, such as the application of the piscicide rotenone, would be challenging. Lake Davis in California is similar in surface area to McPhee Reservoir but its average depth and volume is considerably less. Lake Davis has been treated with rotenone twice to eradicate northern pike and both attempts failed. The target chemical treatment volume of Lake Davis was 45,000 to 48,000 AF. To achieve a similar volume for treatment in McPhee would require the release of 115,000 AF from the inactive storage pool before a chemical removal project to eradicate non-native fishes was feasible.

Walleye were illegally introduced to the reservoir. An unlimited bag limit on walleye has not been effective at curbing the abundance of these fish because anglers have a difficult time capturing the fish by hook and line. One management opportunity to increase angler harvest of walleye in McPhee may be to cease stocking of kokanee salmon in the reservoir. Adult walleye are feeding heavily on kokanee. The removal of this food source may increase angler harvest; however, walleye may simply switch to feeding on abundant yellow perch and rainbow trout in the reservoir.

Removal
There are a number of management opportunities to physically remove non-native fishes from the Dolores River. These management opportunities include:

- Removal of non-native fishes during electrofishing surveys (see Table 8 for a list of sites, frequency, and evaluation). Adult fish are most susceptible to mechanical removal, particularly during spawning periods (June-July). A reduction in the number of reproductive fish may decrease direct predation of native fishes by non-native fishes and the potential number of non-native offspring.
- Target smallmouth bass nests with electrofishing gear to remove reproductive adults.
- Manipulate water temperatures by early water releases to delay the onset of non-native fish spawning (see Section III.1.A, Thermal Regime Modification). Research suggests delaying the onset of smallmouth bass spawning may increase the mortality of young fish during the following winter months.
- Disrupt spawning and recruitment success of smallmouth bass with targeted flow releases. Bass and sunfish are nest spawners. Newly hatched fish are weak swimmers and a well-timed flow spike could result in high mortality of eggs and larval bass and sunfish.
- Target adult and sub-adult smallmouth bass with an organized angling effort to remove the fish each year.
- Chemically treat reaches 2, 3, and 4 with rotenone to remove non-native fishes.

These adaptive management opportunities to reduce predator populations are the subject of considerable education, monitoring and advocacy supported by the Lower Dolores Working Group and the Dolores River Dialogue. The DRD partners are willing to support and advocate intensive removal efforts when they are deemed appropriate. In the short term, efforts that show potential with less intensive investments of time and money will be pursued first and monitored for results. More-intensive actions and investments will be considered, based on the results of less-intensive experiments.

Physical removal of non-native fishes by electrofishing has some constraints. Large-scale removal efforts will require flows of about 400 cfs or greater to float electrofishing boats down the channel (Figure 12). When suitable flows occur, every effort will be made to remove non-native fishes from multiple reaches of the Dolores River. Electrofishing is most effective on large-bodied fishes. Smaller fish have less surface area, and therefore, are less susceptible to getting shocked.

Figure 12. Typical obstacles to raft electrofishing in Reaches 2 and 3 requiring a minimum of 400 cfs to float a boat through.

Electrofishing long sections of the Dolores River to remove non-natives without the use of boats during base flow periods will be difficult. Base flow electrofishing is constrained by equipment limitations, poor or non-existent road access, deep pools, safety concerns with wading over loose, rolling, sharply angled rubble (Figure 13), and time/personnel limitations. Seining and angling appear to be a more effective means to removing non-native fishes at low water levels. However, given the length and area of the lower Dolores River occupied by non-native fishes (about 277 surface acres in a 22-mile section of interest) and the number of seine hauls needed to cover that area (each haul covers about 0.007 acres, for an estimated 39,000+ hauls), this too is a relatively impractical approach for large-scale removal efforts. However, targeting bass on spawning nests with electric seines during low-water periods on the Yampa River has proven effective at reducing the number of adult bass and may improve the number and abundance of native fishes. Some smallmouth bass spawning areas on the Dolores River have been identified during fish sampling efforts, but more work needs to be done.

Figure 13. Smallmouth bass removal effort with seining and angling during 2013. Photo was taken about 4 miles upstream of the Disappointment Creek confluence in the lower section of Reach 3.

Large-scale removal efforts of non-native fishes in the Yampa and San Juan rivers have succeeded in reducing the number of non-native fishes and increasing the abundance of native fishes but at a very high cost. These efforts are labor-intensive, logistically difficult, and expose personnel to dangerous situations. The Yampa and San Juan intensive removal programs are closing in on almost a decade of removal efforts with no discernible ending point at this time. CPW would not be in a position to undertake a non-native fish removal project akin to the Endangered Fish Recovery Programs but could manage and supervise a removal team with additional financial support to purchase needed equipment and hire a crew during the few months bass are spawning. Institutional partners on the Implementation Team have offered to help secure additional financial support for this purpose as this option moves up in priority.

Manipulating water temperatures and flows may offer the best opportunity to reduce the abundance and distribution of non-native warm-water fishes in the Dolores River on a large scale. Smallmouth bass initiate spawning when water temperatures reach 16ºC (~61ºF). Avoiding early warming in the Dolores River by releasing small increments of water during a forecasted spill year (see Section III, Spill Management and Synergies with Thermal and Sediment Flushing Opportunities) may prevent smallmouth bass from spawning early. Early prevention of spawning is important because if one can delay the onset of spawning by a month or more it results in smaller, weaker bass that are highly susceptible to predation and winterkill. Water supply, rights, and contracts constrain the use of this opportunity on an annual basis but when conditions permit, this may be an effective tool in suppressing non-natives in the lower Dolores River, especially when coupled with an intensive and targeted electrofishing removal of spawning bass after a spill.

Smallmouth bass reproduction and growth is disrupted by moderate flooding. Water velocities greater than 0.3 to 1 ft/sec over the nest (Winemiller and Taylor 1982; Johnson et al. 2008) can displace newly hatched fish into more unfavorable habitats and expose the young fry to increased predation. The source, amount, timing, and duration of water deliveries out of McPhee Reservoir to disrupt smallmouth bass spawning and displace newly hatched fry have not been identified through research or agreed on at this time. Unlike bass, native fishes do not build nests or spawn in slowvelocity habitats and the young fish do not require parental care. Rising water velocities (i.e., increasing water discharge) could temporarily slow the development and growth of newly hatched fish but since part of their natural life cycle involves drift of young fish downstream, a simulated flooding event would only serve to disperse native fishes downstream.

Flash flooding, and accompanying sediment flow events, in the Dolores River appear to limit the distribution, abundance, and expansion of non-native (and possibly native fishes) below Disappointment Creek (Figure 14). CPW documented a large fish die-off of both native and non-native fishes during a flash flood event in 2013 (Figures 15a and 15b). CPW re-assessed the same area after the flooding and found roundtail chub and black bullhead alive but not smallmouth bass. Although CPW has no management control over such events, it is important to document and understand their role in controlling non-native fishes and possibly limiting the abundance and expansion of native fishes in the Dolores. It is also important to understand how different base flows from McPhee influence water quality and fish populations below Disappointment Creek during moderate flooding events.

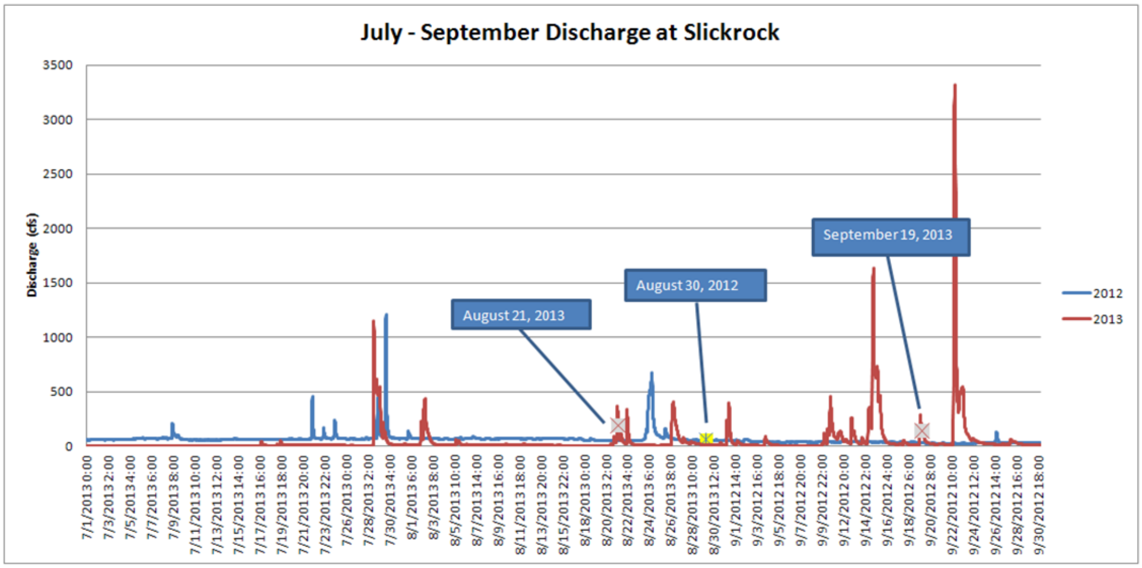


Figure 14. Flash flooding during the 2012 and 2013 monsoon seasons. Dates in blue boxes are CPW fish surveys conducted in Big Gypsum Valley.

Figure 15a and 15b. Dead native fishes (left) and a dying black bullhead near the surface (red circle; right) after a flash flood from Disappointment Creek carried tons of fine sediment in to the Dolores River on August 21, 2013.

Angling to remove smallmouth bass, in combination with other removal techniques, may reduce the number of adult fish in the population. Other smallmouth bass control programs incorporate angling, including the Upper Colorado Endangered Fish Recovery Program. In the Yampa River, over 10,000 smallmouth bass were removed in 2013. About 97% of these were removed by boat electrofishing and the second most effective means was angling, at 2.5% of the total. In the Dolores River, where boating is limited to spills, angling may be one of the control methods with the fewest logistical constraints associated with large-scale removal efforts. Angling also allows the public to participate in non-native fish removal efforts; CPW regulations allow the unlimited harvest of smallmouth bass and brown trout [The Colorado Wildlife Commission recently removed the bag limits] below Bradfield Bridge. Unlimited non-native bag-limit regulations are published annually in the Colorado Parks and Wildlife Fishing Brochure.

Removal of smallmouth bass and other non-natives using piscicides (e.g., rotenone) is associated with a number of difficult challenges. Piscicides are non-selective and kill native and non-native fishes. The chemical-application logistics are significant with little access to large portions of the river for crews, large slow-moving pools that don't mix well, and significant risk of not adequately detoxifying the chemical before it affects non-target areas. Complete eradication of smallmouth bass in the targeted area is highly unlikely. Large rotenone projects aimed at eliminating "rough fish" (native fishes) conducted in the 1960's prior to the closure of Navajo and Flaming Gorge dams failed. A large-scale chemical reclamation project on the Dolores River aimed at non-natives faces long odds for success.

Exclusion

Protecting native fishes by excluding non-native fishes from accessing important habitats is a strategy that works well for some species of fish due to their geographic location in the watershed but is unlikely to be practical for many three-species populations. Fish managers commonly build barriers to migration of non-native fishes to protect headwater species such as cutthroat trout. However, warm-water species occupy lower reaches of a watershed where the logistics of creating barriers to downstream populations of non-native fishes becomes much more difficult and the threat of non-native fishes in upstream reaches (McPhee Reservoir) cannot be mitigated.

The Dolores River has two natural "exclusion" zones that make it difficult for non-native fish expansion downstream of the San Miguel River confluence (Reach 6). The first zone occurs below Disappointment Creek where extreme levels of sediment during flash floods appear to limit the number of non-native, and native, fishes in Reach 4 and possibly Reach 5. The second is the Paradox Valley section (Reach 6) where extremely high salinity levels at low flows may create a chemical barrier to upstream and downstream migration of fishes under low-flow conditions. Total dissolved solids at the northeast, or downstream, side of the valley, are 260,000 mg/L or 8 times the concentration of seawater during low flows. The effect either one of these natural "exclusion" zones have on both native or non-native fishes in the Dolores River is not well understood. However, very few smallmouth bass have been captured in the Big Gypsum Valley (Reach 4) section of the Dolores despite a thriving population of bass in relatively close proximity upstream above the Disappointment Creek confluence. No smallmouth bass have been captured below Paradox Valley (Reach 6) or below the San Miguel confluence. Characterizing the conditions that are lethal to fishes or needed for native fish passage during reproductive and drifting periods is a management need. Efforts will be undertaken to learn more about the impacts, both positive and negative, of the two natural exclusion zones created by Disappointment Creek sediment and Paradox Valley salinity.

The Dolores River below McPhee Dam flows primarily through public lands with little agricultural value. As a result, there are few stock ponds that could harbor additional sources of non-native fishes. If additional stock ponds were developed, CPW would have some authority to exclude stocking of non-native predatory fishes under current regulations.

Prevention, Removal, and Exclusion of Cold-water Species

Colorado Parks and Wildlife manages the Dolores River fishery for trout from McPhee Dam to Bradfield Bridge. This cold-water fishery is an obligation shared by the BOR via commitments in Dolores Project NEPA documents. Below Bradfield Bridge the water generally becomes transitional between cold- and warm-water fish habitat, thus native fish are the management focus from the bridge to the Colorado River confluence.

Brown trout are the most abundant trout between McPhee Dam and Bradfield Bridge and are self-sustaining. Brown trout prefer quiet, low-velocity pools with cover, while rainbow trout prefer pools with deeper riffle/pocket water habitat nearby. Brown trout are more tolerant of warmer water than rainbow trout. Under the current base flow regime, the habitat is more suitable for brown trout than rainbow trout. Brown trout prey items include macroinvertebrates (terrestrial and aquatic), crayfish, and small fishes. The most common sources of food in the Dolores River below Bradfield Bridge are crayfish and mottled sculpin.

A clear distinction between brown trout occupying Reach 1 (Dam to Bradfield Bridge) and trout occupying Reach 2 (Bradfield Bridge to the Dove Creek pump station) is needed. Cold, deep-water releases from McPhee Reservoir limit the number of predatory and problematic non-native fishes in the Dolores River. Those releases may continue in perpetuity, unless the responsible institutions are confident they can eliminate the risk of non-native escapement from higher-level selective outlet releases, to prevent the introduction of additional fish and fish species into the Dolores River. Therefore, the cold-water habitat created by deep releases will provide the habitat needed by trout in Reach 1. Water temperatures become unsuitable for brown trout in Reach 2 and as a result brown trout numbers decline rapidly as the habitat becomes more favorable for warm-water native fishes. The overlap in the native species range and brown trout range is relatively small in the Dolores River and unlikely to expand or contract much, except as a result of fluctuations during drought-related shortages or higher base flow releases. Brown trout do prey on small fishes and removal of brown trout by angling and electrofishing is a high priority when conditions permit in Reach 2, but not in Reach 1, where CPW has a responsibility to manage for cold-water fish.

There are few opportunities to prevent emigration of brown trout below Bradfield Bridge. However, the habitat requirements, ecology, and behavior of brown trout suggest brown trout emigration downstream is relatively rare. Trout studies done in the Dolores River above Bradfield Bridge during the early 1990s by CPW documented some small downstream movements of individual brown trout but no large-scale population shifts downstream. Suitable brown trout habitat below Bradfield Bridge since the early 1990s has declined as the water-delivery systems for the Dolores Project were fully implemented. Trout populations in this section reached a high of 270 fish per mile in 1993 but fell to less than 45 fish per mile in 2007. After the Narraguinnep fire in 2010, with the resulting lethal ash and debris flows, and 2013's low-flow periods, when water temperatures at Bradfield Bridge exceeded 80ºF on several occasions, there were not many brown trout found below Bradfield Bridge. Rainbow trout are not a threat to native fishes below Bradfield Bridge because water temperatures are too warm, the habitat is unsuitable, and rainbow trout primarily eat aquatic and terrestrial insects, not small-bodied fishes.

Removal of brown trout by electrofishing from Reach 2 can be done at 400 cfs and above. There is no road access to Reach 2, which is about 20 miles long. There have been three large-scale electrofishing efforts below Bradfield Bridge in the past but the objective was to conduct a population estimate on trout, not remove them. Future electrofishing efforts below Bradfield Bridge will be aimed at native fish assessment and non-native fish removal. Anglers may also participate in native fish conservation efforts by legally keeping all the brown trout they catch below Bradfield Bridge.

Electrofishing removal of brown trout holds the most promise of diminishing the effects of brown trout predation on native fishes below Bradfield Bridge while maintaining a recreational fishing opportunity in the coldwater habitat in Reach 1. However, large-scale removal opportunities only arise when there is a managed spill in the 400 - 600 cfs range. Floating a large, heavy, electrofishing boat down the channel at flows below 400 cfs is not an option and flows much above 400 cfs are swift and limit the effectiveness of stunning and netting fishes. Brown trout will be removed during annual electrofishing surveys at the Dove Creek pump site and during all other surveys below Bradfield Bridge.

Management options discussed in the following paragraphs for the trout reach *above* Bradfield Bridge (Reach 1) would only be exercised if monitoring efforts demonstrate a clear rising trend in brown trout numbers in Reach 2 and a corresponding sharp reduction in native fishes in Reaches 2 and 3. Little evidence of that trend exists despite 28 years of monitoring at the Dove Creek pump site and three large longitudinal surveys done in Reach 2. Since 2000 the recurring intervals between no-spill and shortage water years have been very effective at limiting the increase in brown trout abundance and distribution in Reaches 2 and 3. Additionally, the tailwater fishery below McPhee Reservoir is one of the Project commitments and any changes would need to be in accordance with Project documents.

Flow manipulations to disadvantage reproduction of brown trout and chemical treatment to remove the population in Reach 1 above Bradfield Bridge are possible but low-priority management opportunities at this time. Dropping stream levels in late November would dry up and kill fish eggs in redds (a brown trout nest). Raising flow levels in late February would push emerging brown trout fry into streamside margins, resulting in high mortality. Chemical treatment to remove the population of trout is an opportunity but a low priority, especially given the questionable benefit and the risk of significant expansion into native fish habitat.

Manipulating flows to reduce the population of brown trout in Reach 1 is possible but may have negative effects on native fishes. Trout and native fishes select deep slow-moving pools to overwinter in. Deep pools are less susceptible to icing conditions. Fish make these habitat selections in late fall and generally don't move much until the spring thaw. Temporarily decreasing flows abruptly to dry up brown trout redds in late fall may strand native fishes in sub-optimal habitats. Conversely, increasing flows abruptly in late winter to displace newly hatched brown trout can push ice down the channel, creating scouring effects, and may displace many adult and juvenile fish from their overwinter habitats. A well-justified, researched, and data-driven design, including the source and amount of water needed to achieve the objectives above, would need to be in place before any releases were made.

Chemical treatment of Reaches 1 and 2 to remove all trout is an option of last resort. Currently, the abundance of brown trout is extremely low in native fish habitat from the Dove Creek pump site downstream (Reach 3 and below). Brown trout do consume small fishes; however, the abundance of alternative prey items such as crayfish and mottled sculpin below Bradfield Bridge suggests an opportunistic feeder like brown trout would be consuming these prey items disproportionately over native fishes. This assumption needs to be tested with a brown trout diet assessment study.

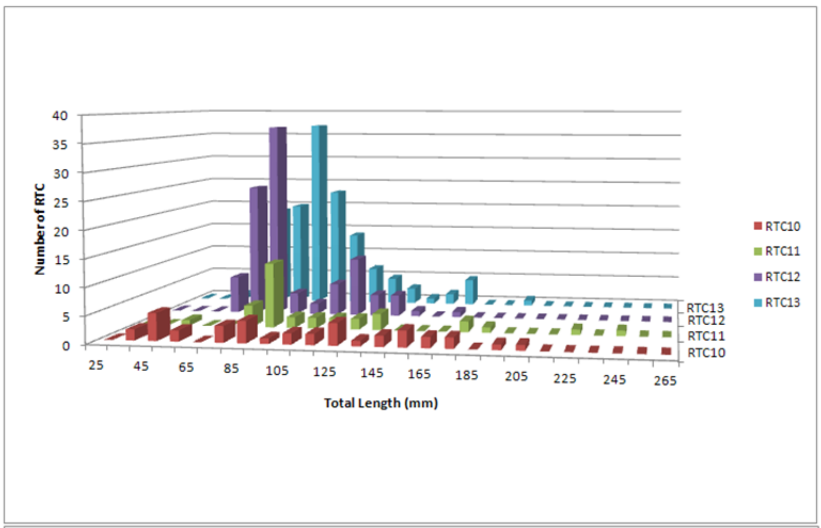
Table 8. Summary of management actions to remove non-native fishes in the Dolores River

ACTION	LOGISTICAL CHALLENGES	FEASIBILITY	TIMING CONSIDERATIONS (frequency? will we ever be 'done'?)
Electrofishing - Raft Shocking - Walk Shocking	Raft: 400+ cfs needed for at least 3 days; lead time needed to set up crews and equipment Walk: Shallow shoreline areas or pools less than 4 feet deep only. Limited large-scale application but good at targeting specific, shallow areas. Electric seine may work with this application. Limited to areas with some road access due to heavy generators needed. Labor-intensive. Turbid water limits effectiveness.	Raft: Feasible give right conditions Walk: Feasible under most base flow conditions. Short sections only due to deep pools.	Raft: Periodic condition-based spring surveys (except for Big Gypsum Valley); in perpetuity Walk: Annual in summer/fall at select areas.
Seining - Young Fish - Adult Fish	Young Fish: Rubble/boulder bottom difficult to seine. Limited in area but equipment is very portable. Can access more remote areas. Select sites only. Adult Fish: Electric seine may be effective for adult fish in small, shallow, targeted areas. Equipment heavy. Generally need road access.	Young Fish: Feasible under most shallow summer conditions Adult Fish: Feasible in selected areas where equipment can be reasonably transported to the stream. Would need additional funding and support.	Young Fish: Late summer; annual; probably in perpetuity. Adult Fish: Early summer; targeted and periodic removals of spawning bass; maybe 3-year push, then evaluate.
Angling	Access to bass habitat is difficult but possible on rough 4-wheel-drive then 4-wheeler-only road. Some areas inaccessible by road.	Feasible under most conditions. Good volunteer project.	Annual during the mid-summer months after the spawn. In perpetuity.
Physical Disruption (nests)	See Adult Fish Seining.	Feasible with additional support	Early summer; removals for 2 months (waiting 3-5 days between sites)
Flow Disruption	Determining timing and duration of release to target newly emerged bass. Determining source of water to release. Not warranted at this time for brown trout. Could have detrimental and unintended consequences for native fishes.	Moderately feasible if water source can be worked out	Condition-based; may occur on its own during a small "fill then spill" year scenario. Rare and condition-based for brown trout.
Chemical	Logistics of appropriate chemical application and detoxification extremely challenging; movement of personnel and equipment in remote roadless / canyon-bound area costly/difficult; harm to native fishes unacceptable and removal efforts impractical; 40+ miles of stream with little chance of complete eradication but high chance of harming native fishes	Not feasible at this time	Rare if at all.

Augmentation of Native Fishes by Stocking

Augmentation or stocking native fishes is a tool used to increase the abundance and distribution of fishes across their historic range. Stocking is complementary to other management activities such as instream flow management and protection, habitat restoration, and non-native fish removals. Stocking is warranted when the target species population is rare, population demographics are skewed towards few breeding adults, and suitable habitat exists. The goal of fish augmentation programs is to establish self-sustaining populations that don't depend on annual stocking. They can also assist with monitoring and research objectives if stocked fish are marked.

Stocking roundtail chub is not warranted at this time. Although the number of individuals in the population fluctuates from year to year, there is enough recruitment from juvenile to adult to sustain the population (Figure 16 A, 16 B).



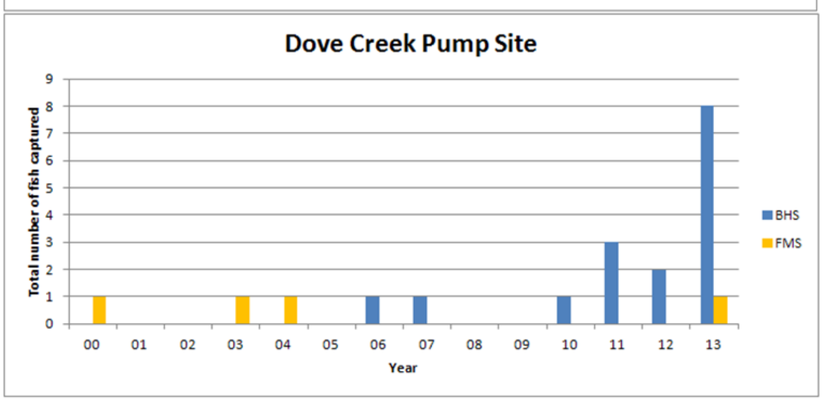


Figure 16A, 16B. Panel A: Number of roundtail chubs (RTC) versus total length of these fish caught at the Dove Creek pump station site during the last four years. Note: Adult fish are typically greater than 100 mm or 4 inches. Panel B: Number of bluehead and flannelmouth suckers caught at the Dove Creek pump site electrofishing station.

Native suckers, particularly bluehead sucker, are rare in Reaches 2-5. The presence of young bluehead suckers at the Dove Creek pump site electrofishing station (Figure 16A, 16B) suggest there may be a small breeding population of adults in Reach 2 and that the habitat is relatively suitable for these fish.

This hypothesis needs to be tested by further monitoring and evaluation. Stocking bluehead suckers below Bradfield Bridge and monitoring their abundance and distribution with electrofishing and PIT tagging may be an opportunity to both expand the population of bluehead suckers in the Dolores River and examine the role of predators and flow regimes at the same time. Given the 28-year history of fish data collected at the Dove Creek pump site, an experimental stocking of bluehead suckers below Bradfield Bridge may be easier to assess. There needs to be careful evaluation as to whether suitable habitat warrants stocking bluehead suckers at either location, given the augmentation criteria outlined above.

Flannelmouth suckers are rare at the Dove Creek pump site (Figure 16A, 16B). Large migratory schools of adult fishes have been documented moving into spawning areas during the spring. Young flannelmouth suckers are rare but do regularly show up in the lower part of Reaches 3 and 4. Little information on young flannelmouth distribution exists in Reach 5 (Slickrock Canyon). Flannelmouth sucker may be a candidate for stocking.

Colorado Parks and Wildlife (CPW) is currently developing broodstocks for native suckers. A roundtail chub broodstock has been maintained for the San Juan, La Plata, and Mancos rivers by CPW since 2002. Once broodstocks are developed and fish reared to a suitable size for stocking (2 inches or more) fish could be marked and stocked by raft. The Dolores PIT-tag array located near Disappointment Creek could be a good tool to assess the effectiveness of a stocking program. Annual and periodic condition-based monitoring will also help determine the success and limitations of a native fish-stocking program on the Dolores River.

There are several issues to consider before embarking on a fish augmentation program. Stocking programs are most successful when other management opportunities such as flow management, habitat restoration, and non-native fish removal are in place and functioning. Stocking must not negatively interfere with wild stocks and should not result in the loss of genetic diversity. Stocking can help overcome losses from predation and contribute to the establishment of a more diverse demographic of native fishes; however, stocking is a tool towards native fish recovery, not a cure.

The potential tools related to both management against non-natives and consideration of stocking require cooperation among multiple institutional partners on the Implementation Team along with education, dialogue and support by the many stakeholders involved in the Lower Dolores Working Group and Dolores River Dialogue. The combination of clearly defined adaptive management objectives, carefully designed experimentation, and monitoring and evaluation, widely shared through these venues, will advance the level of acceptance, support and investment that will be required to aggressively, systematically and effectively address predator removal and consideration of stocking.