# United States Department of the Interior

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Mountain-Prairie Region

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JAN 10 2005



Memorandum

To: Assistant Regional Director, Ecological Services, Region 6

From: Regional Director, Region 6
Fish and Wildlife Service
Denver, Colorado

Subject: Final Programmatic Biological Opinion on the *Management Plan for Endangered Fishes in the Yampa River Basin*

In accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.), and the Interagency Cooperation Regulations (50 CFR 402), this transmits the Fish and Wildlife Service's final programmatic biological opinion for impacts to federally listed endangered species for implementation of the *Management Plan for Endangered Fishes in the Yampa River Basin* (Yampa Plan) (Roehm 2004). Reference is made to your February 4, 2004, correspondence (received in our Grand Junction Field office on February 6, 2004) requesting initiation of formal consultation for the subject project. Based on the information presented in the biological assessment you provided, I concur that the annual depletion of water from the Colorado River Basin may adversely affect the endangered Colorado pikeminnow (formerly squawfish) *(Ptychocheilus lucius*), humpback chub (*Gila cypha*), bonytail (*Gila elegans*), and razorback sucker (*Xyrauchen texanus*) and may adversely affect their critical habitat. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 C.F.R. 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.

Based on the information provided in the biological assessment, I also concur that the subject management plan may affect, but is not likely to adversely affect, the following species: bald eagle (*Haliaeetus leucocephalus*), southwestern willow flycatcher (*Empidonax traillii extimus*), black-footed ferret *Mustela nigripes*, or Ute ladies'-tresses (*Spiranthes diluvialis*). The bald eagle's preferred prey are fish and waterfowl, and the proposed action involves base-flow augmentation that should support its prey base and potentially provide more open water in winter (i.e., less ice cover) for foraging. Moreover, no adverse impacts are expected to the riparian forest that eagles use for roosting. The southwestern willow flycatcher does not occur in the

Yampa River Basin. The nearest population of this subspecies occurs on the Green River downstream from the Town of Green River, Utah. Flow fluctuations in Green River this far downstream from the Yampa River due to the proposed action would be well buffered by inflows from the Upper Green River (upstream from the Yampa River), as well as the Duchesne, White, Price and San Rafael Rivers (downstream from the Yampa River). The proposed action involves water depletions and potential impacts to aquatic habitats, therefore the proposed action would not impact the black-footed ferret's upland habitats or their prey base that occurs in uplands. No significant additional conversion of upland rangeland habitat (potential black-footed ferret habitat) to irrigated cropland is anticipated as part of the proposed action. Ute ladies'-tresses orchids have not been found along the Yampa River. The Green River flow recommendations (Muth et al. 2000) assume that flow targets downstream from the Yampa River confluence can be met considering expected water development to meet future demand in the Yampa Basin. These flow recommendations are intended to provide floodplain inundation at a certain frequency, magnitude and duration that should provide favorable conditions for the Ute ladies'-tresses orchid.

**Consultation History**

Implementation of the Endangered Species Act in the upper Colorado River Basin started with section 7 consultation on Bureau of Reclamation projects in the late 1970's. At that time, the Service determined that the subject endangered fishes were in danger of extinction. Subsequently, section 2 (c) of the Act was amended as follows: It is further declared to be the policy of Congress that Federal agencies shall cooperate with State and local agencies to resolve water resource issues in concert with conservation of endangered species.

In 1984, the Department of the Interior, Colorado, Wyoming, Utah, water users, and environmental groups formed a coordinating committee to discuss a process to recover the endangered fishes while new and existing water development proceeds in the Upper Colorado River Basin in compliance with Federal and State law and interstate compacts.

After 4 years of negotiations, the Secretary of the Interior; Governors of Wyoming, Colorado, and Utah; and the Administrator of the Western Area Power Administration (WAPA) cosigned a Cooperative Agreement on January 21-22, 1988, to implement the Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (USFWS 1987). Current participants in the Recovery Program include: the Service, Reclamation, National Park Service, WAPA, Colorado, Utah, Wyoming, Western Resource Advocates, The Nature Conservancy, Colorado Water Congress, Utah Water Users Association, Wyoming Water Development Association, and the Colorado River Energy Distributors Association. The goal of the Recovery Program is to recover the listed species while providing for new and existing water development in the Upper Colorado River Basin. All participants agreed to cooperatively work toward the successful implementation of a recovery program that will provide for recovery of the endangered fish species, consistent with Federal law and all applicable State laws and systems for water resource development and use. Each signatory assumed certain responsibilities in implementing the Recovery Program. To further define and clarify processes outlined in sections 4.1.5, 4.1.6, and 5.3.4 of the Recovery Program (USFWS 1987), a *Section 7 Consultation, Sufficient Progress, and Historic Projects Agreement* (Section 7 Agreement) and a

*Recovery Implementation Program Recovery Action Plan* (RIPRAP) were developed (USFWS 1993). The Section 7 Agreement established a framework for conducting section 7 consultations on depletion impacts related to new projects and impacts associated with existing projects in the upper basin. Procedures outlined in the Section 7 Agreement are used to determine if sufficient progress is being accomplished in the recovery of endangered fishes to enable the Recovery Program to serve as a reasonable and prudent alternative to avoid the likelihood of jeopardy and/or adverse modification of critical habitat.

Since the inception of the Recovery Program, the Service has consulted on over 700 projects depleting water from the Upper Colorado River Basin. The Recovery Program, through its implementation of the RIPRAP, has avoided the likelihood of jeopardy and/or adverse modification of critical habitat on behalf of these projects.

The RIPRAP outlines specific recovery actions, including such measures as acquiring and managing aquatic habitat and water, re-operating existing reservoirs to provide instream flows for fishes, constructing fish passage facilities, controlling nonnative fishes, and propagating and stocking listed fish species. It also stipulates which entity is responsible for taking action, when these actions would be undertaken, and how they would be funded. The RIPRAP was finalized on October 15, 1993, and has been reviewed and updated annually.

One RIPRAP element, under the FY 2003 Green River Action Plan: Yampa and Little Snake Rivers, subsection I.A.2., is to develop and implement a management plan for the Recovery Program in the Yampa River Basin. This element calls for: 1) developing and implementing a public involvement plan for the Yampa River Basin (ongoing), 2) updating estimates of human water needs in the Yampa River Basin (completed 1998), 3) estimating the low-flow needs of fishes and identifying impediments to fish passage on the Yampa River below Craig (completed 1999), 4) carrying out hydrologic analyses to identify and evaluate flow augmentation needs and strategies (ongoing), 5) installing, operating and maintaining stream gages (ongoing), and 6) developing and implementing an aquatic management plan to reduce nonnative fish impacts, while providing sportfishing opportunities (approved in 1998 and initiated in 1999). For this purpose, the *Management Plan for Endangered Fishes in the Yampa River Basin* (Yampa Plan; Roehm 2004) was developed to promote recovery of four listed endangered fish species as water is depleted from the river to serve current and projected human needs in the Yampa River Basin through the year 2045. Implementation of the Yampa Plan is intended to promote the recovery of these species by facilitating needed management actions specifically identified in the RIPRAP.

On November 7, 1979, the Rural Electrification Administration (REA) requested section 7 consultation on Unit 3 of the Craig Station, for which the REA proposed to guarantee a loan to Colorado-Ute Electric Association (Colorado-Ute), an electric generating company. The Service was asked to consult on construction and operation of a 400-MW coal-fired generating unit, depleting an estimated 6,400 acre-feet (AF)/year for evaporative cooling. The Service issued a biological opinion on March 13, 1980, for Unit 3 of the Craig Station (USFWS 1980) that required Colorado-Ute, with the Service's assistance, to develop a water management plan for Unit 3 to offset the impacts of its depletions. Subsequently, Colorado-Ute sold its interest in the Craig Station to Tri-State Generation and Transmission Associate (Tri-State), which assumed responsibility for developing the water management plan. Under the terms of this management plan (Knutson 1992), Tri-State agreed to bypass up to 1,000 AF/year of its Wessel Canal direct-flow water right to augment instream flows for fish. Water is bypassed if river flows fall below certain flow targets to support habitat needs of endangered fish in the Yampa River. The Water Management Plan is described in further detail in the Yampa Plan. Flow recommendations adopted by the Service in 1999 (Modde et al. 1999) are being implemented as part of the Yampa Plan. The Yampa Plan is considered to supersede Tri-State's Water Management Plan because it implements the most current flow recommendations.

On July 3, 1985, the Service notified the Bureau of Reclamation that a section 7 consultation would need to be completed on the Stagecoach Reservoir Project due to a Bureau of Reclamation grant for the project. The Stagecoach Reservoir Project involved construction of a 33,275 AF reservoir near the headwaters of the Yampa River with storage space dedicated to irrigation, industrial, municipal and recreation purposes. The Service consulted on an average annual depletion of 12,873 AF of water allocated to human use and reservoir evaporation. The consultation was completed in 1986; the reservoir was constructed shortly thereafter and operations are ongoing.

The only project the Service consulted on in the Little Snake River Basin before the inception of the Recovery Program was the Cheyenne Stage II project. The project consists of a trans-mountain diversion depleting 15,800 AF of water from the headwaters of the Little Snake River to augment the municipal water supply for the City of Cheyenne, Wyoming. Consultation was requested on June 5, 1980. The consultation was completed May 29, 1981, with a "no jeopardy" finding.

On July 14, 1999, the Service issued a final biological opinion to the U.S. Army Corps of Engineers on the Little Snake River Supplemental Irrigation Water Supply Project (High Savery) on Savery Creek, a tributary to the Little Snake River in south-central Wyoming. This opinion relies, in part, on the Yampa Plan as a reasonable and prudent alternative for this action. High Savery Reservoir (under construction) will have an active storage capacity of 16,507 AF to provide 12,000 AF of supplement irrigation water to 13,900 acres of land in the Little Snake River Valley in both Wyoming and Colorado. The project is expected to deplete an average of 7,724 AF/year from the Little Snake River.

Impacts related to water depletions from the Green River were addressed in separate consultations for Flaming Gorge Dam, the Narrows Project in the Price River drainage, and the Strawberry Valley Project in the Duchesne River drainage. The depletions covered under those consultations have no direct or indirect effect on the Yampa River. However, with respect to flows in the Green River downstream from its confluence with the Yampa River, depletions from the Yampa River are additive to those from the Green River.

# BIOLOGICAL OPINION

## DESCRIPTION OF THE PROPOSED ACTION

The Recovery Program proposes to implement the Yampa Plan. The purpose of the Yampa Plan is to promote recovery of four listed endangered fish species as water depletions continue to serve existing and projected human needs in the Yampa River basin though the year 2045. The Yampa Plan promotes recovery by facilitating management actions specifically identified in the RIPRAP. The Service will enter into a Cooperative Agreement with the States of Colorado and Wyoming, and the Colorado River Water Conservation District to implement the Yampa Plan (Appendix A). Signing the Cooperative Agreement is a Federal action taken by the Service that requires ESA section 7 consultation.

The action area is the Yampa River Basin, including the Little Snake River, in Colorado and Wyoming; the Green River downstream from its confluence with the Yampa River; and the Colorado River downstream of the confluence with the Green River to Lake Powell.

The proposed action consists of estimated current and projected future water depletions from the Yampa River and its tributaries, as well as actions identified in the RIPRAP as necessary to offset the impacts of water depletions and provide recovery for Colorado pikeminnow, razorback sucker, humpback chub, and bonytail. Water depletions included in the Yampa Plan are part of the proposed Federal action. By incorporating water depletions, the Yampa Plan facilitates the ability for all water users causing water depletions to the Yampa River Basin to rely on Recovery Program actions to avoid the likelihood of jeopardy and adverse modification of critical habitat. Many water depletions will be associated with a future Federal nexus such as Army Corps of Engineers permits, Federal Energy Regulatory Commission relicensing, Federal agency authorization of right-of-ways, or some other Federal involvement. For some water depletions the only Federal nexus will be the inclusion of those depletions in the Yampa Plan and the Service's obligation to implement the Yampa Plan through the Cooperative Agreement. The following is a summary of the proposed action which is described in greater detail in the Yampa Plan.

### Scope of Biological Opinion

Issuance of this programmatic biological opinion does not create an administrative priority concerning depletions from the Upper Colorado River Basin. The opinion neither prejudices nor determines the amount of depletions allowable under the Colorado River Compact or under the Endangered Species Act in other subbasins of the Upper Colorado River Basin.

The Recovery Program does not provide reasonable and prudent alternatives or minimization measures for direct physical impacts of new actions (i.e., projects constructed after January 22, 1988); effects of transbasin diversions out of the Yampa River Basin into the Platte River Basin, on Platte River endangered species; or discharges of pollutants. Therefore, this biological opinion does not address such impacts. This biological opinion does not address impacts of future actions authorized, funded, or carried out by Federal agencies other than those associated with water depletions or the implementation of recovery actions described in the Yampa Plan.

Estimated Current and Future Depletions Included in the Yampa Plan

Existing water development within the Yampa River Basin is limited; total water storage is almost 124,000 AF (124 KAF), or about 8 percent of its average annual yield (Table 1). Moreover, some of the active storage capacity of these reservoirs currently is either under-utilized, reserved for emergency supplies, or dedicated to in-reservoir use, meaning that less than 124 KAF is released and refilled annually.

Table 1. Principal reservoirs in the Yampa River Basin, active storage capacities and uses

| Reservoirs | Capacity (AF) | Year Built | Principal Intended Use(s) |
|---|---|---|---|
| Stillwater Reservoir | 6,088 | 1935 | Supplemental irrigation supply |
| Yamcolo Reservoir [a] | 8,500 | 1981 | Supplemental irrigation supply, M&I |
| Allen Basin Reservoir | 2,250 | 1953 | Supplemental irrigation supply |
| Stagecoach Reservoir [a] | 33,275 | 1988 | Includes 11,000 AF[a] for Tri-State G&T, 15,000 AF for recreation and 4,000 AF for M&I |
| Lake Catamount | 7,422 | 1977 | Used primarily for recreation |
| Fish Creek Reservoir | 4,167 | 1942 | M&I; annual releases have averaged 1,000 AF |
| Steamboat Lake | 26,364 | 1961 | 5,000 AF for Hayden Station (Xcel); 21,364 AF for recreation and instream flow (2,000–3,300 AF) |
| Pearl Lake | 5,657 | 1959 | Used exclusively for fisheries and recreation |
| Elkhead Reservoir | 13,700[b] | 1974 | Includes 1,668 AF M&I and 8,754 AF industrial |
| High Savery Reservoir [c] | 16,507 | 2004 | Supplemental irrigation supply (12,000 AF) |
| TOTAL | 123,930 | | |

[a] Irrigation supply (4,000 AF) exchanged from Stagecoach to Yamcolo for 4,000 AF of industrial supply contracted to Tri-State from Yamcolo and delivered from Stagecoach.
[b] Proposed for expansion to ~25,451 AF total capacity, including 7,000 AF for instream flow.
[c] Located in Wyoming on a tributary to the Little Snake River (under construction)

Current depletions from the Yampa River and its tributaries in Colorado and Wyoming are estimated to average about 125 KAF annually in Colorado and roughly 43 KAF per year in Wyoming. In total, these depletions represent about 10 percent of the average annual undepleted yield of the Yampa River at its confluence with the Green River (~1.7 MAF). Projections of water demand through the year 2045 indicate that additional depletions of ~30 KAF in Colorado and ~23 KAF in Wyoming can be expected, for a total of 155 KAF in Colorado and 66 KAF in Wyoming, 221 KAF basin-wide or about 13 percent of the average annual undepleted yield of the Yampa River (Table 2).

Table 2. Current and projected future depletions from the Yampa Basin by sector

| | Colorado | | | Wyoming | | | Basin Total | | |
|---|---|---|---|---|---|---|---|---|---|
| Sector | Current | Future | Diff. | Current | Future | Diff. | Current | Future | Diff. |
| Agriculture | 87,765 | 92,258 | 4,493 | 26,905 | 37,451 | 10,546 | 114,670 | 129,709 | 15,039 |
| Municipal [a] | 5,201 | 15,307 | 10,106 | 76 | 88 | 12 | 5,277 | 15,395 | 10,118 |
| Industrial [b] | 16,947 | 32,350 | 15,403 | 0 | 3,000 | 3,000 | 16,947 | 35,350 | 18,403 |
| Export | 2,815 | 2,917 | 102 | 14,400 | 22,656 | 8,256 | 17,215 | 25,573 | 8,358 |
| Evaporation | 12,543 | 12,543 | 0 | 1,202 | 2,816 | 1,614 | 13,745 | 15,359 | 1,614 |
| TOTALS | 125,271 | 155,375 | 30,104 | 42,583 | 66,011 | 23,428 | 167,854 | 221,386 | 53,532 |

[a] Including domestic, commercial and light industrial consumption
[b] Principally evaporation of cooling water for thermo-electric power generation

Agriculture consumes the greatest percentage of water, representing about 68 percent of current depletions basin-wide. Agriculture is expected to consume a smaller percentage of projected future depletions (59 percent), with the largest gain (18 KAF) expected in the industrial sector (10 percent of current depletions vs. 16 percent of future depletions) due to an estimated twofold increase in consumption during the next 40+ years. Nevertheless, some growth (15 KAF) in agricultural depletions is expected. Municipal depletions are expected to experience almost a threefold increase (10 KAF) during the same period.

The proportion of depletions attributed to each sector is relevant to the extent that different sectors deplete water at different rates during the year. In Colorado, agriculture, export (for agriculture outside the basin), and evaporation follow similar temporal patterns, with most of their depletions occurring between April and October. Municipal and industrial (M&I) also deplete more water during the summer months, but their depletions also occur year-round. The primary industrial use in the Yampa River Basin is thermal power production. We would expect the pattern of depletions to be similar in Wyoming, except that most of the volume of export serves the municipal sector and is diverted during peak flow and stored in East Slope reservoirs. The summer depletions for agriculture are an order of magnitude higher than those of any other sector alone.

**Conservation Measures**

Conservation measures are actions that the action agency agrees to implement to further the recovery of the species under review. The beneficial effects of conservation measures were taken into consideration for determining jeopardy, adverse modification of critical habitat and incidental take analyses.

As part of the proposed action, the Recovery Program proposes to implement the following measures from the Yampa Plan to minimize the effects of the proposed action on the listed fish and their critical habitats. The Yampa Plan stipulates that a variety of recovery actions be taken to offset the impacts of these depletions and to promote recovery of the endangered fishes. These actions are classified into five broad categories in the RIPRAP:

1. Provide and Protect Instream Flows
2. Reduce Negative Impacts of Nonnative Fishes
3. Restore Habitat (Habitat Development and Maintenance)
4. Manage Genetic Diversity/Augment or Restore Populations
5. Monitor Populations and Habitat

These recovery actions, and the process for their development, are specified in the Yampa Plan, along with approaches to account for depletions, monitor fish populations and habitat, and evaluate the effectiveness of these actions in meeting long-term objectives (e.g., reducing populations of nonnative fishes) with the ultimate goal of recovering the endangered fishes. Schedules to initiate and complete recovery actions will be specified and clarified in annual revisions of the RIPRAP and incorporated into annual work plans. The Recovery Program will be responsible for funding and implementing these recovery actions. To offset the impacts of current and future depletions for endangered fish species in the Yampa River, the Recovery Program will implement the following:

**Provide and Protect Instream Flows**

The Service and the Colorado Water Conservation Board (CWCB) entered into a Memorandum of Agreement on September 21, 1993, wherein the Board agreed to ". . . take such actions under state law, including requesting administration by the State Engineer and the appropriate division engineer and initiating water court proceedings, as may be necessary to fully exercise its water rights or to obtain delivery of acquired water or interest in water. Such water shall be protected within the entire stream reach for which the appropriation or acquisition is made." This agreement (commonly called the Enforcement Agreement) provides a legal mechanism to protect water obtained for the endangered fish under the Recovery Program. Categories of water this applies to include contract deliveries, water leases, and acquired water rights.

The Recovery Program proposes to implement a base-flow augmentation plan on the Yampa River. The Recovery Program adopted the Service's Yampa River flow recommendations (Modde et al. 1999) for the August–October base-flow period, when river flows typically are at their lowest levels. Modeling suggests that the undepleted hydrograph of the Yampa River followed a similar pattern, wherein flows during this period were generally lower than the remainder of the base-flow period (November–February), with the lowest flows in September. Modde et al. (1999) determined that riffle habitat declined most rapidly at flows below 93 cfs. Riffles are considered the most sensitive of three meso-habitats (i.e., riffles, runs and pools) to changes in flow and important for their production of macro-invertebrates, the basis for the aquatic food web on which the endangered fishes rely. They also found that flows had fallen below 93 cfs at Maybell roughly 38 percent of the years during the 80-year period of record they studied (1916–1995) with an average duration of about 9 days/year (68 days in 1934), and endangered fish populations had not declined as a result of these occasional low flows. Therefore, their flow recommendation called for a base flow of 93 cfs to be maintained in an "historical context." That is, flows should not fall below 93 cfs with any greater frequency, magnitude or duration than had occurred in the past. Moreover, because of uncertainties regarding the winter flow needs of the fishes, the Service extended the flow recommendations to include the entire base-flow period, adding a 33 percent buffer to its winter flow recommendation (124 cfs) also in an historic context (Roehm 2004).

The Service developed an augmentation protocol to meet these recommendations and estimated the volume of water that would be necessary to do so. The protocol called for water to be released from storage or otherwise delivered to augment stream flows when unaugmented flows at Maybell fall below 78 cfs July–October and 109 cfs November–February. Water would be delivered at a rate of 50 cfs until augmented flow at Maybell exceeds 138 cfs July–October and 169 cfs November–February. No water would be delivered during peak flows (March 1–June 30). On this basis, the volume of water for augmentation to meet the flow recommendation in 90 percent of the years was estimated to be 6,000 AF, plus an allowance of 1,000 AF for transit losses. At 50 cfs, 6,000 AF would provide about 2 months (61 days) of continuous or intermittent augmentation. Water also would be available to augment stream flows during the driest 10 percent of years; however, it would not totally satisfy the flow recommendations. If the release rate were not adjusted, the augmentation water supply would be exhausted in dry years, while a need for augmentation persisted. During such drought conditions, the release rate would be reduced to 33 cfs, thereby extending the duration of releases to 3 months (92 days). In those years, the need for augmentation would be partially satisfied, and a minimum flow of at least 33 cfs would be provided. Even this minimum flow is an improvement over historic conditions; flows have fallen as low as 2 cfs at Maybell (in 1934 and 2002). Modeling with the Colorado River Decision Support System (CRDSS) suggests that Yampa River flows at Maybell would have fallen to 13 cfs in 1934, even if there were no depletions. The Recovery Program through the Yampa Plan will implement the subject protocol for streamflow augmentation.

To provide 7,000 AF of augmentation including transit losses, the Bureau of Reclamation (Reclamation), acting on behalf of the Recovery Program, intends to enter into an agreement with the CWCB and the Colorado River Water Conservation District (CRWCD) to fund a portion of the proposed 11,750 AF expansion of Elkhead Reservoir. The CRWCD has applied for a Department of the Army permit under section 404 of the Clean Water Act. Before issuing a permit for the project, the Corps of Engineers must ensure that potential impacts of and alternatives to the proposed action are fully documented in compliance with the National Environmental Policy Act.

The proposed action would allocate 5,000 AF of the expansion, known as the "Permanent Water Supply," specifically for the purpose of base-flow augmentation. Reclamation intends to transfer the water right to CWCB for instream flow use only, and CWCB will administer it at the Service's request. The remaining 2,000 AF for base-flow augmentation, known as the "Short-term Water Supply," would be leased from the CRWCD's 6,750 AF portion of 11,750 AF expansion of Elkhead Reservoir. The CRWCD's portion of the Elkhead Reservoir enlargement is primarily intended for human use.

The initial lease term would be 20 years at an annual fixed rate of $50/AF for the amount of water requested, not to exceed $100,000/year. The Short-term Water Supply would be secondary to the Permanent Water Supply. Modeling predicts that augmentation in excess of

5,000 AF is likely to occur in about 25 percent of all years, with an overall estimated average annual leased volume of about 500 AF. On this basis, the average annual cost of the lease would be $25,000, but could range from $0–100,000 in any given year. If the Service determines that water from the Short-term Water Supply is needed following the end of the initial 20-year lease term, the Service and Reclamation would have the first option to renegotiate the lease with the CRWCD under terms acceptable to all parties. However, it is anticipated that the Service and Reclamation would initiate negotiations prior to the expiration of the initial lease term, if deemed necessary, to ensure continuity of deliveries from the Short-term Water Supply.

The CRWCD wants to market any unused water from the Short-term Water Supply on an annual basis. However, the Service would have the first option on the water each year, and would notify the CRWCD of its intent to lease water in accordance with the following three-tiered schedule:

I. On or before May 1: The Service will notify the CRWCD of its intent to take a minimum of 500 AF of water from the Short-term Water Supply or relinquish the entire 2,000 AF volume to the CRWCD at that time;

II. On or before June 1: In any year in which the Service calls for 500 AF of the Short-term Water Supply in accordance with tier I, the Service will notify the CRWCD of its intent to take an additional 500 AF or relinquish the remaining 1,500 AF to the CRWCD at that time;

III. On or before July 1: In any year in which the Service calls for 1,000 AF of the Short-term Water Supply in accordance tiers I and II, the Service will notify the CRWCD of its intent to take the remaining 1,000 AF or relinquish that amount to the CRWCD.

If the Service fails to make an affirmative request in any year for water pursuant to Paragraphs I, II and /or III, the Service shall be considered to have relinquished the remaining balance of the Short-Term Water Supply until the Short-Term Water Supply resets on March 1 in accordance with the lease agreement.

These three tiers are based on historical hydrologic criteria, as follows:

I. 149,000 AF of runoff during the period from April 1 through April 30 (50 percent exceedance).

II. 526,000 AF of runoff during the period from April 1 through May 31 (50 percent exceedance).

III. 713,000 AF of runoff during the period from April 1 through June 30 (70 percent exceedance).

They represent the hydrologic thresholds above which no water would be required from the Short-term Water Supply during the historical record, based on modeling. Modeling suggests that strict adherence to these hydrologic criteria would satisfy 100 percent of the estimated augmentation requirement from the Short-term Water Supply. However, strict adherence to the proposed augmentation protocol would require less water from the Short-term Water Supply than these criteria call for in most years. Therefore, these criteria are considered conservative in that they would provide water from the Short-term Water Supply at least as often as it is needed based on the protocol. To provide the Service with the greatest possible operational flexibility, however, the terms of the lease will not specify any hydrologic criteria, but allow the Service to use these criteria and/or any other information the Service deems relevant, and apply scientific judgment in making its decisions with regard to the Short-term Water Supply. For example, a cold, wet spring season may not produce as much runoff as relatively warmer and drier seasons that initially produce greater volumes of snowmelt. However, if the snowpack continues to accumulate during such a cold, wet period, it is likely that delayed and/or prolonged runoff would be sufficient to preclude the need for base-flow augmentation from the Short-term water supply. Therefore, on this basis, the Service may opt to relinquish the entire 2,000 AF, even though early hydrologic criteria had not been met. Based on experience during the course of the 20-year lease, application of adaptive management will allow these criteria to be modified, as appropriate, to better predict, and satisfy, the need for water from the Short-term Water Supply.

In years when the Service relinquishes all or a portion of the Short-term Water Supply the CRWCD shall have the right to use any relinquished portion for other CRWCD purposes, including leasing the water to third parties. The 4,750 AF human use pool would share the same priority for filling as the Permanent Water Supply, whereas the Short-term Water Supply would fill under a junior priority (i.e., after the Permanent Water Supply and 4,750 AF human use pools). However, water from the Short-term Water Supply not used in any year would be carried over for use in the following or subsequent year(s) to reduce a potential shortfall of filling the 2,000 AF pool. Moreover, hydrologic modeling suggests that Elkhead Creek can refill the Short-term Water Supply at the frequency it is likely to be needed, even with its relatively junior fill priority. However, the Short-term Water Supply Pool will never exceed 2000 AF, regardless of any carry-over.

**<u>Manage Nonnative Fish Populations</u>**

Predatory and competitive nonnative fishes have been identified as an impediment to recovery of the endangered fishes throughout much of the Upper Colorado River Basin (USFWS 2002a-d). The Recovery Program and its participating partners adopted a policy with respect to nonnative fish management on February 4, 2004 (UCRRIP 2004), which states:

> *Nonnative fish management is one of many management actions necessary to achieve and maintain recovery of the endangered fishes, and failure to adequately manage nonnative fishes may nullify the positive effects of other Recovery Program actions...*

The Yampa River, in particular, has experienced dramatic growth in nonnative fish populations. The species of greatest and most immediate concern are northern pike (*Esox lucius*), smallmouth bass (*Micropterus dolomieui*) and channel catfish (*Ictalurus punctatus*). All three species are believed to prey upon the smaller life stages of the endangered fishes and other native species, such as roundtail chub (*Gila robusta*), flannelmouth sucker (*Catostomus latipinnis*), and speckled dace (*Rhinichthys osculus*). These native species also serve as prey for the Colorado pikeminnow. Northern pike have been documented preying upon subadult and young adult

Colorado pikeminnow and razorback sucker in the Yampa and Green Rivers (J. Hawkins, pers. comm.; K. Christopherson, pers. comm.)

The Recovery Program recently developed a nonnative fish management policy (UCRRIP 2004). The overall goal of the policy is to attain and maintain fish communities where populations of the endangered and other native fish species can persist and thrive to achieve recovery of the endangered fishes. Management of nonnative fish species will initially follow an experimental approach to develop effective strategies and identify the levels of management necessary to minimize or remove threats to the endangered fishes. An annual assessment of data will determine future nonnative fish management strategies, including possible changes to the list of target nonnative fish species, geographic scope of management areas, and methods employed. However, this adaptive process should not unduly delay timely and effective actions to minimize or remove the nonnative threat to the endangered fishes (UCRRIP 2004).

The Recovery Program currently is undertaking a variety of studies to determine appropriate levels of nonnative fish control needed to promote recovery of the endangered fishes, as well as the most effective means of reaching those levels. Preliminary study results indicate that the Yampa River is extremely vulnerable to the impacts of nonnative fishes and, consequently, stands to benefit the most from an aggressive nonnative fish control program. A variety of measures are already underway in the Yampa River to reduce the impacts of nonnative fishes on the endangered fishes:

<u>Implementing nonnative fish stocking procedures (NNSP)</u>

The states of Colorado, Utah and Wyoming adopted *Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin* (USFWS 1996) to help prevent competitive and predatory nonnative species from escaping into the Upper Colorado River system. The NNSP call for the outlets of ponds and reservoirs below 6,500 feet in elevation, that connect with the river to be screened to prevent stocked nonnative fish from escaping to the river. Outlets of both existing and new ponds and reservoirs must be screened before they are stocked with nonnative fish. As part of the proposed action, the Recovery Program will screen Elkhead Reservoir to minimize escapement of nonnative fishes (see detailed description below). In addition, new water storage projects that have a sport fisheries component will comply with the NNSP (e.g., screening to prevent escapement and/or stocking restrictions) in the project design and specifications, if these measures are warranted based upon location and connectivity with the river.

<u>Removing angler bag and possession limits in Colorado</u>

To facilitate recovery of endangered fishes, the Colorado Wildlife Commission approved removing bag and possession limits for northern pike statewide, and channel catfish , black bullhead (*Ameiurus melas*), walleye (*Stizostedion vitreum*), smallmouth bass, largemouth bass (*Micropterus salmoides*), green sunfish (*Lepomis cyanellus*), bluegill (*L. macrochirus*) and black crappie (*Pomoxis nigromaculatus*) in the Yampa and Green rivers in Colorado. The intent of this measure is to encourage anglers to harvest more nonnative sportfish. However, the measure does not require anglers to harvest them and, in some cases, anglers return sportfish to the river alive.

Removing and translocating northern pike and smallmouth bass

From 1999 through 2003, biologists removed 2,979 northern pike from the Yampa River on behalf of the Recovery Program (Roehm 2004). Of these, 1,914 were translocated to other water bodies isolated from the river. Since 1999, northern pike have been removed from the Yampa River in Juniper Canyon, Maybell and Lily Park, below Craig, Colorado. Beginning in 2001, northern pike were removed from backwaters and sloughs at the Yampa State Wildlife Area (SWA) and The Nature Conservancy's (TNC) Carpenter Ranch in the vicinity of Hayden, Colorado. Receiving waters included: SWA ponds; Rio Blanco Reservoir, west of Meeker, Colorado; and Loudy-Simpson Park, near Craig.

The following is a description of the current nonnative fish removal program which is designed to minimize the threat of predation and competition on endangered fishes and offset the effects of existing and future proposed water depletions included in the Yampa Plan. The area of northern pike removal has increased 20 miles, smallmouth bass treatment and control reaches have doubled in length from 6 miles to 12 miles each, and almost double the number of removal passes will be attempted for each species. Six passes through the 95-mile study reach will occur during sampling for northern pike. The first will be a river-wide marking pass, during which all captured pike will be, tagged, and released. Five additional removal passes will be made. Most effort during those passes will be focused in locations where pike were noted as the most abundant during the first sampling pass and where pike had high densities in previous years. Northern pike concentration areas typically contain few Colorado pikeminnow, so potentially harmful effects of repeated electrofishing should not be significant. Capture-recapture data from the first two sampling passes will be used to estimate abundance of pike in the study area, with this level of effort expected to achieve about a 70 percent removal of pike, assuming flows are sufficient for completion of the required number of sampling passes and that capture efficiency is relatively high (about 20 percent) (Hawkins 2004).

Smallmouth bass sampling will occur concurrent with pike sampling, focusing on two main areas described above. In Little Yampa Canyon, a total of 10 sampling passes will be completed, which includes six of those described for northern pike sampling, plus four additional passes. During the first pass, smallmouth bass will be marked and released in both control and treatment reaches. An additional nine removal sampling passes will be attempted in the treatment reach. In the control reach, smallmouth bass will be captured, tagged, and released on four sampling occasions, all of which will be done with pike sampling passes. Lily Park sampling for smallmouth bass will be done during pike sampling, with the first pass a mark and release pass followed by five removal passes. Between 1999 and 2003 Recovery Program efforts removed 1,407 smallmouth bass from the Yampa River (Roehm 2004).

The Recovery Program will expand control efforts with respect to northern pike and smallmouth bass within critical habitat, and northern pike upstream from critical habitat if results from ongoing control activities indicate expansion is needed. Removal of northern pike from the Hayden Reach is considered essential to serve as a buffer for any potential pike movement into critical habitat from populations upstream. In addition, it will allow biologists to determine to what extent such immigration may be occurring.

Controlling escapement of nonnative fishes from Elkhead Reservoir

To prevent escapement of nonnative fishes from Elkhead Reservoir the Recovery Program proposes to implement the following measures:

1. Prior to drawing down Elkhead Reservoir for construction, the existing outlet will be screened to prevent escapement of nonnatives through the outlet during draw-downs following spring runoff in 2005 and 2006. Divers will install rigid, wedge-wire screens with ¼-inch openings on the existing outlet prior to drawing down the reservoir.

2. Prior to spring runoff in 2005, the existing spillway will be partially removed, effectively lowering the spillway crest elevation by about 19 feet. To prevent escapement of adult and subadult nonnative fishes, an 8-foot high, 85-foot long, ¼-inch mesh screen will be installed in the excavated channel leading to the spillway notch.

3. Following construction, the controlled outlets will be operated in a manner which minimizes releases over the spillway. Up to 540 cfs will be discharged through the tower (440cfs) outlet and service outlet (90 cfs) during spring runoff. Flows over the spillway will occur only when inflows exceed 540 cfs.

4. All controlled releases of water will be screened. This will include installation of ¼-inch wedge-wire screens on all three of the tower intakes and the service intake.

5. The Recovery Program will continue to monitor the escapement of fish from the spillway. The Biology Committee will develop criteria for an escapement threshold that would trigger a decision to screen the spillway and/or curtail stocking into Elkhead Reservoir.

6. Anchors for a spillway net will be installed while the reservoir is drawn down for construction. Future installation of a spillway net will be considered based on results of spillway escapement monitoring and nonnative fish control efforts in the Yampa River.

<u>Lethal removal of channel catfish and small mouth bass from Yampa Canyon</u>

Channel catfish control began in 1998 as a research project (Project 88) to determine if channel catfish populations in Yampa Canyon could be depleted by harvesting. During the study, which was completed in 1999, more than 4,400 catfish, weighing 2,700 pounds, were removed from Yampa Canyon. A variety of gear types and techniques were used, including fyke nets, hoop nets, trot lines, angling and electrofishing. Angling and electrofishing were considered to be the most effective techniques.

As a result of this study, the Recovery Program funded another project (Project 110) beginning in 2001 to continue removing catfish from this reach, which is critical habitat for the humpback chub. During 2001 and 2002, this project removed more than 7,400 channel catfish, with an average length of 284 mm (11 inches). This project will continue through 2005.

The Colorado Division of Wildlife (CDOW) requested that catfish removed from Yampa Canyon be translocated to Kenney Reservoir on the White River east of Rangely, Colorado.

However, trips through Yampa Canyon typically last several days, and the live-well cannot hold all of the catfish captured during this period. Moreover, floating the river during low water is possible only in canoes; under extremely low-water conditions, access to the canyon is limited to hiking. Therefore, channel catfish will no longer be translocated to Kenney Reservoir and will continue to be lethally removed.

Electrofishing catch rates of smallmouth bass have dramatically increased in the Yampa and Green rivers since the late 1990s. This increase in smallmouth bass abundance may exacerbate the negative impacts of nonnatives on the endangered fishes and confound other recovery actions. Concerns for humpback chub and Colorado pikeminnow susceptibility to smallmouth bass predation and competition were raised at the Recovery Program's nonnative fish control workshop in December 2003. Because of the threat posed to endangered and other native fishes in the lower Yampa River by smallmouth bass, lethal removal of smallmouth bass from the same critical habitat reach concurrent with removal of channel catfish has been initiated as part of the Recovery Program's nonnative fish control efforts.

**Restore Habitat (Habitat Development and Maintenance)**

This recovery element includes several different, unrelated actions designed to promote recovery of the endangered fishes:

a. Acquire/enhance floodplain habitats
b. Restore/maintain native fish passage at diversion structures
c. Evaluate/remediate entrainment by diversion structures

Acquire and enhance floodplain habitats along the Green River

The Recovery Program's floodplain program (USDI 1998) is intended to provide suitable nursery habitats for the endangered fishes by acquiring, in fee or by easement, suitable properties within the floodplain of the Green River, among other rivers, and enhancing these properties for the benefit of the endangered fishes. Inducing inundation by releasing large volumes of water from Flaming Gorge Dam on the Green River upstream from the confluence with the Yampa River is either not practicable due to the hydraulic constraints of dam operations or sociologically unacceptable due to potential impacts to life and property (USDI 1998). Although unregulated flows from the Yampa River provide volume and a more natural shape to the Green River hydrograph, additional measures are needed to create and/or enhance floodplain habitats that serve as nurseries for the endangered fishes.

Artificial and natural levees prevent the river from connecting with floodplain areas; breaching levees allows water to enter these depressions at lower peak flows. Some of these areas are located on public land. But some of the best sites are on private land, requiring the consent and cooperation of the landowner(s). The Recovery Program has entered into agreements with and/or acquired rights from willing landowners to protect and enhance floodplain habitat to benefit the endangered fishes (USDI 1998).
The Recovery Program recently developed a floodplain management plan for the Green River subbasin (Valdez and Nelson 2004) to provide restoration and management strategies for

existing floodplain sites. The plan focuses on a 107-mile reach of the Green River between Split Mountain Canyon and Desolation Canyon containing 37 potential floodplain sites totaling 11,400 acres. The plan identifies 16 floodplain sites (up to 4,448 acres) for restoration and management. The Recovery Program has restored and currently manages 6 of these sites (819 acres). The current plan calls for restoration and management at other sites including Stewart Lake Waterfowl Management Area (570 acres) and floodplain habitats Ouray National Wildlife Refuge.

<u>Restore/maintain native fish passage at diversion structures</u>

The Recovery Program has undertaken several studies to determine whether existing diversion structures on the Yampa River within critical habitat impede upstream migration of endangered fishes. Modde et al. (1999) specifically examined the Maybell and Patrick Sweeney diversions in 1996 and 1997. They found that Colorado pikeminnow migrated upstream from their spawning sites on the descending limb of the spring hydrograph when water depths and velocities allowed them to move freely across these structures. These long-distance migrations occurred only immediately before and immediately after spawning. Their movements during the remainder of the year were not constrained by artificial barriers any more than they were by natural barriers, such as shallow riffles. Therefore, no remedial action is required to facilitate fish passage at any existing diversion structures, as currently constructed and operated.

Pursuant to the Green River Action Plan: Yampa and Little Snake rivers, the Recovery Program will provide written guidelines for construction of any new/modified diversions and other structures in critical habitat on the Yampa River to facilitate fish passage and to minimize impacts inherent to their routine maintenance. Guidelines will describe specific parameters for fish passage, such as minimum depth and maximum slope/rise and velocity. The incremental construction cost, if any, will be borne by the Recovery Program if structures were in service on or before January 22, 1988, regardless of whether such modifications allow diversion of more water than they had historically. If structures were placed into service after January 22, 1988, the incremental costs of passage would have to be borne by the project proponents.

<u>Evaluate/remediate entrainment of endangered fishes by diversion structures</u>

The Recovery Program will develop a plan to evaluate entrainment of Colorado pikeminnow in existing diversion canals. This plan will serve the dual purpose of evaluating, as well as minimizing, potential incidental take due to entrainment. If native fish are found to enter irrigation canals or other diversion structures, the Recovery Program initially will salvage any native fish found alive and return them to the river. Unless initial investigations establish that endangered fish do not enter the canals or enter only with very low frequency, the Recovery Program will develop a plan to remediate this potential problem, which could include annual fish salvage operations or installation of fish preclusion devices on the problem structure(s).

**Manage genetic diversity/augment or restore populations**

Maintaining the genetic integrity of wild and captive-reared endangered fishes is important to their recovery and to preventing irreversible losses of genetic diversity. The Recovery Program developed the following genetic management goals: 1) prevent immediate extinction; 2) conserve genetic diversity through recovery efforts that will establish viable wild stocks by removing or significantly reducing factors that caused the population declines; 3) maintain the genetic diversity of captive-reared fish; and 4) produce genetically diverse fish for augmentation efforts (Czapla 1999). However, supplemental stocking with endangered fish propagated from captive brood stocks is not intended to replace natural reproduction and recruitment.

In 1999, the CDOW developed a plan to stock bonytail in the Yampa and Green rivers in Colorado. This stocking plan was revised in 2001 (CDOW 2001). Restoring bonytail through stocking above Lodore Canyon on the Green River and within the lower reaches of the Yampa is a high priority for the CDOW. Stocking began in 2000, with a total of 23,000 juvenile bonytail stocked to date in the Green River near Brown's Park, Colorado, and in the Yampa River near its confluence with the Green River at Echo Park. Both sites are within Dinosaur National Monument (DNM), and stocking is carried out by the CDOW with the cooperation of the National Park Service (NPS). The State of Utah stocks razorback sucker to the Green River below Split Mountain to supplement the Middle Green/Yampa population. This activity also is a high priority for the Recovery Program.

**Monitor Populations and Habitat**

Recovery goals have been published for the four Colorado River endangered fish species (USFWS 2002a-d). They include both population and habitat criteria considered necessary for recovery. Monitoring endangered fish populations, as well as those habitats essential to their recovery, is necessary to determine when populations have recovered to the extent that they may be downlisted to threatened status or delisted (i.e., removed from the list of threatened and endangered species). Conversely, if populations of these species decline, additional recovery actions may be needed or existing actions may need to be modified following an adaptive management process. Monitoring also will provide the Service with information relevant to the criteria established to reinitiate formal section 7 consultation on this proposed action.

The Recovery Program will monitor adult Colorado pikeminnow, razorback sucker and humpback chub populations to ascertain the status of these populations (e.g., numerical abundance, age-class structure, evidence of recruitment), using standardized protocols. Larval sampling will determine whether and to what extent these populations are spawning. Survival of stocked fish also will be assessed. Endangered fish population data will be collected fortuitously during nonnative fish management activities; conversely, the status of nonnative fish populations also can be monitored in conjunction with endangered fish population surveys to make the most efficient use of the Recovery Program's limited resources.

A substantial decline in numbers of nonnatives fishes is presumptive evidence of a benefit to the endangered fishes; however, to confirm that nonnative fish management has, in fact, achieved the desired benefits for native species, it will be necessary to examine populations of the endangered fishes, and/or surrogate native species, such as roundtail chub and flannelmouth sucker, which suffer similar impacts due to competition and predation by nonnatives. An increase in their overall abundance, especially younger, smaller life stages, would be indicative of reproduction, larval survival, and potential recruitment into the adult populations, thereby allowing the endangered fish populations to become self-sustaining.

The Recovery Program initiated an investigation in 2004 to study underlying geomorphic processes relevant to the formation and maintenance of backwater habitats in both the Colorado and Green rivers. The Recovery Program identified priorities for habitat monitoring by summarizing past geomorphic research and conducting workshops to gather information from geomorphologists and biologists. The goal of the workshops was to identify important river reaches and fluvial processes where there is insufficient data to make management decisions. The Yampa River at Deerlodge Park and the Green River at Jensen, Utah, were ranked as high priority among other reaches to begin habitat monitoring. The Recovery Program will coordinate with the U.S. Geological Survey (USGS) to review and compile past data at the priority sites and begin collection of suspended sediment data at USGS stream flow gages on the Green River at Jensen, Utah, and on the Gunnison River at Whitewater, Colorado. Other sediment sampling stations will be added as additional funding becomes available. Based on the results of the USGS data the Recovery Program will design and implement a long-term basin-wide habitat monitoring program.

## STATUS OF THE SPECIES AND CRITICAL HABITAT

### **Colorado Pikeminnow**

#### Species/Critical Habitat Description

The Colorado pikeminnow is the largest cyprinid fish (minnow family) native to North America and evolved as the main predator in the Colorado River system. It is an elongated pike-like fish that during predevelopment times may have grown as large as 6 feet in length and weighed nearly 100 pounds (Behnke and Benson 1983). Today, Colorado pikeminnow rarely exceed 3 feet in length or weigh more than 18 pounds; such fish are estimated to be 45-55 years old (Osmundson et al. 1997). The mouth of this species is large and nearly horizontal with long slender pharyngeal teeth (located in the throat), adapted for grasping and holding prey. The diet of Colorado pikeminnow longer than 3 or 4 inches consists almost entirely of other fishes (Vanicek and Kramer 1969). Males become sexually mature earlier and at a smaller size than do females, though all are mature by about age 7 and 500 mm (20 inches) in length (Vanicek and Kramer 1969, Seethaler 1978, Hamman 1981). Adults are strongly countershaded with a dark, olive back, and a white belly. Young are silvery and usually have a dark, wedge-shaped spot at the base of the caudal fin.

Critical habitat was designated on March 21, 1994 (59 FR 13374) within the historic range of the Colorado River in the following sections of the Yampa and Green rivers:

> Yampa River: The river and its 100-year floodplain from the State Highway 394 bridge in T. 6 N., R. 91 W., section 1 (6th Principal Meridian) to the confluence with the Green River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian).
>
> Green River: The river and its 100 year floodplain from the confluence with the Yampa River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian) to the confluence with the Colorado River in T. 30 S., R. 19 E., section 7 (Salt Lake Meridian).

The Service has identified water, physical habitat, and the biological environment as the primary constituent elements of critical habitat (59 FR 13374). Water includes a quantity of water of sufficient quality delivered to a specific location in accordance with a hydrologic regime required for the particular life stage for each species. The physical habitat includes areas of the Colorado River system that are inhabited or potentially habitable for use in spawning and feeding, as a nursery, or serve as corridors between these areas. In addition, oxbows, backwaters, and other areas in the 100-year floodplain, when inundated, provide access to spawning, nursery, feeding, and rearing habitats. Food supply, predation, and competition are important elements of the biological environment.

Status and Distribution

Based on early fish collection records, archaeological finds, and other observations, the Colorado pikeminnow was once found throughout warmwater reaches of the entire Colorado River Basin down to the Gulf of California, and including reaches of the upper Colorado River and its major tributaries, the Green River and its major tributaries, and the Gila River system in Arizona (Seethaler 1978). Colorado pikeminnow apparently were never found in colder, headwater areas. The species was abundant in suitable habitat throughout the entire Colorado River Basin prior to the 1850s (Seethaler 1978). By the 1970s they were extirpated from the entire lower basin (downstream of Glen Canyon Dam) and portions of the upper basin as a result of major alterations to the riverine environment. Having lost some 75 to 80 percent of its former range due to habitat loss, the Colorado pikeminnow was federally listed as an endangered species in 1967 (Miller 1961, Moyle 1976, Tyus 1991, Osmundson and Burnham 1998). Full protection under the Act of 1973, occurred on January 4, 1974.

Colorado pikeminnow are presently restricted to the Upper Colorado River Basin and inhabit warmwater reaches of the Colorado, Green, and San Juan rivers and associated tributaries. The Colorado pikeminnow recovery goals (USFWS 2002a) identify occupied habitat of wild Colorado pikeminnow as follows: the Green River from Lodore Canyon to the confluence of the Colorado River; the Yampa River downstream of Craig, Colorado; the Little Snake River from its confluence with the Yampa River upstream into Wyoming; the White River downstream of Taylor Draw Dam; the lower 89 miles of the Price River; the lower Duchesne River; the upper Colorado River from Palisade, Colorado, to Lake Powell; the lower 34 miles of the Gunnison River; the lower mile of the Dolores River; and 150 miles of the San Juan River downstream from Shiprock, New Mexico, to Lake Powell. Table 3 summarizes the present distribution of Colorado pikeminnow in the Green River subbasin.

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

Major declines of native fishes first occurred in the lower basin where large dams were constructed from the 1930s through the 1960s. In the upper basin, the following major dams were not constructed until the 1960s: Glen Canyon Dam on the mainstem Colorado River, Flaming Gorge Dam on the Green River, Navajo Dam on the San Juan River, and the Aspinall Unit Dams on the Gunnison River. To date, some native fish populations in the Upper Basin have managed to persist, while others have become nearly extirpated. River segments where native fish have declined more slowly than in other areas are those where the hydrologic regime most closely resembles the natural condition, such as the Yampa River, where adequate habitat for important life phases still exists, and where migration corridors are unblocked and allow connectivity among life phases.

Table 3. Present Distribution of Colorado pikeminnow Green River subbasin (USFWS 2002a)

| River | Occupied Habitat/Rivermiles | Limits of Distribution |
|---|---|---|
| Green | Lodore Canyon to Colorado River confluence (360 RM) | Releases from Flaming Gorge Dam have been warmed and species has naturally expanded upstream into Lodore Canyon; species distributed downstream to Colorado River confluence. |
| **Yampa** | **Craig, CO, to Green River confluence (141 RM)** | **Present distribution similar to historic.** |
| **Little Snake** | **Wyoming to Yampa River confluence (50 RM.)** | **Habitat is marginal; flows are reduced; historic distribution unknown.** |
| White | Taylor Draw Dam to Green River confluence (62 RM) | Upstream distribution blocked by Taylor Draw Dam. |
| Price | Lower 89 RM above Green River confluence | Streamflow reduced; barriers occur above current distribution. |
| Duchesne | Lower 6 RM above Green River confluence | Streamflow reduced; barriers occur above current distribution. |

Threats to the Species

The primary threats to Colorado pikeminnow are stream flow regulation and habitat modification; competition with and predation by nonnative fishes; and pesticides and pollutants (USFWS 2002a). The existing habitat, altered by these threats, has been modified to the extent that it impairs essential behavior patterns, such as breeding, feeding, and sheltering. These impairments are described in further detail below.

Stream flow regulation includes main stem dams that cause the following adverse effects to Colorado pikeminnow and its habitat:

1. block migration corridors
2. changes in flow patterns, reduced peak flows and increased base flows
3. release cold water, making temperature regimes less than optimal
4. change river habitat into lake habitat
5. retain sediment that is important for forming and maintaining backwater habitats

In the Upper Basin, 435 miles of Colorado pikeminnow habitat has been lost by reservoir inundation from Flaming Forge Reservoir on the Green River, Lake Powell on the Colorado River, and Navajo Reservoir on the San Juan River. Cold water releases from these dams have eliminated suitable habitat for native fishes, including Colorado pikeminnow, from river reaches downstream for approximately 50 miles below Flaming Gorge Dam and Navajo Dam. In addition to main stem dams, many dams and water diversion structures occur in and upstream from critical habitat that reduce flows and alter flow patterns, which adversely affect critical habitat. Diversion structures in critical habitat divert fish into canals and pipes where the fish are permanently lost to the river system. It is unknown how many endangered fish are lost in irrigation systems, but in some years, in some river reaches, majority of the river flow is diverted into unscreened canals. High spring flows maintain habitat diversity, flush sediments from spawning habitat, increase invertebrate food production, form gravel and cobble deposits important for spawning, and maintain backwater nursery habitats (McAda 2000; Muth et al. 2000). Peak spring flows in the Green River at Jensen, Utah, have decreased 13–35 percent and base flows have increased 10–140 percent due to regulation by Flaming Gorge Dam (Muth et al. 2000).

Predation and competition from nonnative fishes have been clearly implicated in the population reductions or elimination of native fishes in the Colorado River Basin (Dill 1944, Osmundson and Kaeding 1989, Behnke 1980, Joseph et al. 1977, Lanigan and Berry 1979, Minckley and Deacon 1968, Meffe 1985, Propst and Bestgen 1991, Rinne 1991). Data collected by Osmundson and Kaeding (1991) indicated that during low water years nonnative minnows capable of preying on or competing with larval endangered fishes greatly increased in numbers. More than 50 nonnative fish species were intentionally introduced in the Colorado River Basin prior to 1980 for sportfishing, forage fish, biological control and ornamental purposes (Minckley 1982, Tyus et al. 1982, Carlson and Muth 1989). Nonnative fishes compete with native fishes in several ways. The capacity of a particular area to support aquatic life is limited by physical habitat conditions. Increasing the number of species in an area usually results in a smaller population of most species. The size of each species population is controlled by the ability of each life stage to compete for space and food resources and to avoid predation. Some life stages of nonnative fishes appear to have a greater ability to compete for space and food and to avoid predation in the existing altered habitat than do some life stages of native fishes. Tyus and Saunders (1996) cite numerous examples of both indirect and direct evidence of predation on razorback sucker eggs and larvae by nonnative species.

Threats from pesticides and pollutants include accidental spills of petroleum products and hazardous materials; discharge of pollutants from uranium mill tailings; and high selenium concentration in the water and food chain (USFWS 2002a). Accidental spills of hazardous material into critical habitat can cause immediate mortality when lethal toxicity levels are exceeded. Pollutants from uranium mill tailings cause high levels of ammonia that exceed water quality standards. High selenium levels may adversely affect reproduction and recruitment (Hamilton and Wiedmeyer 1990; Stephens et al. 1992; Hamilton and Waddell 1994; Hamilton et al. 1996; Stephens and Waddell 1998; Osmundson et al. 2000a).

Life History

The following excerpt from the Colorado pikeminnow recovery goals (USFWS 2002a) provides a summary of Colorado pikeminnow life history.

> The Colorado pikeminnow is a long-distance migrator; adults move hundreds of miles to and from spawning areas, and require long sections of river with unimpeded passage. Adults require pools, deep runs, and eddy habitats maintained by high spring flows. These high spring flows maintain channel and habitat diversity, flush sediments from spawning areas, rejuvenate food production, form gravel and cobble deposits used for spawning, and rejuvenate backwater nursery habitats. Spawning occurs after spring runoff at water temperatures typically between 18 and 23 °C. After hatching and emerging from spawning substrate, larvae drift downstream to nursery backwaters that are restructured by high spring flows and maintained by relatively stable base flows. Flow recommendations have been developed that specifically consider flow-habitat relationships in habitats occupied by Colorado pikeminnow in the upper basin, and were designed to enhance habitat complexity and to restore and maintain ecological processes. The following is a description of observed habitat uses in the Upper Colorado River Basin.
>
> Colorado pikeminnow live in warm-water reaches of the Colorado River mainstem and larger tributaries, and require uninterrupted stream passage for spawning migrations and dispersal of young. The species is adapted to a hydrologic cycle characterized by large spring peaks of snow-melt runoff and low, relatively stable base flows. High spring flows create and maintain in-channel habitats, and reconnect floodplain and riverine habitats, a phenomenon described as the spring flood-pulse (Junk et al. 1989; Johnson et al. 1995). Throughout most of the year, juvenile, subadult, and adult Colorado pikeminnow use relatively deep, low-velocity eddies, pools, and runs that occur in nearshore areas of main river channels (Tyus and McAda 1984; Valdez and Masslich 1989; Tyus 1990, 1991; Osmundson et al. 1995). In spring, however, Colorado pikeminnow adults use floodplain habitats, flooded tributary mouths, flooded side

canyons, and eddies that are available only during high flows (Tyus 1990, 1991; Osmundson et al. 1995). Such environments may be particularly beneficial for Colorado pikeminnow because other riverine fishes gather in floodplain habitats to exploit food and temperature resources, and may serve as prey. Such low-velocity environments also may serve as resting areas for Colorado pikeminnow. River reaches of high habitat complexity appear to be preferred.

Because of their mobility and environmental tolerances, adult Colorado pikeminnow are more widely distributed than other life stages. Distribution patterns of adults are stable during most of the year (Tyus 1990, 1991; Irving and Modde 2000), but distribution of adults changes in late spring and early summer, when most mature fish migrate to spawning areas (Tyus and McAda 1984; Tyus 1985, 1990, 1991; Irving and Modde 2000). High spring flows provide an important cue to prepare adults for migration and also ensure that conditions at spawning areas are suitable for reproduction once adults arrive. Specifically, bankfull or much larger floods mobilize coarse sediment to build or reshape cobble bars, and they create side channels that Colorado pikeminnow sometimes use for spawning (Harvey et al. 1993).

Colorado pikeminnow spawning sites in the Green River subbasin have been well documented. The two principal locations are in Yampa Canyon on the lower Yampa River and in Gray Canyon on the lower Green River (Tyus 1990, 1991). These reaches are 42 and 72 km long, respectively, but most spawning is believed to occur at one or two short segments within each of the two reaches. Another spawning area may occur in Desolation Canyon on the lower Green River (Irving and Modde 2000), but the location and importance of this area has not been verified. Although direct observation of Colorado pikeminnow spawning was not possible because of high turbidity, radiotelemetry indicated spawning occurred over cobble-bottomed riffles (Tyus 1990). High spring flows and subsequent post-peak summer flows are important for construction and maintenance of spawning substrates (Harvey et al. 1993). In contrast with the Green River subbasin, where known spawning sites are in canyon-bound reaches, currently suspected spawning sites in the upper Colorado River subbasin are at six locations in meandering, alluvial reaches (McAda 2000).

After hatching and emerging from the spawning substrate, Colorado pikeminnow larvae drift downstream to backwaters in sandy, alluvial regions, where they remain through most of their first year of life (Holden 1977; Tyus and Haines 1991; Muth and Snyder 1995). Backwaters and the physical factors that create them are vital to successful recruitment of early life stages of Colorado pikeminnow, and age-0 Colorado pikeminnow in backwaters have received much research attention (e.g., Tyus and Karp 1989; Haines and Tyus 1990; Tyus 1991; Tyus and Haines 1991; Bestgen et al. 1997). It is important to note that these backwaters are formed after cessation of spring runoff within the active channel and are not floodplain features. Colorado pikeminnow larvae occupy these in-channel backwaters soon after hatching. They tend to occur in backwaters that are large, warm, deep (average, about 0.3 m in the Green River), and turbid (Tyus and Haines 1991). Recent research (Day et al. 1999a, 1999b; Trammell and Chart 1999) has confirmed these preferences and suggested that a particular type of backwater is preferred by Colorado pikeminnow larvae and juveniles. Such backwaters are created when a secondary channel is cut off at the upper end, but remains connected to the river at the downstream end. These chute channels are deep and may persist even when discharge levels change dramatically. An optimal river-reach environment for growth and survival of early life stages of Colorado pikeminnow has warm, relatively stable backwaters, warm river channels, and abundant food (Muth et al. 2000).

Population Dynamics

Preliminary population estimates presented in the Recovery Goals (USFWS 2002a) for the three Colorado pikeminnow populations (Green River Subbasin, Upper Colorado River Subbasin, San Juan River Subbasin) ranged from 6,600 to 8,900 wild adults. These numbers provided a general indication of the total wild adult population size at the time the Recovery Goals were developed, however, it was also recognized that the accuracy of the estimates vary among populations. Monitoring of Colorado pikeminnow populations is ongoing, and sampling protocols and the reliability of the population estimates are being assessed by the Service and cooperating entities. A recent draft report on the status of Colorado pikeminnow in the Green River Basin (Bestgen et al. 2004) presented population estimates for adult (>450 mm total length (TL)) and recruit-sized (400 – 449 mm TL) Colorado pikeminnow. The Service recognizes that at this time, the report is draft and the analysis of the data is preliminary, however, the Service finds this is the best scientific information available regarding current population status in the Green River Basin. The draft report suggests that over the study period (2001 to 2003) there was a decline in abundance of Colorado pikeminnow in the Green River Basin from 3,338 (95 percent confidence interval, 2815 to 3861) animals in 2001 to 2,324 (95 percent confidence interval 1395 to 3252) animals in 2003. In the Yampa River estimates of adult abundance declined from 322 animals in 2000 to 250 animals in 2003. Adult abundance estimates in the White River declined from 1,115 animals in 2000 to 465 animals in 2003 and recruit-sized estimates declined from 44 animals in 2000 to zero in 2003. In the middle Green River (Yampa River confluence to Desolation Canyon) abundance estimates for adults ranged from 1,629 animals in 2000 to 747 animals in 2003 and estimates of abundance of recruit-sized fish ranged from 103 animals in 2000 to 50 animals in 2003. Estimates for the Desolation-Gray Canyon reach of the Green River ranged from 681 adults in 2001 to 585 adults in 2003 and recruit-sized estimates ranged from 162 animals in 2001 to 64 animals in 2003. In the lower Green River (Green River, Utah to the confluence of the Colorado River) abundance estimates were 366 adults in 2001 and 273 adults in 2003 and recruit-sized estimates ranged from 70 in 2001 to 104 in 2003. Studies indicate that significant recruitment of Colorado pikeminnow may not occur every year, but occurs in episodic intervals of several years (Osmundson and Burnham 1998).

The demographic criteria for the Green River subbasin presented in the Recovery Goals for removing Colorado pikeminnow from the endangered species list is a self-sustaining, reproducing population of more than 2,600 adults. The estimated minimum viable population needed to ensure long-term genetic and demographic viability is 2,600 self-sustaining, reproducing adults (USFWS 2002a).

The estimate of adult Colorado pikeminnow associated with the spawning site in Yampa Canyon in the lower 32 km of the Yampa River is approximately 1,400 fish. The estimate for the Three

Fords spawning site in Gray Canyon in the lower Green River is approximately 1,000 adults (Crowl and Bouwes 1998). Because some Colorado pikeminnow from the Green River migrate into the Yampa River to spawn, the Colorado pikeminnow in the Yampa River are considered part of the Green River subbasin population.

All life stages of Colorado pikeminnow in the Green River demonstrate wide variations in abundance at seasonal, annual, or longer time scales, but reasons for shifts in abundance are poorly understood. Bestgen et al. (1998) captured drifting larvae produced from the two main spawning areas in the Green River system and found order-of-magnitude differences in abundance from year to year. They reported that low- or high-discharge years were often associated with poor reproduction but could not ascribe a specific cause-effect mechanism (Bestgen et al. 1998). In general, similar numbers of age-0 fish were found in autumn in the middle Green River, in spite of different-sized cohorts of larvae produced each summer in the Yampa River. Conversely, numbers of Colorado pikeminnow larvae produced in the lower Green River were similar among years but resulted in variable age-0 fish abundance in autumn.

Status of Colorado pikeminnow and Critical Habitat in the Action Area

The Colorado pikeminnow is a year-round resident of the Yampa and Green rivers, and occurs seasonally in the Little Snake River (Marsh et al. 1991; Wick et al. 1991). Spawning habitat in the Yampa River below the confluence with the Little Snake River is one of the known spawning sites in the Green River subbasin and has been identified as important habitat for Colorado pikeminnow (Bestgen et al. 1998, Tyus 1990).

In the Green River Basin, radio-telemetry studies have shown that distribution of adults changes in late spring and early summer when most mature fish migrate to spawning areas in the lower Yampa River in Yampa Canyon and the lower Green River in Gray Canyon (Tyus and McAda 1984; Tyus 1985; Tyus 1990; Tyus 1991; Irving and Modde 2000). Those fish remain in spawning areas for 3–8 weeks before returning to home ranges. Because adult Colorado pikeminnow converge on spawning areas from throughout the Green River system to reproduce at these two known localities, migration cues are an important part of the reproductive life history. In general, adults begin migrating in late spring or early summer. Migrations began earlier in low-flow years and later in high-flow years (Tyus and Karp 1989; Tyus 1990; Irving and Modde 2000). Migrations to the Yampa River spawning area occur coincident with, and up to 4 weeks after, peak spring runoff when water temperatures are usually 14–16 $^{o}$C (Tyus 1990; Irving and Modde 2000). Rates of movement for individuals are not precisely known, but 2 individuals made the approximately 400 km migration from the White River below Taylor Draw Dam to the Yampa River spawning area in less than 2 weeks. Alteration of the natural hydrograph may alter the environmental cues triggering these spawning migrations.

High magnitude flows of infrequent occurrence are necessary to create and maintain spawning habitat. Infrequent intense flooding redistributes and creates spawning bars (O'Brien 1984). Annual lower-level flooding followed by recessional flows dissect and secondarily redistribute gravels, preparing them for spawning (Harvey et al. 1993). These studies conducted at a known spawning location in Yampa Canyon show that both processes are important for habitat maintenance and activities that reduce or re-time the annual peak or reduce the frequency of high magnitude flows are likely to reduce essential spawning habitat in amount and quality.

Similar to adults, distribution of early life stages of Colorado pikeminnow is dynamic on a seasonal basis and linked to habitat in the mainstem Green River downstream of spawning areas. After hatching and emergence from spawning substrate, larvae are dispersed downstream. A larva may drift for only a few days, but larvae occur in main channels of the Yampa and Green rivers for 3–8 weeks depending on length of the annual reproductive period (Nesler et al. 1988; Tyus and Haines 1991; Bestgen et al. 1998). The Yampa River spawning area consistently produces more larvae than the spawning area in the lower Green River (Bestgen et al. 1998).

Currently, two primary reaches of Colorado pikeminnow nursery habitat are present in the Green River system. The upper one occurs from near Jensen, Utah, downstream to the Duchesne River confluence. The lower one occurs from near Green River, Utah, downstream to the Colorado River confluence (Tyus and Haines 1991; McAda et al. 1994a; McAda et al. 1994b; McAda et al. 1997). Larvae from the lower Yampa River are thought to mostly colonize backwaters in alluvial valley reaches between Jensen, Utah, and the Ouray National Wildlife Refuge. Most floodplain habitat along the current-day Green River is concentrated in this reach. Although the density of age-0 fish in autumn was usually higher in the lower than in the middle Green River (Tyus and Haines 1991; McAda et al. 1994a), differences in habitat quantity may have confounded abundance estimates. The reach of the Green River defined mostly by Desolation and Gray Canyons also provides nursery habitat for Colorado pikeminnow (Tyus and Haines 1991; Day et al. 1999b). These backwaters are especially important during the Colorado pikeminnow's critical first year of life.

Backwaters and physical factors that create them are vital to successful recruitment of early life stages of Colorado pikeminnow. Occasional very high spring flows are needed to transport sediment and maintain or increase channel complexity. Sediment transport from the Little Snake River provides an estimated 60 percent of the total sediment supply to the Green River and is important to maintain equilibrium channel morphology and ensure continued creation and maintenance of backwater nursery habitats for Colorado pikeminnow and humpback chub (Hawkins and O'Brien 2001). During high-discharge events, the elevation of sand bars increases and if high flows persist through summer, few backwaters are formed (Tyus and Haines 1991). Post-runoff low flows sculpt and erode sand bars and create complex backwater habitat critical for early life stages of all native fishes, particularly Colorado pikeminnow. Deeper, chute-channel backwaters are preferred by age-0 Colorado pikeminnow in the Green River (Tyus and Haines 1991; Day and Crosby 1997, Day et al. 1999a; Trammell and Chart 1999). Alterations to the amount and timing of flows defining the natural hydrology and sediment transport processes may inhibit the processes that create and maintain these habitats.

Past research indicated that certain discharge levels may optimize backwater habitat availability below Jensen for age-0 Colorado pikeminnow (Pucherelli et al. 1990; Tyus and Haines 1991; Tyus and Karp 1991). However, many geomorphic processes are dynamic over time and driven by the level of spring flows, the frequency of large floods, and post-peak discharge levels (Bell et al. 1998; Rakowski and Schmidt 1999). Consequently, flows to achieve optimum backwater availability may be different each year and dependent upon year-to-year bar topography (Rakowski and Schmidt 1999).

## **Razorback Sucker**

Species/Critical Habitat Description

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

Critical habitat was designated in 1994 within the 100-year floodplain of the razorback sucker's historical range in the following area of the upper Colorado River (59 F.R. 13374). The primary constituent elements are the same as critical habitat for Colorado pikeminnow described above.

> Colorado: Moffat County. The Yampa River and its 100-year floodplain from the mouth of Cross Mountain Canyon in T. 6 N., R. 98 W., section 23 (6th Principal Meridian) to the confluence with the Green River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian).
>
> Utah: Uintah County; and Colorado: Moffat County. The Green River and its 100-year floodplain from the confluence with the Yampa River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian) to Sand Wash in T. 11 S., R. 18 E., section 20 (6th Principal Meridian).
>
> Utah: Uintah, Carbon, Grand, Emery, Wayne, and San Juan Counties. The Green River and its 100-year floodplain from Sand Wash at river mile 96 at T. 11 S., R. 18 E., section 20 (6th Principal Meridian) to the confluence with the Colorado River in T. 30 S., R. 19 E., section 7 (6th Principal Meridian).

Status and Distribution

On March 14, 1989, the Service was petitioned to conduct a status review of the razorback sucker. Subsequently, the razorback sucker was designated as endangered under a final rule published on October 23, 1991 (56 FR 13374). The final rule stated "Little evidence of natural recruitment has been found in the past 30 years, and numbers of adult fish captured in the last 10 years demonstrate a downward trend relative to historic abundance. Significant changes have occurred in razorback sucker habitat through diversion and depletion of water, introduction of nonnative fishes, and construction and operation of dams" (56 F.R. 13374). Recruitment of razorback suckers to the population continues to be a problem.

Historically, razorback suckers were found in the mainstem Colorado River and major tributaries in Arizona, California, Colorado, Nevada, New Mexico, Utah, Wyoming, and in Mexico (Ellis 1914; Minckley 1983). Bestgen (1990) reported that this species was once so numerous that it was commonly used as food by early settlers and, further, that commercially marketable quantities were caught in Arizona as recently as 1949. In the Upper Basin, razorback suckers were reported in the Green River to be very abundant near Green River, Utah, in the late 1800s (Jordan 1891). An account in Osmundson and Kaeding (1989) reported that residents living along the Colorado River near Clifton, Colorado, observed several thousand razorback suckers during spring runoff in the 1930s and early 1940s. In the San Juan River drainage, Platania and Young (1989) relayed historical accounts of razorback suckers ascending the Animas River to Durango, Colorado, around the turn of the century.

A marked decline in populations of razorback suckers can be attributed to construction of dams and reservoirs, introduction of nonnative fishes, and removal of large quantities of water from the Colorado River system. Dams on the mainstem Colorado River and its major tributaries have segmented the river system, blocked migration routes, and changed river habitat into lake habitat. Dams also have drastically altered flows, temperatures, and channel geomorphology. These changes have modified habitats in many areas so that they are no longer suitable for breeding, feeding, or sheltering. Major changes in species composition have occurred due to the introduction of numerous nonnative fishes, many of which have thrived due to human-induced changes to the natural riverine system. These nonnative fishes prey upon and compete with razorback suckers.

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

In the Upper Colorado River Basin, above Glen Canyon Dam, razorback suckers are found in limited numbers in both lentic (lake-like) and riverine environments. The largest populations of razorback suckers in the upper basin are found in the upper Green and lower Yampa rivers (Tyus 1987). In the Colorado River, most razorback suckers occur in the Grand Valley area near Grand Junction, Colorado; however, they are increasingly rare. Osmundson and Kaeding (1991) reported that the number of razorback sucker captures in the Grand Junction area has declined dramatically since 1974. Between 1984 and 1990, intensive collecting effort captured only 12 individuals in the Grand Valley (Osmundson and Kaeding 1991). The wild population of razorback sucker is considered extirpated from the Gunnison River (Burdick and Bonar 1997).

Table 4. Present distribution of razorback sucker in the Green River subbasin (USFWS 2002b)

| River | Occupied Habitat/Rivermiles | Limits of Distribution |
|---|---|---|
| Green | Lodore Canyon to Colorado River confluence (360 RM): ~100 adults from Yampa River to Duchesne River; population augmentation ongoing. | Coldwater releases from Flaming Gorge Dam previously restricted distribution; warmed releases may allow for range expansion upstream into historic habitat. |
| **Yampa** | **Craig, CO to Green River confluence (141 RM); few wild fish remaining.** | **Present in low numbers in historic habitat.** |
| White | Taylor Draw Dam to Green River (62 RM.); few wild fish remaining. | Found in low numbers; distribution upstream blocked by Taylor Draw Dam. |
| Duchesne | Lower 1.2 RM above Green River; few wild fish remaining. | Found as small aggregations at river mouth during spring runoff. |

Razorback suckers are in imminent danger of extirpation in the wild. As Bestgen (1990) pointed out:

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

The virtual absence of any recruitment suggests a combination of biological, physical, and/or chemical factors that may be affecting the survival and recruitment of early life stages of razorback suckers. Within the Upper Basin, recovery efforts endorsed by the Recovery Program include the capture and removal of razorback suckers from all known locations for genetic analyses and development of discrete brood stocks. These measures have been undertaken to develop refugia populations of the razorback sucker from the same genetic parentage as their wild counterparts such that, if these fish are genetically unique by subbasin or individual population, then separate stocks will be available for future augmentation. Such augmentation may be a necessary step to prevent the extinction of razorback suckers in the Upper Basin.

Threats to the Species

The primary threats to razorback sucker are stream flow regulation and habitat modification; competition with and predation by nonnative fishes; and pesticides and pollutants (USFWS 2002b). The existing habitat, altered by these threats, has been modified to the extent that it impairs essential behavior patterns, such as breeding, feeding, and sheltering. The threats to razorback sucker are essentially the same threats identified for Colorado pikeminnow.

Life History

McAda and Wydoski (1980) and Tyus (1987) reported springtime aggregations of razorback suckers in off-channel habitats and tributaries; such aggregations are believed to be associated with reproductive activities. Tyus and Karp (1990) and Osmundson and Kaeding (1991) reported off-channel habitats to be much warmer than the mainstem river and that razorback suckers presumably moved to these areas for feeding, resting, sexual maturation, spawning, and other activities associated with their reproductive cycle. Prior to construction of large mainstem dams and the suppression of spring peak flows, low velocity, off-channel habitats (seasonally flooded bottomlands and shorelines) were commonly available throughout the Upper Basin (Tyus and Karp 1989; Osmundson and Kaeding 1991). Dams changed riverine ecosystems into lakes by impounding water, which eliminated these off-channel habitats in reservoirs. Reduction in spring peak flows eliminates or reduces the frequency of inundation of off-channel habitats. The absence of these seasonally flooded riverine habitats is believed to be a limiting factor in the successful recruitment of razorback suckers in their native environment (Tyus and Karp 1989; Osmundson and Kaeding 1991). Wydoski and Wick (1998) identified starvation of larval razorback suckers due to low zooplankton densities in the main channel and loss of floodplain habitats which provide adequate zooplankton densities for larval food as one of the most important factors limiting recruitment.

While razorback suckers have never been directly observed spawning in turbid riverine environments within the Upper Basin, captures of ripe specimens (in spawning condition), both males and females, have been recorded (Valdez et al. 1982a; McAda and Wydoski 1980; Tyus 1987; Osmundson and Kaeding 1989; Tyus and Karp 1989; Tyus and Karp 1990; Osmundson and Kaeding 1991; Platania 1990) in the Yampa, Green, Colorado, and San Juan rivers. Sexually mature razorback suckers are generally collected on the ascending limb of the hydrograph from mid-April through June and are associated with coarse gravel substrates (depending on the specific location).

Outside of the spawning season, adult razorback suckers occupy a variety of shoreline and main channel habitats including slow runs, shallow to deep pools, backwaters, eddies, and other relatively slow velocity areas associated with sand substrates (Tyus 1987; Tyus and Karp 1989; Osmundson and Kaeding 1989; Valdez and Masslich 1989; Osmundson and Kaeding 1991; Tyus and Karp 1990).

Habitat requirements of young and juvenile razorback suckers in the wild are not well known, particularly in native riverine environments. Prior to 1991, the last confirmed documentation of a razorback sucker juvenile in the Upper Basin was a capture in the Colorado River near Moab, Utah (Taba et al. 1965). In 1991, two early juvenile (36.6 and 39.3 mm total length (TL)) razorback suckers were collected in the lower Green River near Hell Roaring Canyon (Gutermuth et al. 1994). Juvenile razorback suckers have been collected in recent years from Old Charley Wash, a wetland adjacent to the Green River (Modde 1996). Between 1992 and 1995 larval razorback suckers were collected in the middle and lower Green River and within the Colorado River inflow to Lake Powell (Muth 1995). In 2002, eight larval razorback suckers were collected in the Gunnison River (Osmundson 2002b). No young razorback suckers have been collected in recent times in the Colorado River.

Population Dynamics

The largest concentration of razorback suckers in the Upper Basin exists in low-gradient flat-water reaches of the middle Green River between and including the lower few miles of the Duchesne River and the Yampa River (Tyus 1987; Tyus and Karp 1990; Muth 1995; Modde and Wick 1997; Muth et al. 2000). This area includes the greatest expanse of floodplain habitat in the Upper Colorado River Basin, between Pariette Draw at river mile (RM) 238 and the Escalante Ranch at RM 310 (Irving and Burdick 1995).

Lanigan and Tyus (1989) used a demographically closed model with capture-recapture data collected from 1980 to 1988 and estimated that the middle Green River population consisted of about 1,000 adults (mean, 948; 95 percent confidence interval, 758–1,138). Based on a demographically open model and capture-recapture data collected from 1980 to 1992, Modde et al. (1996) estimated the number of adults in the middle Green River population at about 500 fish (mean, 524; 95 percent confidence interval, 351–696). That population had a relatively constant length frequency distribution among years (most frequent modes were in the 505–515 mm-TL interval) and an estimated annual survival rate of 71 percent. Bestgen et al. (2002) estimated the current population of wild razorback sucker in the middle Green River to be about 100, based on data collected in 1998 and 1999

There are no current population estimates of razorback sucker in the Yampa River due to low numbers captured in recent years.

Status of Razorback Sucker and Critical Habitat in the Action Area

The lower Yampa River provides adult habitat, spawning habitat, and potential nursery areas occur downstream in the Green River (USFWS 1998). Modde and Smith (1995) reported that adult razorback suckers were collected between RM 13 and RM 0.1 of the Yampa River. They also reported only one juvenile razorback sucker has been collected in the Yampa River. The single fish (389 mm) was collected at RM 39 in June 1994. The Green River from the confluence with the Yampa River to Sand Wash has the largest existing riverine population of razorback sucker (Lanigan and Tyus 1989, Modde et al. 1996). Razorback suckers are rarely found upstream as far as the confluence with the Little Snake River (McAda and Wydoski 1980 and Lanigan and Tyus 1989). Tyus and Karp (1990) located concentrations of ripe razorback suckers at the mouth of the Yampa River during the spring in 1987-1989. Ripe fish were captured in runs associated with bars of cobble, gravel, and sand substrates in water averaging 0.63 m deep and mean velocity of 0.74 m/s.

Razorback suckers are permanent residents of the Green River below its confluence with the Yampa River and are reliant on in-channel habitat for spawning and flooded off-channel habitats for several aspects of their life history. In turn, these habitats are created and maintained by the natural hydrology and sediment transport provided by the Yampa River.

Spring migrations by adult razorback suckers were associated with spawning in historic accounts (Jordan 1891; Hubbs and Miller 1953; Sigler and Miller 1963; Vanicek 1967), and a variety of local and long-distance movements and habitat-use patterns have been subsequently documented. Spawning migrations (one-way movements of 30.4–106.0 km) observed by Tyus and Karp (1990) included movements between the Ouray and Jensen areas of the Green River and between the Jensen area and the lower Yampa River. Initial movement of adult razorback suckers to spawning sites was influenced primarily by increases in river discharge and secondarily by increases in water temperature (Tyus and Karp 1990; Modde and Wick 1997; Modde and Irving 1998). Flow and temperature cues may serve to effectively congregate razorback suckers at spawning sites, thus increasing reproductive efficiency and success. Reduction in spring peak flows may hinder the ability of razorback suckers to form spawning aggregations, because spawning cues are reduced (Modde and Irving 1998).

Captures of ripe fish and radio-telemetry of adults in spring and early summer were used to locate razorback sucker spawning areas in the middle Green River. McAda and Wydoski (1980) found a spawning aggregation of 14 ripe fish (2 females and 12 males) over a cobble bar at the mouth of the Yampa River during a 2-week period in early to mid-May 1975. These fish were collected from water about 1 m deep with a velocity of about 1 m/s and temperatures ranging from 7 to 16 °C (mean, 12 °C). Tyus (1987) captured ripe razorback suckers in three reaches: 1) Island and Echo parks of the Green River in Dinosaur National Monument, including the lower mile of the Yampa River; 2) the Jensen area of the Green River from Ashley Creek (RM 299) to Split Mountain Canyon (RM 319); and 3) the Ouray area of the Green River, including the lower few miles of the Duchesne River. The Jensen area contributed 73 percent of the 60 ripe razorback suckers caught over coarse sand substrates or in the vicinity of gravel and cobble bars in those 3 reaches during spring 1981, 1984, and 1986.

Recently, tuberculate or ripe razorback suckers have been collected from reaches of the lower Green River in Labyrinth Canyon near the mouth of the San Rafael River at RM 97 (Tyus 1987, Miller and Hubert 1990, Muth 1995, Chart et al. 1999). Muth et al. (1998) suggested that many of the 439 razorback sucker larvae collected from the lower Green River between RM 28 and 97 during spring and early summer 1993–1996 had been spawned downstream of RM 110 (lower end of the Green River Valley reach), possibly near the mouth of the San Rafael River.

Substantial numbers of razorback sucker adults have been found in flooded off-channel habitats in the vicinity of mid-channel spawning bars shortly before or after spawning. Tyus (1987) located concentrations of ripe fish associated with warm floodplain habitats and in shallow eddies near the mouths of tributary streams. Similarly, Holden and Crist (1981) reported capture of 56 adult razorback suckers in the Ashley Creek-Jensen area of the middle Green River from 1978 to 1980, and about 19 percent of all ripe or tuberculate razorback suckers collected during 1981–1989 ($N = 57$) were from flooded lowlands (e.g., Old Charlie Wash and Stewart Lake Drain) and tributary mouths (e.g., Duchesne River and Ashley Creek) (Tyus and Karp 1990). Radio-telemetry and capture-recapture data compiled by Modde and Wick (1997) and Modde and Irving (1998) demonstrated that most razorback sucker adults in the middle Green River moved into flooded environments (e.g., floodplain habitats and tributary mouths) soon after spawning. Tyus and Karp (1990, 1991) and Modde and Wick (1997) suggested that use of warmer, more productive flooded habitats by adult razorback suckers during the breeding season is related to temperature preferences (23–25 °C; Bulkley and Pimental 1983) and abundance of appropriate foods (Jonez and Sumner 1954; Vanicek 1967; Marsh 1987; Mabey and Shiozawa 1993; Wolz and Shiozawa 1995; Modde 1997; Wydoski and Wick 1998). Twelve ripe razorback suckers were caught in Old Charlie Wash during late May–early June 1986, presumably due to the abundant food in the wetland (Tyus and Karp 1991). Eight adult razorback suckers collected from Old Charlie Wash in late summer 1995 entered the wetland when it was connected to the river during peak spring flows (Modde 1996). Reduced spring flooding caused by lower regulated river discharges, channelization, and levee construction has restricted access to floodplain habitats used by adult razorback suckers for temperature conditioning, feeding, and resting (Tyus and Karp 1990; Modde 1997; Modde and Wick 1997; Wydoski and Wick 1998). The fact that these fish actively seek out this habitat suggests that the conditioning it provides them is important to their continued successful reproduction.

Razorback sucker larvae were collected each year in the Green River during 1992–1996. Over 99 percent (N = 1,735) of the larvae caught in the middle Green River during spring and early summer were from reaches including, and downstream of, the presumed spawning area near the Escalante Ranch (Muth et al. 1998). Based on the few larvae (*N* = 6) recorded from collections in the Echo Park reach in 1993, 1994, and 1996, reproduction by razorback suckers at the lower Yampa River spawning site appeared minimal, but sampling efforts in the two reaches immediately downstream of that site were comparatively low (Muth et al. 1998). Mean catch per unit effort (CPUE) was highly variable among years and river reaches but it is unclear whether this was a true measure of population abundance or was biased by differences in sampling efficiency (Muth et al. 1998). Numbers of razorback sucker larvae captured per year ranged from 20 in 1992 to 1,217 in 1994 for the middle Green River and from 5 in 1995 to 222 in 1996 for the lower Green River.

Collections in the lower Green River during 1993–1996 produced the first ever captures of razorback sucker larvae from this section of river. In the lower Labyrinth-upper Stillwater Canyon reach, 363 razorback suckers were caught; all from flooded side canyons, washes, backwaters, and side channels. Razorback sucker larvae were collected in the Echo Park area of the Green River in 1993, 1994, 1996, indicating successful spawning in the lower Yampa River (Muth et al. 1998).

Historically, floodplain habitats inundated and connected to the main channel by overbank flooding during spring-runoff discharges would have been available as nursery areas for young razorback suckers in the Green River. Tyus and Karp (1990) associated low recruitment with reductions in floodplain inundation since 1962 (closure of Flaming Gorge Dam), and Modde et al. (1996) associated years of high spring discharge and floodplain inundation in the middle Green River (1983, 1984, and 1986) with subsequent suspected recruitment of young adult razorback suckers. These floodplain habitats are essential for the survival and recruitment of larval fish. Relatively high zooplankton densities in these warm, productive habitats are necessary to provide adequate zooplankton densities for larval food. Loss or degradation of these productive floodplain habitats probably represents one of the most important factors limiting recruitment in this species (Wydoski and Wick 1998). The importance of these habitats is further underscored by the relationship between larval growth and mortality due to non-native predators (Bestgen et al. 1997). Predation by adult red shiners on larvae of native catostomids in flooded and backwater habitats of the Yampa, Green, or Colorado Rivers was documented by

Ruppert et al.(1993) and Muth and Wick (1997). Water depletions and changes in timing of flows may reduce the quantity and availability of floodplain habitat, thus reducing larval growth and recruitment.

**Humpback Chub**

Species/Critical Habitat Description

The humpback chub is a medium-sized freshwater fish (less than 500 mm) of the minnow family. The adults have a pronounced dorsal hump, a narrow flattened head, a fleshy snout with an inferior-subterminal mouth, and small eyes. It has silvery sides with a brown or olive colored back.

The humpback chub is endemic to the Colorado River Basin and is part of a native fish fauna traced to the Miocene epoch in fossil records (Miller 1946; Minckley et al. 1986). Humpback chub remains have been dated to about 4000 B.C., but the fish was not described as a species until the 1940s (Miller 1946), presumably because of its restricted distribution in remote white water canyons (USFWS 1990). Because of this, its original distribution is not known. The humpback chub was listed as endangered on March 11, 1967.

Until the 1950s, the humpback chub was known only from Grand Canyon. During surveys in the 1950s and 1960s humpback chub were found in the upper Green River including specimens from Echo Park, Island Park, and Swallow Canyon (Smith 1960, Vanicek et al. 1970). Individuals were also reported from the lower Yampa River (Holden and Stalnaker 1975b), the White River in Utah (Sigler and Miller 1963), Desolation Canyon of the Green River (Holden and Stalnaker 1970) and the Colorado River near Moab (Sigler and Miller 1963).

Critical habitat was designated in 1994 within the humpback chub's historical range in the following sections of the upper Colorado River (59 F.R. 13374). The primary constituent elements are the same as those described for the Colorado pikeminnow.

Colorado, Moffat County. The Yampa River from the boundary of Dinosaur National Monument in T. 6 N., R. 99 W., section 27 (6th Principal Meridian) to the confluence with the Green River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian).

Utah, Uintah County; and Colorado, Moffat County. The Green River from the confluence with the Yampa River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian) to the southern boundary of Dinosaur National Monument in T. 6 N., R. 24 E., section 30 (Salt Lake Meridian).

Utah, Uintah and Grand Counties. The Green River (Desolation and Gray Canyons) from Sumner's Amphitheater in T. 12 S., R. 18 E., section 5 (Salt Lake Meridian) to Swasey's Rapid in T. 20 S., R. 16 E., section 3 (Salt Lake Meridian).

Status and Distribution

Although historic data are limited, the apparent range-wide decline in humpback chubs is likely due to a combination of factors including alteration of river habitats by reservoir inundation, changes in stream discharge and temperature, competition with and predation by introduced fish species, and other factors such as changes in food resources resulting from stream alterations (USFWS 1990).

Failure to recognize *Gila cypha* as a species until 1946 complicated interpretation of historic distribution of humpback chubs in the Green River (Douglas et al. 1989, 1998). Best available information suggests that before Flaming Gorge Dam, humpback chubs were distributed in canyon regions throughout much of the Green River, from the present site of Flaming Gorge Reservoir downstream through Desolation and Gray canyons (Vanicek 1967; Holden and Stalnaker 1975a; Holden 1991). In addition, the species occurred in the Yampa and White rivers. Pre-impoundment surveys of the Flaming Gorge Reservoir basin (Bosley 1960; Gaufin et al. 1960; McDonald and Dotson 1960; Smith 1960) reported both humpback chubs and bonytails from the Green River near Hideout Canyon, now inundated by Flaming Gorge Reservoir.

Historic collection records of humpback chub exist from the Yampa and White rivers, both tributaries to the Green River. Tyus (1998) verified the presence of seven humpback chubs in collections of the University of Colorado Museum, collected from the Yampa River in Castle Park between 19 June and 11 July 1948. A single humpback chub was found in the White River near Bonanza, Utah, in June 1981 (Miller et al. 1982b), and a possible bonytail-humpback chub intergrade was also captured in July 1978 (Lanigan and Berry 1981).

Present concentrations of humpback chub in the Upper Basin occur in canyon-bound river reaches ranging in length from 3.7 km (Black Rocks) to 40.5 km (Desolation and Gray Canyons). Humpback chubs are distributed throughout most of Black Rocks and Westwater Canyons (12.9 km), and in or near whitewater reaches of Cataract Canyon (20.9 km), Desolation and Gray Canyons (65.2 km), and Yampa Canyon (44.3 km), with populations in the separate canyon reaches ranging from 400 to 5,000 adults (see population dynamics). The Utah Division of Wildlife Resources has monitored the fish community in Desolation and Gray Canyons since 1989 and has consistently reported captures of age-0, juvenile, and adult *Gila,* including humpback chub, indicating a reproducing population (Chart and Lentsch 1999b). Distribution of humpback chubs within Whirlpool and Split Mountain Canyons is not presently known, but it is believed that numbers of humpback chub in these sections of the Green River are low.

The Yampa River is the only tributary to the Green River presently known to support a reproducing humpback chub population. Between 1986 and 1989, Karp and Tyus (1990) collected 130 humpback chubs from Yampa Canyon and indicated that a small but reproducing population was present. Continuing captures of juveniles and adults within Dinosaur National Monument indicate that a population persists in Yampa Canyon (T. Modde, U.S. Fish and Wildlife Service, personal communication). Small numbers of humpback chub also have been reported in Cross Mountain Canyon on the Yampa River and in the Little Snake River about 10 km upstream of its confluence with the Yampa River (Wick et al. 1981; Hawkins et al. 1996).

Threats to the Species

The primary threats to humpback chub are stream flow regulation and habitat modification; competition with and predation by nonnative fishes; parasitism; hybridization with other native *Gila* species; and pesticides and pollutants (USFWS 2002c). The existing habitat, altered by these threats, has been modified to the extent that it impairs essential behavior patterns, such as breeding, feeding, and sheltering. The threats to humpback chub in relation to flow regulation and habitat modification, predation by nonnative fishes, and pesticides and pollutants are essentially the same threats identified for Colorado pikeminnow.

The humpback chub population in the Grand Canyon is threatened by predation from nonnative trout in the Colorado River below Glen Canyon Dam. This population is also threatened by the Asian tapeworm reported in humpback chub in the Little Colorado River (USFWS 2002c). No Asian tapeworms have been reported in the upper basin populations.

Hybridization with roundtail chub (*Gila robusta*) and bonytail, where they occur with humpback chub, is recognized as a threat to humpback chub. A larger proportion of roundtail chub have been found in Black Rocks and Westwater Canyon during low flow years (Kaeding et al. 1990; Chart and Lentsch 2000), which increase the chances for hybridization.

Life History

Unlike Colorado pikeminnow and razorback sucker, which are known to make extended migrations of up to several hundred miles to spawning areas in the Green and Yampa rivers, humpback chubs in the Green River do not appear to make extensive migrations (Karp and Tyus 1990). Radio-telemetry and tagging studies on other humpback chub populations have revealed strong fidelity by adults for specific locations with little movement to areas outside of home canyon regions. Humpback chubs in Black Rocks (Valdez and Clemmer 1982), Westwater Canyon (Chart and Lentsch 1999a), and Desolation and Gray Canyons (Chart and Lentsch 1999b) do not migrate to spawn.

Generally, humpback chub show fidelity for canyon reaches and move very little (Miller et al. 1982a; Archer et al. 1985; Burdick and Kaeding 1985; Kaeding et al. 1990). Movements of adult humpback chub in Black Rocks on the Colorado River were essentially restricted to a 1-mile reach. These results were based on the recapture of Carlin-tagged fish and radiotelemetry studies conducted from 1979 to 1981 (Valdez et al. 1982) and 1983 to 1985 (Archer et al. 1985; USFWS 1986; Kaeding et al. 1990).

In the Green River and upper Colorado River, humpback chubs spawned in spring and summer as flows declined shortly after the spring peak (Valdez and Clemmer 1982; Valdez et al. 1982; Kaeding and Zimmerman 1983; Tyus and Karp 1989; Karp and Tyus 1990; Chart and Lentsch 1999a, 1999b). Similar spawning patterns were reported from Grand Canyon (Kaeding and Zimmerman 1983; Valdez and Ryel 1995, 1997). Little is known about spawning habitats and behavior of humpback chub. Although humpback chub are believed to broadcast eggs over mid-channel cobble and gravel bars, spawning in the wild has not been observed for this species. Gorman and Stone (1999) reported that ripe male humpback chubs in the Little Colorado River aggregated in areas of complex habitat structure (i.e., matrix of large boulders and travertine masses combined with chutes, runs, and eddies, 0.5–2.0 m deep) and were associated with deposits of clean gravel.

Chart and Lentsch (1999b) estimated hatching dates for young *Gila* collected from Desolation and Gray Canyons between 1992 and 1995. They determined that hatching occurred on the descending limb of the hydrograph as early as 9 June 1992 at a flow of 139 $m^3/s$ and as late as 1 July 1995 at a flow of 731 $m^3/s$. Instantaneous daily river temperatures on hatching dates over all years ranged from 20 to 22 °C.

Newly hatched larvae average 6.3–7.5 mm TL (Holden 1973; Suttkus and Clemmer 1977; Minckley 1973; Snyder 1981; Hamman 1982; Behnke and Benson 1983; Muth 1990), and 1-month-old fish are approximately 20 mm long (Hamman 1982). Unlike Colorado pikeminnow and razorback sucker, no evidence exists of long-distance larval drift (Miller and Hubert 1990; Robinson et al. 1998). Upon emergence from spawning gravels, humpback chub larvae remain in the vicinity of bottom surfaces (Marsh 1985) near spawning areas (Chart and Lentsch 1999a).

Backwaters, eddies, and runs have been reported as common capture locations for young-of-year humpback chub (Valdez and Clemmer 1982). These data indicate that in Black Rocks and Westwater Canyon, young utilize shallow areas. Habitat suitability index curves developed by Valdez et al. (1990) indicate young-of-year prefer average depths of 2.1 feet with a maximum of 5.1 feet. Average velocities were reported at 0.2 feet per second.

Valdez et al. (1982) Wick et al. (1979) and Wick et al. (1981) found adult humpback chub in Black Rocks and Westwater Canyons in water averaging 50 feet in depth with a maximum depth of 92 feet. In these localities, humpback chub were associated with large boulders and steep cliffs.

Population Dynamics

The humpback chub Recovery Goals (USFWS 2002c) provided the following preliminary population estimates for adults in the six populations:

Black Rocks, Colorado River, Colorado-900–1,500
Westwater Canyon, Colorado River, Utah-2,000–5,000
Yampa Canyon, Yampa River, Colorado-400–600
Desolation/Gray Canyons, Green River, Utah-1,500
Cataract Canyon, Colorado River, Utah-500
Grand Canyon, Colorado River and Little Colorado River, Arizona-2,000–4,700

Monitoring humpback chub populations is ongoing, and sampling protocols and reliability of population estimates are being assessed by the Service and cooperating entities. The demographic criteria of the Recovery Goals (USFWS 2002c) for downlisting the humpback chub to "threatened," call for maintaining the six populations and at least one core population in both the Upper and Lower Colorado River Basins of >2,100 adults that are self-sustaining with recruitment.

Low numbers of humpback chub have been captured in Whirlpool Canyon and Split Mountain Canyon on the Green River in Dinosaur National Monument; however, these fish were considered part of the Yampa River population in the Recovery Goals (USFWS 2002c), and not separate populations.

Status of Humpback Chub and Critical Habitat in the Action Area

Tyus and Karp (1991) found that in the Yampa and Green rivers in Dinosaur National Monument, humpback chubs spawn during spring and early summer following peak flows at water temperatures of about 20 °C. They estimated that the spawning period for humpback chub ranges from May into July, with spawning occurring earlier in low-flow years and later in high-flow years; spawning was thought to occur only during a 4–5 week period (Karp and Tyus 1990). Similar to the Yampa and Green rivers, peak hatch of *Gila* larvae in Westwater Canyon on the Colorado River appears to occur on the descending limb of the hydrograph following spring runoff at maximum daily water temperatures of approximately 20 to 21 °C (Chart and Lentsch 1999a). Tyus and Karp (1989) reported that humpback chubs occupy and spawn in and near shoreline eddy habitats and that spring peak flows were important for reproductive success because availability of these habitats is greatest during spring runoff.

High spring flows that simulate the magnitude and timing of the natural hydrograph provide a number of benefits to humpback chubs in the Yampa and Green rivers. Bankfull and overbank flows provide allochthonous energy input to the system in the form of terrestrial organic matter and insects that are utilized as food. High spring flows clean spawning substrates of fine sediments and provide physical cues for spawning. High flows also form large recirculating eddies used by adult fish. High spring flows (50 percent exceedance or greater) have been implicated in limiting the abundance and reproduction of some nonnative fish species under certain conditions (Chart and Lentsch 1999a, 1999b) and have been correlated with increased recruitment of humpback chubs (Chart and Lentsch 1999b).

Critical habitat for humpback chub includes canyon reaches of the Yampa and Green rivers. Yampa Canyon has not been affected by stream flow regulation like Split Mountain, Desolation, and Gray Canyons on the Green River. However, Yampa Canyon has recently been invaded by high numbers of smallmouth bass changing the biological environment of critical habitat.

**Bonytail**

Species/Critical Habitat Description

Bonytail are medium-sized (less than 600 mm) fish in the minnow family. Adult bonytail are gray or olive colored on the back with silvery sides and a white belly. The adult bonytail has an elongated body with a long, thin caudal peduncle. The head is small and compressed compared to the rest of the body. The mouth is slightly overhung by the snout and there is a smooth low hump behind the head that is not as pronounced as the hump on a humpback chub.

Critical habitat was designated in 1994 within the bonytail's historical range in the following sections of the upper Colorado River (59 F.R. 13374). The primary constituent elements are the same as those described for the Colorado pikeminnow.

> Colorado, Moffat County. The Yampa River from the boundary of Dinosaur National Monument in T. 6 N., R. 99 W., section 27 (6th Principal Meridian) to the confluence with the Green River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian).
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> Utah, Uintah County; and Colorado, Moffat County. The Green River from the confluence with the Yampa River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian) to the boundary of Dinosaur National Monument in T. 6 N., R. 24 E., section 30 (Salt Lake Meridian).
>
> Utah, Uintah and Grand Counties. The Green River (Desolation and Gray Canyons) from Sumner's Amphitheater in T. 12 S., R. 18 E., section 5 (Salt Lake Meridian) to Swasey's Rapid (river mile 12) in T. 20 S., R. 16 E., section 3 (Salt Lake Meridian).

Status and Distribution

The bonytail is the rarest native fish in the Colorado River. Little is known about its specific habitat requirements or cause of decline, because the bonytail was extirpated from most of its historic range prior to extensive fishery surveys. It was listed as endangered on April 23, 1980. Currently, no documented self-sustaining populations exist in the wild. Formerly reported as widespread and abundant in mainstem rivers (Jordan and Evermann 1896), its populations have been greatly reduced. Remnant populations presently occur in the wild in low numbers in Lake Mohave and several fish have been captured in Lake Powell and Lake Havasu (USFWS 2002d). The last known riverine area where bonytail were common was the Green River in Dinosaur National Monument, where Vanicek (1967) and Holden and Stalnaker (1970) collected 91 specimens during 1962-1966. From 1977 to 1983, no bonytail were collected from the Colorado or Gunnison rivers in Colorado or Utah (Wick et al. 1979, 1981; Valdez et al. 1982; Miller et al. 1984). However, in 1984, a single bonytail was collected from Black Rocks on the Colorado River (Kaeding et al. 1986). Several suspected bonytail were captured in Cataract Canyon in 1985-1987 (Valdez 1990). Current stocking plans for bonytail identify the middle Green River and the Yampa River in Dinosaur National Monument as the highest priority for stocking in Colorado and the plan calls for 2,665 fish to be stocked per year over the next six years (Nesler et al. 2003).

Threats to the species include stream flow regulation, habitat modification, predation by introduced nonnative fish species, hybridization, and pesticides and other pollutants (USFWS 2002d).

Threats to the Species

The primary threats to bonytail are stream flow regulation and habitat modification; competition with and predation by nonnative fishes; hybridization with other native *Gila* species; and pesticides and pollutants (USFWS 2002d). The existing habitat, altered by these threats, has been modified to the extent that it impairs essential behavior patterns, such as breeding, feeding, and sheltering. The threats to bonytail in relation to flow regulation and habitat modification, predation by nonnative fishes, and pesticides and pollutants are essentially the same threats identified for Colorado pikeminnow. Threats to bonytail in relation to hybridization are essentially the same threats identified for humpback chub.

Life History

The bonytail is considered a species that is adapted to mainstem rivers, where it has been observed in pools and eddies (Vanicek 1967; Minckley 1973). Spawning of bonytail has never been observed in a river, but ripe fish were collected in Dinosaur National Monument during late June and early July suggesting that spawning occurred at water temperatures of about 18 °C (Vanicek and Kramer 1969). Similar to other closely related *Gila* species, bonytail probably spawn in rivers in spring over rocky substrates; spawning has been observed in reservoirs over rocky shoals and shorelines.

Population Dynamics

Bonytail are so rare that it is currently not possible to conduct population estimates. A stocking program is being implemented to reestablish populations in the upper Colorado River basin. The Recovery Goals (USFWS 2002d) call for reestablished populations in the Green River and upper Colorado River subbasins, each with >4,400 adults that are self-sustaining with recruitment.

Status of Bonytail and Critical Habitat in the Action Area

The only known bonytail that presently occur in the Yampa River are the individuals recently reintroduced at Echo Park, near the confluence with the Green River. In July of 2000 approximately 5,000 juveniles (5 to 10 cm) were stocked. Between 1998 and 2003, the number of bonytail stocked in the Green River subbasin was 189,438 fish, with majority of the fish being juveniles at the time of stocking.

Critical habitat for bonytail includes canyon reaches of the Yampa and Green rivers. Yampa Canyon has not been affected by stream flow regulation like Split Mountain, Desolation, and Gray canyons on the Green River. However, Yampa Canyon has recently been invaded by high numbers of smallmouth bass changing the biological environment of critical habitat.

IMPORTANCE OF THE YAMPA RIVER

The Yampa River, a principal tributary to the Green River in northwest Colorado, is widely regarded as one of the most important tributaries in the Upper Colorado River Basin to the recovery of four endangered fishes. The Yampa River supports remnant populations of three of these species, the humpback chub, Colorado pikeminnow and razorback sucker. In addition, bonytail have been stocked at the confluence of the Yampa and Green rivers to try to re-establish a population of this species. The Yampa River also is considered essential to maintaining suitable habitat conditions for endangered fish populations in the Green River downstream from their confluence (Holden 1978, 1980), due to its relatively unaltered patterns of seasonal flows and sediment inputs (Andrews 1978, 1986; Tyus and Karp 1989, 1991; Modde and Smith 1995). Tyus and Saunders (2001) ranked the Yampa first out of 13 major tributaries in terms of its potential contribution to recovery.

The Yampa River contributes about the same average annual water volume as the discharge of the Green River above its confluence with the Yampa. Flaming Gorge Dam, located on the Green River about 65 RMs upstream from the Yampa River confluence, impounds a 3.8 MAF reservoir, reducing peak flows and elevating base flows in the Green River downstream from the dam. As the largest tributary to the Green River, the Yampa is important for providing both volume and shape to the Green River hydrograph at Jensen, Utah (Figure 1).

Unlike the Green River, the Yampa River still exhibits a relatively natural hydrograph. Undiminished by large dams and reservoirs or large out-of-basin diversions, the Yampa River is the only stream of its size in the Upper Colorado River Basin where spring peak flows have changed relatively little since water development began near the turn of the 20th century. Spring peak flows result from melting snowpack accumulated at higher elevations during the winter. Spring runoff typically begins as early as mid-March and wanes no later than mid-July, with flow maxima at the USGS gage near Maybell, Colorado, occurring between April 25 and June 19. However, more than 60 percent (57 of 94 occurrences) of these peak flows historically occurred within a 3-week period (May 10–31), during which more than one-fourth of the average annual discharge passed the Maybell gage.

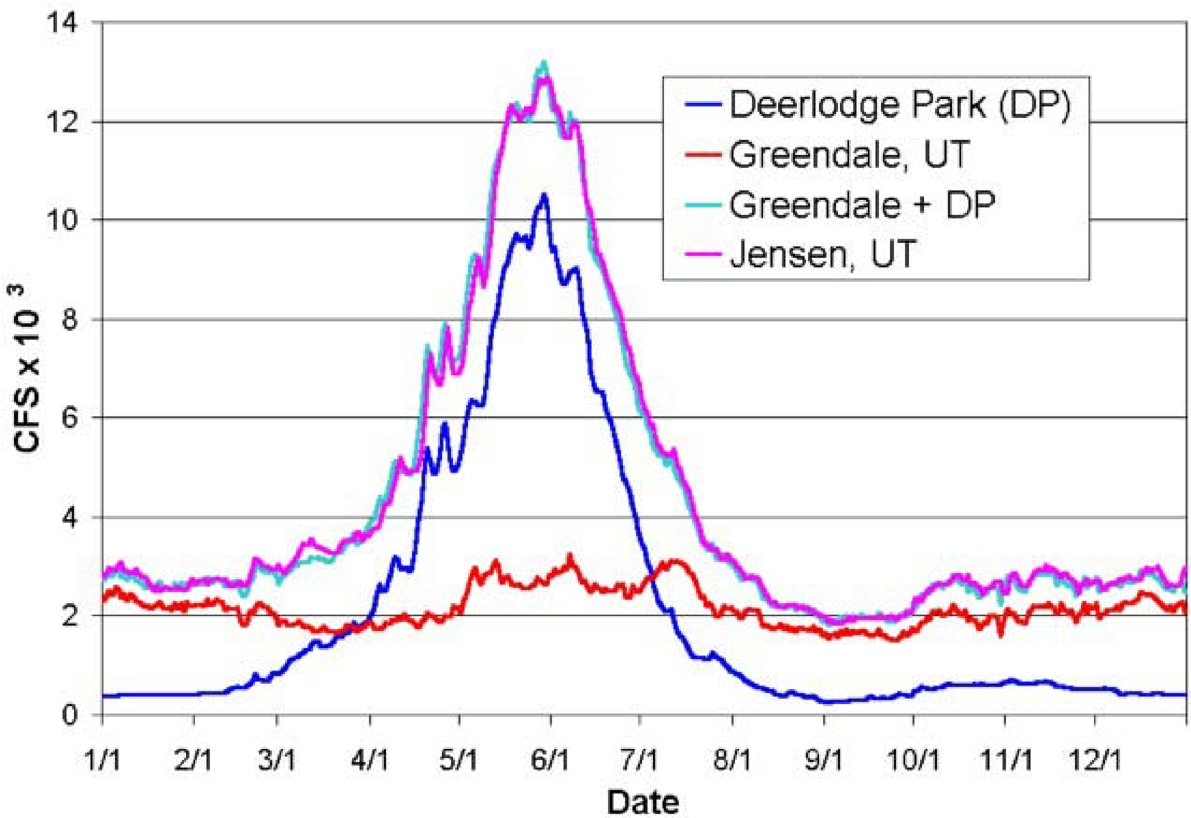


Figure 1. Comparison of average annual hydrographs for the Yampa River at Deerlodge Park, Colorado, and the Green River at Greendale and Jensen, Utah (1982–1994)

Flows in the Yampa River vary both between and within years. From 1916 through 1998, the highest flow recorded at the Maybell gage (24,400 cfs) was recorded on May 17, 1984, whereas the lowest peak flow (3,180 cfs) was recorded on June 5 and June 10, 1977. Flow maxima from 6,000 to 12,000 cfs occurred at Maybell in 56 out of 83 years (67 percent) with an average recurrence interval of 1.5 years. Peak flows greater than 12,000 cfs occurred in 9 of 83 years (11 percent), while peaks less than 6,000 cfs occurred in 18 of 83 years (22 percent). Seasonal extremes range from average spring peaks of about 10,000 cfs to average minimum late-summer base flows of about 140 cfs, roughly two orders of magnitude less than average peak flows. Between years, extremes are even greater, as much as four orders of magnitude, from 24,400 cfs in 1984 to low flows less than 2 cfs in 1934 and 2002, both extremely dry years.

The Little Snake River, the largest tributary to the Yampa River, joins the Yampa at RM 50 in Lily Park, Colorado. Its watershed covers roughly as large an area as that of the Yampa River upstream from their confluence; however, with an average annual discharge of 428 KAF, it yields only about 28 percent of the average annual volume of water (1.5 MAF) the Yampa River historically delivered to the Green River at Echo Park. The principal contribution of the Little Snake River is sediment, accounting for about 77 percent of the average annual sediment load to the Yampa River (O'Brien 1987). High spring flows are important for transporting this sediment through Yampa Canyon to the Green River and beyond. O'Brien (1987) concluded that the sediment budget of the Yampa Canyon is roughly in long-term equilibrium. However, he also stated:

> *The effect of reducing the discharge in the Little Snake* [River] *will be to reduce the sediment load in the canyon. Concomitantly, reducing the water supply in the Yampa River upstream of the confluence with the Little Snake River will have the effect of limiting the river's ability to transport the sediment load in the canyon.*

Since its completion in October 1962, Flaming Gorge Dam has significantly reduced peak flows in the Green River, while increasing base flows. Sediment load at Jensen, Utah, has been reduced 54 percent since Flaming Gorge Dam was completed, because the reservoir acts as a sediment trap for the Green River, which contributed 3.6 million tons of the sediment per year prior to 1962 (Andrews 1986). However, Andrews (1986) also concluded that, since 1962, an equilibrium between sediment supply and transport has existed in the Green River, from the Yampa River downstream to Jensen, which he attributes to the proximity of Flaming Gorge Dam to the Yampa River, a significant source of sediment.

## FLOW NEEDS FOR ENDANGERED FISHES IN THE YAMPA RIVER

The Yampa River provides critical habitat for all four endangered fish species. The razorback sucker and Colorado pikeminnow spawn in the lower reaches of Yampa Canyon. Yampa Canyon also harbors one of five remaining populations of humpback chub in the Upper Colorado River Basin. In addition to its direct contribution to recovery, the Yampa River provides half of the average annual flow to the Green River below their confluence, as well as a more natural shape to its hydrograph (Figure 1). Relative to other rivers in the Upper Colorado River Basin, flows in the Yampa River have not been significantly impacted by reservoir development or depletions for agriculture, municipalities and industry. Depletions represent roughly 8 percent of the undepleted yield of the river. Agriculture consumes about 68 percent of total depletions. Industrial use is mainly to cool two power plants, Hayden Station and Craig Station. Reservoirs with a total active storage capacity of about 124 KAF take water from the peak of the hydrograph and, in drier years, allocate some of this stored water for use in late summer and early fall, when portions of the rivers may be de-watered. However, absence of significant water storage capacity in the Yampa River Basin may exacerbate critically low flows during late summer through early fall, when flows reach their lowest point. Minimum flows, averaging less than 140 cfs, generally occur in September. Flows as low as 2 cfs have been recorded at Maybell.

The Service first attempted to develop flow recommendations for the Yampa River in 1989 (Tyus and Karp 1989), in which the authors identified the life history and general habitat needs of the Colorado squawfish (now known as the Colorado pikeminnow), humpback chub, razorback sucker and bonytail. The report made some general observations about flows that appeared to be beneficial to the endangered fish based on historical hydrologic conditions. Although the report did not provide any discrete flow recommendations for the Yampa River, it identified a need to maintain both inter- and intra-annual variability typical of historical hydrographs. Flow recommendations were to be developed separately in a stand-alone document.

After completion and acceptance of the Tyus and Karp 1989 report, the Service released what was known as Phase II flow recommendations for the Yampa River on November 9, 1989. To develop monthly flow recommendations at Deerlodge Park, the Phase II report relied upon the biological information from Tyus and Karp (1989) and took into consideration water-project depletions backcast over historical monthly hydrologic records for the Yampa River. The Phase II flow recommendations proved to be too general, and because the recommendations were based on flows at Deerlodge Park, they did not correlate with flows at the Maybell gage, which historically has been used for stream-flow accounting.

Modde and Smith (1995) developed flow recommendations for the Yampa River that updated interim recommendations for the Yampa River promulgated by the Service in 1990 based on a review of biological data on endangered fishes developed by Tyus and Karp (1990). The approach used by Modde and Smith (1995) was selected following the failure of an Instream Flow Incremental Methodology (IFIM) Physical Habitat Simulation (PHABSIM) to demonstrate predicative cause-and-effect relationships between instream flows and distribution of endangered fishes in the Green River Basin (Rose and Hann 1989). Flows recommended in the Modde and Smith 1995 report relied heavily on biological information presented by Tyus and Karp (1989), but also included information generated by endangered fish monitoring activities carried out by the Recovery Program, an instream flow report by Stanford (1993), a comparison of estimated historical and undepleted Yampa River flows at Maybell by O'Brien (1987), and generally accepted, published ecological principles.

The primary goal of the Modde and Smith (1995) recommendations was to maintain a relatively natural hydrograph. High spring flows were identified as necessary to support biological processes, with relatively stable base flows to support fish through the late summer, fall and winter based upon natural variability (Table 5).

Table 5. Monthly flow targets (cfs) based on 80 percent exceedance of estimated undepleted daily flows [a] of the Yampa River at Maybell, Colorado (Modde and Smith 1995).

| NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 172 | 157 | 187 | 221 | 305 | 1150 | 4153 | 3326 | 175 | 125 | 45 | 88 |

[a] Hydrosphere 1995

In their report entitled, *"Determination of Habitat Availability, Habitat Use, and Flow Needs of Four Endangered Fish in the Yampa River Between August and October"*, Modde et al. (1999) took a new approach to estimate instream flow needs of the endangered fishes in the Yampa River during the base-flow period. After testing several approaches, the authors selected a curve-break analysis to estimate base-flow targets for the Yampa River. This approach simulated habitat availability at several different base-flow levels to identify the availability of three different meso-habitat types—riffles, runs and pools—as a function of discharge. Riffles are considered to be the most sensitive mesohabitat to changes in stream flow. They also contribute significantly to production of macroinvertebrates that serve as the basis of a food web for the endangered fishes. Therefore, habitat data from riffle transects were used in this analysis. The curve break identifies the stream flow at which that habitat parameter begins declining more rapidly with any further reduction in flow.

Using the curve break methodology, an average curve break of all riffle transects is 93 cfs; therefore, 93 cfs was determined to be the target base flow for the Yampa River from August through October. The study concluded that flows of 93 cfs or greater would be sufficient to maintain instream riffle habitats critical for production of prey organisms for the endangered fishes during this period. However, the study also concluded that flows of this magnitude need only be achieved at their historical frequencies, magnitudes and durations. In other words, Yampa River flows had fallen below 93 cfs in the past and may do so in the future, as long as they do not fall below 93 cfs more frequently or for longer periods than had occurred in the past under otherwise similar hydrologic conditions (Modde et al. 1999).

Base-flow Recommendation

By adopting the Modde et al. (1999) August through October base-flow target of 93 cfs, the Service has, in effect, modified its 1995 recommendations (Modde and Smith 1995). Moreover, Yampa River flows at Maybell occasionally have fallen below 93 cfs in July. Therefore, for the purpose of developing a base-flow augmentation strategy, the Service extended the 93 cfs flow target to include July. Furthermore, winter flow needs of the endangered fishes are not as clearly understood and, given these uncertainties, the Service cannot justify extending the 93 cfs flow target beyond October nor reaffirm its 1995 winter flow recommendations based exclusively on statistical analyses of historical data, without any biological nexus. As a contingency against these uncertainties, Service biologists and hydrologists recommended a 33 percent buffer be added to the 93-cfs flow target (93 + 31= 124 cfs) to meet the needs of the endangered fishes from November through February (USFWS 2003).

To achieve these flow recommendations, a base-flow augmentation plan was developed as part of the proposed action. Modeling based on projections of future water development and using a base-flow augmentation strategy developed by Roehm (2003), indicates that instream flow augmentation would be needed, to some extent, to satisfy a 124 cfs winter flow target in an historical context an average of about 1 in 7 years, whereas some augmentation would be needed an average of 1 in 2 years to satisfy the 93 cfs flow target from July through August.

Value of peak flows to the endangered fishes

Although the Service made no numerical peak-flow recommendations, the value of peak flows to the endangered fishes has been well documented (Day & Crosby 1997; Holden 1978, 1980; Muth et al. 2000; Rakowski & Schmidt 1999; Schmidt 1996; Tyus 1987; Tyus & Karp 1991; Wick 1997). Peak flows are particularly important in creating and maintaining spawning habitats for the endangered fishes in the Yampa, as well as nursery habitats of the Colorado pikeminnow and razorback sucker in the Middle Green River downstream from the Yampa confluence to Ouray, Utah (Andrews 1978, 1986; Elliott et al. 1984; O'Brien 1987). These habitats are critical to the recovery of the Yampa/Green River populations of these fish species.

Stanford (1994) was contracted by the Recovery Program to review these and other flow recommendations in the basin and generally supported the basic recommendations, in addition to recommending further studies. He noted that a high spring peak to base flow ratio is strongly implied by available science and not simply professional judgment. The Yampa River not only contributes as much volume as the Green River, but also provides a more natural shape to the hydrograph downstream from their confluence. A clear understanding of how peak-flow reductions due to depletions and reservoir storage will affect sediment delivery and transport, particularly to and through the Yampa Canyon reach is a key to understand how essential fish habitat is created in the Jensen-Ouray reach of the Green River.

## ENVIRONMENTAL BASELINE

The environmental baseline for this consultation is not typical, because for the purposes of this analysis, all of the current water depletions included in the Yampa Plan are part of the action. The environmental baseline, according to ESA regulations, typically includes the past and present impacts of all Federal, State, and private actions and other human activities in the action area; the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal section 7 consultation; and the impact of State or private actions contemporaneous with the consultation process. Environmental baselines do not include the effects of the Federal action(s) under review in the consultation. Therefore, all water depletions as outlined in the description of the proposed action, are not included in this environmental baseline. The environmental baseline for this consultation is represented by river flow conditions with the impacts of human depletion actions taken out and shall be referred to in this biological opinion as "baseline flow conditions." Because of the large scope of this programmatic biological opinion, it is not possible to determine the extent of existing or future Federal discretion for all current and new water depletions covered by this opinion. It is likely that most water depletion projects have or will have a Federal action associated with them and will rely on the Recovery Program to avoid the likelihood of jeopardy and adverse modification of critical habitat. Other impacts, such as those due to the presence of nonnative fish, dams, other fish barriers, water quality, and bank stabilization, are assumed to be in place under baseline conditions. The purpose of using "baseline flow conditions" in this analysis is to adequately characterize the affects of existing and new water depletions included in the Yampa Plan. This baseline does not confer any obligation on the Federal action agencies to restore the river to a condition similar to that existing prior to human depletion actions. Baseline flow conditions were modeled as described below.

Because there was no hydrologic record prior to settlement and subsequent development of surface water resources near the turn of the 20th Century, we have no direct evidence of hydrologic conditions as they existed prior to the advent of depletions. The existing hydrologic record was used to simulate the undepleted baseline for this consultation by adding estimated depletions back into the historic hydrograph. The Colorado River Decision Support System (CRDSS) was used to estimate depletions from the Yampa River in Colorado during a 90-year period of record (October 1908-September 1998). The CRDSS includes the State of Colorado's Stream Simulation Model, which is a monthly or daily water allocation and accounting model capable of making comparative analyses for the assessment of various historic and future water management policies in a river basin. While the model is capable of doing daily operations, daily data does not exist in sufficient quantity to operate on a daily basis. It is designed to be applied to any river basin by inputting appropriate data. The State Model's operation, like the stream itself, is governed by its hydrology, water rights, and the associated structures and operating rules. The State Model is capable of simulating stream diversions, instream demands, reservoir operations and river flows on a monthly basis for any stream system using user specified data.

One major component of the model is the Base Flow module, which produces a set of stream flows that would have occurred in the basin without a user specified level of human development. When the effects of depletions are removed, the results would represent baseline flow conditions. However, the CRDSS monthly time-step does not provide enough resolution for the purposes of this analysis. A daily time-step is needed to more precisely describe differences between historic and undepleted hydrographs. To accomplish this, unitless daily values were interpolated between simulated CRDSS values of monthly discharge for both historic and undepleted flow conditions. Each pair of daily values was compared, and the undepleted value expressed as a percentage of the historic value (e.g., undepleted=103 percent historic). Each of these daily percentages was multiplied by its corresponding daily average gaged flow to approximate flow conditions that would have occurred under identical hydrologic conditions but without depletions. This process produced undepleted hydrographs similar in appearance to their historic counterparts, though undepleted flows were somewhat greater.

Using these simulated undepleted data, average monthly maximum baseline flow conditions for the Yampa River during wet (0–30 percent exceedance), average (31–70 percent exceedance) and dry (71–100 percent exceedance) hydrologic conditions at Maybell and Deerlodge Park (Figures 2 and 3, respectively). Baseline flow conditions provided higher spring peaks and lower base flows. In wet years, May peak flows averaged in excess of 13,000 cfs at Maybell and 19,000 cfs at Deerlodge Park. Appendix B describes modeling assumptions used to make the model runs. The results of these runs were used to develop the following figures and tables.

Undepleted hydrologic data for the Little Snake River were simulated by adding depletions back into the historic gage data at Lily Park, Colorado. This simulation produced average monthly maximum baseline flow conditions during wet (0–30 percent exceedance), average (31–70 percent exceedance) and dry (71–100 percent exceedance) hydrologic conditions (Figure 4).

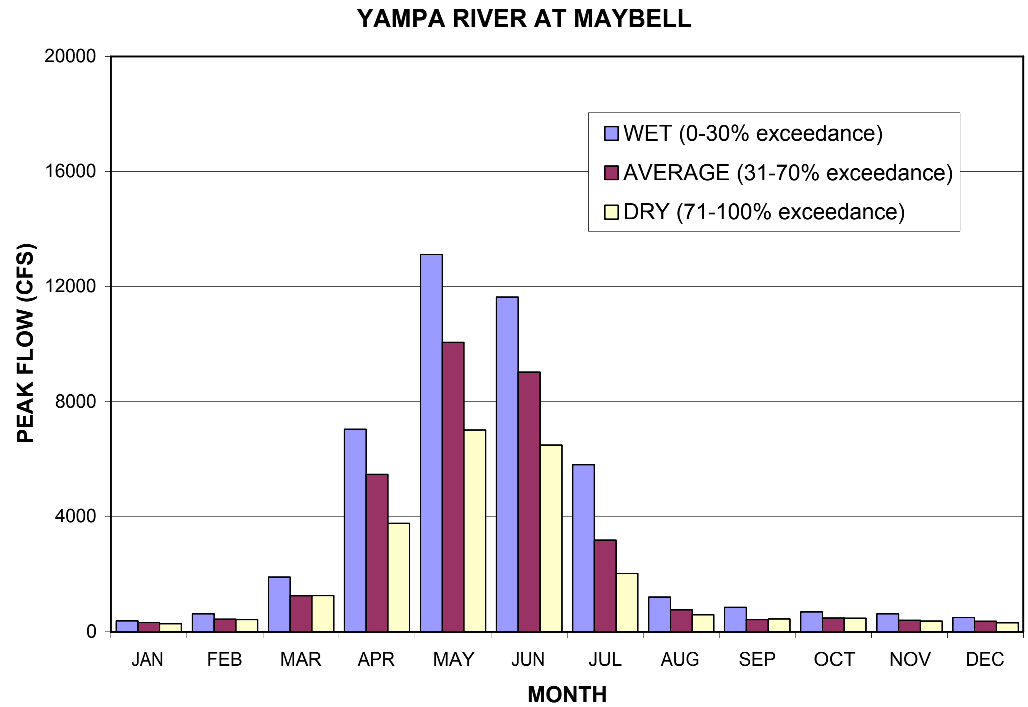


Figure 2. Average daily undepleted peak flows in the Yampa River at Maybell by month as a function of annual hydrologic conditions.

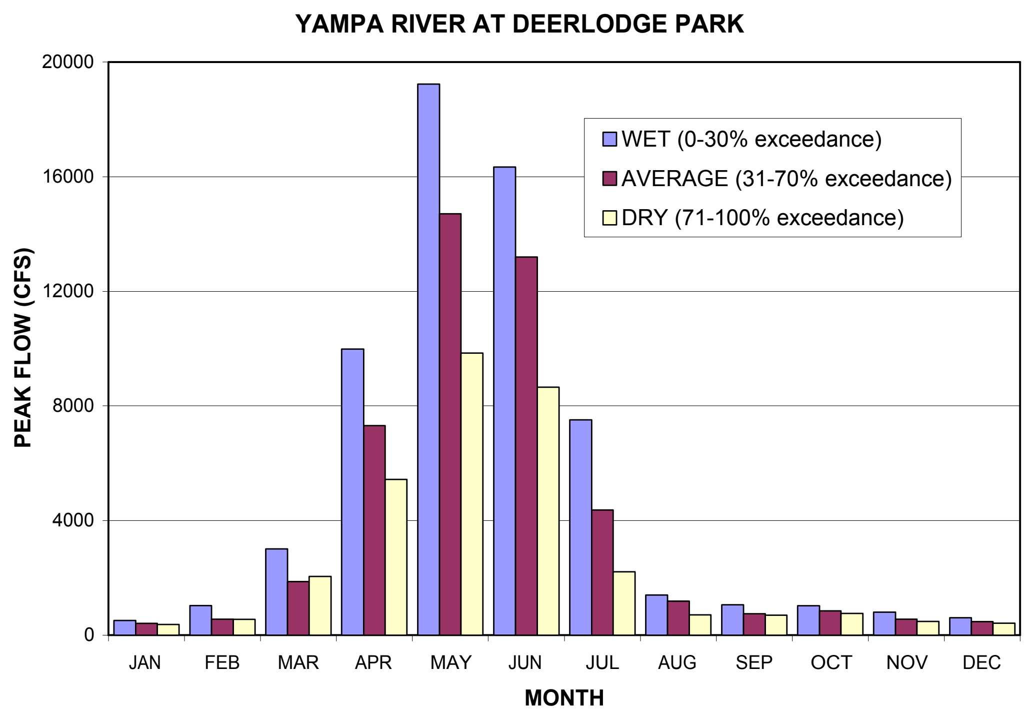


Figure 3. Average daily undepleted peak flows in the Yampa River at Deerlodge Park by month as a function of annual hydrologic conditions.

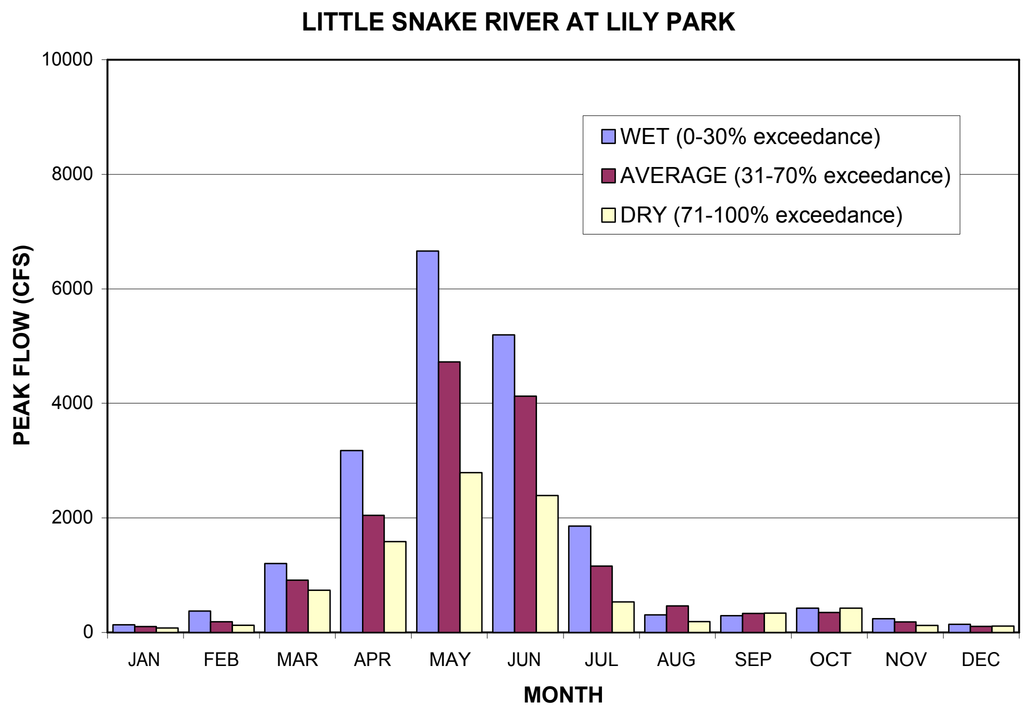


Figure 4. Average daily undepleted peak flows in the Little Snake River at Lily Park by month as a function of annual hydrologic conditions.

Status of the Species Within the Action Area

Information regarding the four fish species under more natural flow conditions is limited to a few technical papers (Abbott 1861, Baird and Girard 1853, Chamberlain 1904, Cope and Yarrow 1875, Ellis 1914, Evermann and Rutter 1895, Girard 1856, Jordan 1891, Jordan and Evermann 1896) and historical photos and accounts of senior citizens interviewed in 1991 (Quartarone 1995). The technical papers generally document the wide spread distribution and report some endangered species common throughout the Colorado River Basin (humpback chub were not even described until 1946 (Miller 1946)). However, this historical information is limited to taxonomic and distributional data. Very little was known about the life history of these species prior to the 1960's (Miller 1964). Moreover, it is difficult to determine the status of the endangered fishes under baseline flow conditions, because other factors, such as nonnative fish, dams, fish barriers, dikes, bank stabilization, and other habitat modifications are assumed to be in place. These other factors have all been identified as negatively impacting the endangered fishes. Limited information exists regarding the four species under more natural flow conditions, but this information would not necessarily include the negative impacts of nonnative fish, dams, fish barriers, dikes, or bank stabilization.

Factors Affecting Species Environment within the Action Area

The Service assumes that baseline (i.e., undepleted) flow conditions would provide improved habitat for the endangered fishes compared to existing or projected future flow conditions.

However, even with baseline flow conditions, other limiting factors for the endangered fishes exist under the environmental baseline. Under the modeled baseline flow conditions, competition and predation from nonnative fishes would be a factor. Also, under the modeled baseline flow conditions, it is likely that many floodplain habitats would be diked off and bank stabilization would be in place. Impacts from dams, such as changes in water temperatures, water quality and sediment loads, and other barriers to fish movement would alter habitat conditions for endangered fishes.

## EFFECTS OF THE ACTION

### Factors to be Considered

The Service concludes that water depletions are a major factor contributing to the reductions in the populations of the Colorado pikeminnow, humpback chub, bonytail, and razorback sucker. Other major factors include impacts of dams, competition from and predation by nonnative fishes, changes in flow and temperature regimes, and changes in river channel (which are also related to water depletions). These reductions in populations and loss of habitat caused the Service to list these species as endangered and to implement programs to conserve the species. Implementation of the Recovery Actions outlined in the proposed action are designed to offset depletion impacts to the Yampa River downstream to, and including, the Green River below their confluence.

Removing water from the river system reduces the ability of the river to create and maintain important habitats and reduce the frequency and duration of availability of these habitats, as described below. Food supply, predation, and competition are important elements of the biological environment. Food supply is a function of nutrient supply and productivity. High spring flows inundate bottomland habitats and increase the nutrient supply and productivity of the river environment. Reduction of high spring flows by water storage reservoirs that store water during spring peak flows may reduce food supply. The Service concludes that water depletions adversely affect all four species of endangered fishes and the primary constituent elements of their critical habitat.

The proposed implementation of the Recovery Action Plan would have beneficial effects on the four listed Colorado River fishes and their critical habitats within the action area. These benefits include: augmentation of late summer/fall base flows in the Yampa River; habitat restoration in the Green River; and fish passage, entrainment prevention, nonnative fish management, and propagation and stocking of endangered fishes in both rivers.

### Analyses for Effects of the Action

*Water Quantity*

New and existing water depletions from the Yampa River and its tributaries have and will cause discrete, identifiable, additive, adverse impacts to the Colorado River endangered fishes. As shown in the following flow analysis, the action subject to consultation has and will cause flow depletions that alter baseline flow regimes. The proposed action includes continuation of existing annual depletions of about 168 KAF (125 KAF in Colorado and 43 KAF in Wyoming). In addition, new depletions beyond existing levels up to 53 KAF (30 KAF per year in Colorado and 23 KAF per year in Wyoming) are expected in the foreseeable future (total annual depletions of about 155 KAF in Colorado and 66 KAF in Wyoming). Existing and projected future depletions are defined under the description of the proposed action (Tables 1 and 2).

To determine the effects of the existing and future levels of depletions on water quantity and alteration of the hydrologic regime, an analysis of flow changes was conducted. This analysis compares existing and future conditions against the environmental baseline conditions (flow conditions without depletions).

The CRDSS was used to model Colorado depletions under existing and supply-limited projected future demand conditions. These demands are distributed both temporally and spatially. These distributions were based on patterns of demand, as well as on when water would be available. Although Wyoming depletions have not been distributed, we would expect them to follow a temporal pattern similar to Colorado depletions.

Because there are no stream-flow records prior to the advent of water development in the Yampa Basin, the CRDSS also was used to simulate undepleted baseline flow conditions. The output of the CRDSS is the total monthly discharge in AF. To simulate daily flow conditions, daily data points for undepleted, historic and future flow conditions were interpolated between each of the monthly data. Each of the undepleted and future daily data was divided by its corresponding historic daily datum, and the resulting ratio was multiplied by the corresponding daily average gaged flow. In this way, annual hydrographs for each of the three demand conditions were produced. See Appendix C for figures that show a comparison of undepleted (baseline), historic (gaged) and future flows during wet, moderately wet, average, moderately dry, and dry hydrologic conditions.

Because there is little reservoir storage relative to undepleted yield in the Yampa Basin, and few large direct-flow diversions, impacts of depletions on peak flows are not significant in wetter-than-average years. Future depletions are not expected to exacerbate these impacts (Appendix C, Figures C1 and C2). Under average and drier conditions, the reduction of peak flows becomes more apparent, although the shape of the hydrograph is not expected to change from that of a typical snowmelt-driven hydrograph (Appendix C, Figures C3 to C5). Percentage reductions in peak flows are greater under drier conditions, although absolute peak-flow reductions may be less than those under wetter-than-average conditions, because water may be less readily available under drier conditions (Appendix C, Table C1).

*Augmentation of Late Summer, Fall and Winter Base Flows*

The Colorado River endangered fishes require natural flow regimes, with high flows during spring snow melt and low flows through out the rest of the year. Peak flows are essential for habitat formulation and maintenance in both the Yampa and Green Rivers. Adequate base flows are also important to maintain suitable habitat conditions on the Yampa River during low flow periods. Because reservoir storage to meet consumptive demand in the Yampa River Basin is limited, depletions are expected to have a proportionately greater impact on base flows, particularly July through October, than on peak flows. Percentage reductions in base flows are greater than those of peak flows, although absolute peak-flow reductions from baseline flow conditions may be greater than absolute base-flow reductions. For this reason, base-flow augmentation is one of the key measures of the proposed action to minimize the impacts of depletions. Up to 6,000 AF of water per year will be available to augment instream flows between July 1 and March 1. In addition, up to 1,000 AF will be available to compensate for bed and evaporation losses. The goal of the augmentation strategy is to emulate historic flow conditions with respect to flow targets of 93 cfs summer-fall and 124 cfs in winter. Under the proposed action, water would be released from storage in Elkhead Reservoir at a prescribed rate when flows fall below a specified level (78 cfs summer-fall and 109 cfs winter). Augmentation would continue at the prescribed rate until augmented flows exceed a specified level (138 cfs summer-fall and 169 cfs winter) or until the full 7,000 AF of the augmentation water supply is exhausted. Flows generally fall below these thresholds only in average or drier years. An augmentation rate of 50 cfs would provide 2 months (61 days) of continuous augmentation. In the driest years, the prescribed rate of release would be reduced to 33 cfs, thereby extending the duration of augmentation to 3 months (92 days). Appendix C, Figures C6 to C7 demonstrate the effect of this augmentation strategy on base flows. Increasing flows during the base flow period increases usable habitat by providing adequate water depth, wetted river width, and appropriate velocities for endangered fishes in the Yampa River.

Under most hydrologic conditions, Yampa River flows would be augmented at a delivered rate of 50 cfs using up to 7,000 AF of water stored in Elkhead Reservoir (Appendix C, Figure C6). However, under extremely dry conditions, such as those experienced in 1934, 1977, and 2002, the available water supply would have been exhausted by early to mid-September at this rate even though the need for augmentation may continue into October (Appendix C, Figure C7). By reducing the augmentation rate to 33 cfs, duration of augmentation can be extended to satisfy the need for augmentation, dictated by the previously described augmentation protocol. Moreover, even at this reduced rate of augmentation, Appendix C, Figure C7 shows that augmented projected future flows exceed historic flows and, therefore, satisfy the flow recommendations of Modde et al. (1999). Because augmentation will result in future flows that exceed historic flows under some conditions, the listed fishes will benefit from the proposed action by an increase in suitable habitat.

*Water Quality*

This biological opinion is limited to addressing water depletions above the confluence of the Green River (water quantity) and their effects in the action area; however, changes in water quantity also may affect water quality, in both the Yampa and Green rivers which is a primary constituent element of critical habitat. Waste streams that enter the Yampa River from community wastewater treatment systems, coal-mining, gas and oil development, and other point sources, as well as from non-point sources such as irrigation return flows, can result in increased concentrations of heavy metals, selenium, salts, PAHs, pesticides, and other contaminants. Increases in water depletions will cause associated reductions in assimilative capacity and dilution potential for any contaminants which enter critical habitat in the Yampa and Green rivers.

Stephens and Waddell (1998) and Chafin et al. (2001) presented the fact that the Yampa River is the first substantial contributor of selenium to the Green River. An increase in selenium concentrations in the Yampa and Green rivers would likely result in an increase in the bioaccumulation of these contaminants in the food chain, which could adversely affect the reproduction and survival of endangered fishes. Selenium toxicity thresholds in fish and wildlife tissues are as follows: 4 ug/g dry weight in whole body fish, 8 ug/g dry weight in muscle tissue, 10 ug/g in fish eggs, 3 ug/g for food items (eaten by fish and wildlife) and 6 ug/g for bird eggs (Lemly 1996, USDI 1998). Selenium concentrations found in biota in the middle Green River are presented in Stephens et al. 1988,1991 and 1992. Selenium may be of particular concern due to its effects on fish reproduction and its tendency to concentrate in low-velocity areas that are important habitats for Colorado pikeminnow and razorback suckers. Selenium concentrations in the Jensen, Utah, area of the Green River exceed concentrations shown to impact fish and wildlife elsewhere (Stephens and Waddell 1998, USFWS 2002b).

Expansion of oil and gas development in the Yampa and Green River Basins may also result in increased contaminants in the Yampa and Green rivers. Polyaromatic hydrocarbons (PAHs) are compounds that may reach aquatic environments in domestic and industrial sewage effluents, in surface runoff from land, from deposition of airborne particulates from power plants, and particularly from spillage of petroleum and petroleum products into water bodies (Eisler 1987). Fish exposure to PAHs has been associated with liver damage and tumors (Eisler 1987). Bile samples taken from suckers collected in the Yampa River after a diesel spill in 1997 contained high PAH concentrations, demonstrating exposure (Barb Osmundson, unpublished data). Water depletions associated with oil and gas development in the Yampa River Basin are part of the proposed action.

The Recovery Program is intended to offset water quality impacts associated with flow reductions (USFWS 1987). These impacts include changes in temperature, salinity and turbidity, as well as the reduced dilution factor associated with depletions. However, the Recovery Program is not intended to offset any point or non-point discharges of pollutants, which will have to be offset or avoided by other means, including discharges of irrigation water with elevated levels of selenium. While the Recovery Program will not change discharges of irrigation water, the Recovery Program will offset water quality impacts associated with flow reductions by augmentation of late summer, fall, and winter base flows. This augmentation will increase dilution and assimilative capacity of the Yampa and Green rivers, reducing concentration of selenium and other contaminants.

*Physical Habitat*

Water depletions during spring runoff affect physical habitat in several ways. High spring flows are very important for creating and maintaining complex channel geomorphology and suitable spawning substrates, and in creating and providing access to off-channel habitats. In the Yampa/Green River system, peak flows are particularly important for transporting and depositing sediment in the preferred low-velocity nursery habitats of the Colorado pikeminnow and razorback sucker.

The ascending limb and peak of the spring hydrograph are considered to be important for transporting sediment, preparing spawning beds and providing cues to Colorado pikeminnow that spawn in Yampa Canyon. Most sediment would be transported in wet and moderately wet years. During drier-than-average years, little sediment would be transported, because critical discharge generally would not be achieved regardless of depletions. The Little Snake, provides 69 percent of the sediment to the Yampa River at Deerlodge Park, whereas the Yampa River above the confluence of the Little Snake River contributes only 27 percent (Andrews 1978). Without this sediment from the Little Snake, little downstream transport of sediment would occur regardless of flows in the Yampa River mainstem.

According to O'Brien (1987):

> *The potential for water resource development in the upper basins of the Little Snake and Yampa rivers must be carefully evaluated because of the complex interdependence of the sediment load and water discharge in both rivers. While sediment load is beneficial to maintaining substrate conditions for viable spawning, an adequate sediment supply must be maintained for beach replenishment and riparian vegetation in the canyon.*

The same holds true for the Green River downstream from the Yampa, which relies upon the Yampa (and ultimately the Little Snake River) for roughly 60 percent of the sediment that builds and maintains floodplain nursery habitats in the Jensen–Ouray reach of the Green River (Andrews 1986).

Andrews (1980) determined the effective discharges for a number of river reaches in the Yampa River Basin. He defined effective discharge as "the discharge that transported the most sediment during the period of record..." Andrews' effective discharge was 9,111 cfs for the Yampa River at Maybell and 4,485 cfs for the Little Snake River at Lily Park. Andrews found that the average durations of those discharges was 2.5 percent of the time at Maybell and 1.1 percent of the time at Lily Park. Using historic gage data from 1922–1997 and the CRDSS-estimated discharge data under undepleted and future demand conditions, Table 6 provides a comparison of the effects of depletions on durations of the effective discharge under various hydrologic conditions.

Table 6. Effective discharge average durations under various hydrologic/demand conditions [a]

| | Hydrologic Category [b] | Undepleted | | Historic | | Future (2045) | |
|---|---|---|---|---|---|---|---|
| | | Days/year | % year | Days/year | % year | Days/year | % year |
| Maybell | Wet (n = 8) | 34 | 9.3% | 30 | 8.2% | 30 | 8.2% |
| | Mod. Wet (n = 15) | 19 | 5.2% | 13 | 3.6% | 12 | 3.3% |
| | Average (n = 30) | 8 | 2.2% | 6 | 1.6% | 5 | 1.4% |
| | Mod. Dry (n = 15) | 2 | 0.5% | 1 | 0.3% | 0 | 0.1% |
| | Dry (n = 8) | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| | Wgt. Avg. (n = 76) | 11 | 3.0% | 8 | 2.2% | 8 | 2.2% |
| Lily Park | Wet (n = 8) | 24 | 6.6% | 19 | 5.2% | 14 | 3.8% |
| | Mod. Wet (n = 15) | 11 | 3.0% | 8 | 2.2% | 5 | 1.4% |
| | Average (n = 30) | 6 | 1.6% | 4 | 1.1% | 1 | 0.3% |
| | Mod. Dry (n = 15) | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| | Dry (n = 8) | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| | Wgt. Avg. (n = 76) | 7 | 1.9% | 5 | 1.4% | 3 | 0.8% |

[a] Based on gaged historic and CRDSS-estimated undepleted and future hydrographs for 76-year period of record (January 1, 1922 – December 31, 1997)

[b] Wet (≤10 percent exceedance), Mod. Wet (>10–30 percent exceedance), Average (>30–70 percent exceedance),
Mod. Dry (>70–90 percent exceedance), Dry (>90 percent exceedance)

Historically, the effective discharge was exceeded only 1.6 percent of the time at Maybell and 1.1 percent of the time at Lily Park during average hydrologic conditions. Even under undepleted demand conditions, the effective discharge would have been exceeded 2.2 percent of the time at Maybell and 1.6 percent of the time at Lily Park during average hydrologic conditions, and only 0.5 percent of the time at Maybell during moderately dry conditions. Effective discharge has never been exceeded during drier-than-average conditions at Lily Park. Overall, effective discharge was exceeded 3 percent of the time at Maybell and 1.9 percent of the time at Lily Park under undepleted conditions, compared with 2.2 percent at Maybell under both historic and future conditions, and 1.4 percent and 0.8 percent at Lily Park under historic and future conditions, respectively. Water depletions included in the proposed action will reduce the effective discharge and sediment transport by small percentages. Reduction in sediment transport reduces the ability to form nursery habitats downstream in the Green River.

O'Brien (1987) found that annual sediment loads at Deerlodge Park were equivalent to those at Mathers Hole. Moreover, he concluded ". . . sediment transported through the canyon was in approximate long-term equilibrium with the upstream supply." The Little Snake River supplies 69 percent of the sediment to Deerlodge Park (Andrews 1980), but sediment transport beyond Deerlodge Park is constrained by flow conditions (O'Brien 1987). Therefore, the sediment load at Deerlodge Park constitutes the sediment supply to Yampa Canyon. Predicted sediment transport capacity at Mathers Hole is greater than at Deerlodge Park, because of its steeper slope. However, because there are no significant sources of sediment downstream from Deerlodge Park, the sediment load at Mathers Hole is constrained by the ability of the upstream alluvial reach to supply that sediment (O'Brien 1987).

Bedload, sediment transported along the riverbed rather than in suspension, is less than 1 percent of the total load. Suspended sediment accounts for more than 99 percent of the total load and, therefore, was used to reflect the total historic load (O'Brien 1987). Quantities of sediment that would be transported by gauged and CRDSS-simulated hydrographs through several key river reaches under various demand and hydrologic conditions (Appendix C, Figure C8) were estimated using flow-transport relationships developed by O'Brien (1987). This approach also provides an assessment of sediment balance between these reaches.

Average annual sediment transport in all reaches and hydrologic categories is reduced under historic and projected future demand conditions relative to comparable undepleted conditions (Appendix C, Figure C8). However, the differences in sediment transport were less apparent at Maybell, due to the relatively flat slope of its flow-sediment relationship. Within each reach and demand condition, absolute changes in sediment transport were greatest during wet years, whereas the percentage of change was greatest during dry years.

Relative to undepleted conditions, estimated future annual sediment supply is reduced by as little as 10 percent at Maybell under wet hydrologic conditions and by as much as 47 percent at Lily Park under dry conditions. Even though estimates of sediment supplied to Yampa Canyon is reduced, estimated supply and transport capacity remain roughly in balance under all conditions. That is, the reduction in the amount of sediment delivered to the head of Yampa Canyon is comparable to the reduction in the amount of sediment transported through the canyon. Sediment load at Deerlodge Park and Mathers Hole also are reduced from about 11 percent under wet conditions to about 31 percent under dry conditions. These estimates are not supply-limited, but are based solely on site-specific regression formulae (Appendix C, Figure C8) and gauged daily average flows (Q). They are well within the observed variability of measured sediment loads (O'Brien 1984). Historically, supplies of sediment to and transport through the Yampa Canyon appear to be in long-term equilibrium. Moreover, existing and proposed depletions do not appear to threaten this equilibrium in the foreseeable future (2045). Therefore, impacts to spawning bars and beaches in Yampa Canyon should be minimal.

*Habitat Restoration*

The habitat restoration element of the Recovery Program will enhance, restore, and protect natural floodplain habitat through easement/acquisition of floodplain property, dike removal, and physical manipulation of habitat. Floodplain habitats are primarily located on the Green River downstream of the Yampa River confluence. Floodplain habitats inundated and connected to the main channel by high spring flows are typically warmer and substantially more productive than the adjacent river and have abundant vegetative cover. Floodplain habitat has been identified as important for adult Colorado pikeminnow during the pre-spawning period and for all life stages of razorback sucker. Restoration of bottomland habitat is providing pre-spawning staging habitat for Colorado pikeminnow. It will also provide pre-spawning, post-spawning, and nursery habitat for razorback sucker. Bottomland habitats have not been identified as important to humpback chub. Not enough information is available to determine potential benefits to bonytail.

The lack of availability of seasonally flooded habitats has been identified as a major factor in the decline of razorback sucker populations. Wydoski and Wick (1998) concluded that zooplankton densities in the main channel of the Green River never reached densities required for larval razorback sucker to survive. However, they consistently found zooplankton densities necessary for survival in floodplain habitats. Because razorback suckers spawn on the ascending limb of the spring runoff hydrograph, when main channel food organism densities are extremely low, Wydoski and Wick (1998) concluded that starvation may be a factor in larval razorback mortality. Wydoski and Wick (1998) also concluded that floodplain habitat with vegetative cover provides protection from nonnative predators for larval and juvenile razorbacks. The Service believes that restoring floodplain habitats will increase densities of zooplankton and benthic invertebrates to provide adequate quantity and quality of food organisms for larval razorback sucker growth and survival; and the vegetative cover provided in floodplain habitat will help reduce predation by nonnative fishes.

The Recovery Program recently developed a floodplain management plan for the Green River subbasin (Valdez and Nelson 2004) to provide restoration and management strategies for existing floodplain sites. The plan focuses on a 107-mile reach of the Green River between Split Mountain Canyon and Desolation Canyon where there are 37 potential floodplain sites totaling 11,400 acres. The plan identifies 16 floodplain sites (4,448 acres) for restoration and management, the Recovery Program has restored and currently manages 6 of these sites (819 acres). The plan will be implemented in three phases. Phase I will provide restoration and management at Thunder Ranch (330 acres) and Stewart Lake Waterfowl Management Area (570 acres). Phase II will provide restoration and management of two sites at Ouray National Wildlife Refuge (1,162 acres), with potential for restoration of additional sites on the Refuge. Phase III involves restoration of five additional sites totaling 3,936 acres. The Green River subbasin floodplain management plan is one action of the Recovery Action Plan which is an adaptive management plan. Additional information and changing priorities sometimes require modification of the Recovery Action Plan. Therefore, the Recovery Action Plan is reviewed annually and updated and changed when necessary. Therefore, it is possible that the specifics of the Green River subbasin floodplain management plan could be changed through the Recovery Action Plan annual review process.

A model was developed to determine the amount of floodplain depressions necessary to provide nursery and rearing habitat to support a self-sustaining population of razorback sucker in the Green River subbasin (Valdez 2004). The model estimates that an average of 2,032 acres of floodplain depressions will be required. Existing restoration and management and implementation of Phase I and II of the floodplain management plan will provide a total of 2,551 acres at 9 sites.

*Biological Environment*

Food supply, predation, and competition are important elements of the biological environment. Stocking of nonnative fishes and the modification of flow regimes, water temperatures, sediment levels, and other habitat conditions caused by water depletions has contributed to the establishment of nonnative fishes in the Yampa and Green rivers. Nonnative fishes often are stocked in and enter rivers from off-channel impoundments. In the Yampa River Basin, northern pike and smallmouth bass have escaped from Elkhead Reservoir in the past and now are believed to support self-sustaining populations in the river. Channel catfish had been stocked into the

Yampa River and are widely distributed in critical habitat reaches. The periodic introduction of these nonnative fishes into a river allows them to bypass limitations to reproduction, growth, or survival that they might encounter in the river. Consequently, populations of nonnative fishes in the river are enhanced. Endangered and other native species in the river experience greater competition and predation as a result. Tyus and Saunders (1996) concluded that nonnative fish play a significant role in the decline of the Colorado River endangered fishes.

*Nonnative Fish Management*

The Recovery Program recently finalized the *Nonnative Fish Management Policy* that states "management of nonnative fish species will initially follow an experimental approach to develop effective strategies and identify the levels of management necessary to minimize of remove threats to the endangered fishes." An assessment of data every year will determine future nonnative fish management strategies. Currently the nonnative species of greatest concern are: northern pike (*Esox lucius*), smallmouth bass (*Micropterus dolomieui*), and channel catfish (*Ictalurus punctatus*).

The implementation of the Nonnative Fish Stocking Procedures (USFWS 1996) will help reduce competition and predation from nonnative fish by prohibiting these species from being stocked into waters occupied by the endangered fishes. Further reduction of nonnative fishes should come with the State of Colorado's removal of bag limits on all nonnative warmwater sportfishes within critical habitat.

In the recent past, the Recovery Program has removed northern pike from the Yampa River upstream from Yampa Canyon, while removing channel catfish from Yampa Canyon. Northern pike have been translocated into off-channel ponds and reservoirs where they are available to anglers, but unlikely to return to the river. In 2003, this effort was expanded to include smallmouth bass, which were translocated to Elkhead Reservoir. Although the ongoing nonnative management actions are not expected to eradicate these species from the river, the expectation is that their populations will be reduced sufficiently to allow endangered fish populations to expand.

A Fisheries Management Plan is being developed for Elkhead Reservoir, but it has not yet been finalized. This plan is expected to incorporate measures for nonnative fish control and management of sportfish in the reservoir, including a stipulation that smallmouth bass, translocated from the Yampa River may be stocked into Elkhead Reservoir, along with hatchery-produced bluegill, black crappie, and trout. Northern pike, largemouth bass and channel catfish would not be stocked unless approved by all signatories of the Nonnative Fish Stocking Procedures.

As outlined in the description of the proposed action, to prevent escapement of nonnative fishes from Elkhead Reservoir the Recovery Program proposes to screen all controlled releases of water up to 550 cfs through the tower outlet (480 cfs) and service outlet (70 cfs) with ¼-inch wedge-wire screens. To provide operational flexibility and redundancy, the tower will be fitted with three gated intakes: one bottom intake; one intermediate intake; and one upper intake. All three tower intakes and the service intake will be screened. The Recovery Program will continue to monitor the escapement of fish from the spillway and install anchors for a spillway net while the reservoir is drawn down for construction. Future installation of a spillway net will be considered based on results of spillway escapement monitoring and nonnative fish control efforts in the Yampa River.

*Propagation*

Recovery Program propagation activities will provide endangered fishes for augmentation of populations and provide refugia to insure various stocks of endangered fishes will not be lost. Propagation facilities have been or will be expanded at the Ouray National Fish Hatchery, Wahweap, and in the Grand Valley. In addition, the State of Colorado recently completed the Mumma Native Aquatic Species Facility near Monte Vista.

Populations of razorback sucker and bonytail are so low in the Upper Colorado River Basin that augmentation of populations is an essential tool for species recovery. Both species have been stocked into the Green River in recent years. Bonytail also have been stocked in the Yampa River near its mouth. All stocking is implemented in accordance with state stocking plans approved by the Service.

## Critical Habitat Response to the Proposed Action

As identified earlier, the primary constituent elements of critical habitat for the Colorado River endangered fishes are water, physical habitat, and the biological environment (59 F.R. 13374). Water includes a quantity of water of sufficient quality delivered to a specific location in accordance with a hydrologic regime required for the particular life stage for each species. The physical habitat includes areas of the Colorado River system that are inhabited or potentially habitable for use in spawning and feeding, as a nursery, or serve as corridors between these areas. In addition, oxbows, backwaters, and other areas in the 100-year floodplain, when inundated, provide access to spawning, nursery, feeding, and rearing habitats. Food supply, predation, and competition are important elements of the biological environment.

*Water and Physical Habitat*

Depletions from the Yampa River have and will continue to have adverse impacts on the endangered fishes and their habitats in the Yampa and Green river systems. Compared to other tributaries of the Colorado and Green rivers, there is little reservoir storage in the Yampa River Basin to reduce peak flows or augment base flows. As a result, although flows are diminished across the entire annual hydrograph relative to baseline flow conditions, the Yampa River hydrograph will retain its natural, snowmelt-driven shape. It is this characteristic of the Yampa River that makes it particularly important to the endangered fishes, providing shape to the hydrograph of the Green River, as well.

Peak flows are particularly important for transporting sediment. Adequate sediment transport is important because cobble and gravel deposits free of silt and sand are preferred spawning sites of the endangered fishes (Tyus 1990; Harvey et al. 1993; Harvey and Mussetter 1994; Wick 1997), and backwaters (the preferred nursery habitat of young Colorado pikeminnow) are maintained by periodic removal of accumulated sediments and rejuvenation of deposits that provide the structure for formation of the habitat after spring flows recede (Rakowski and Schmidt 1999, Osmundson et al. 1995). The Service believes that improving spawning and nursery habitats should result in increased reproductive success and survival of young fish (i.e., enhanced recruitment) which, over time, should lead to increases in endangered fish populations.

The Yampa River may experience extremely low flow conditions in dry years, historically as little as 2 cfs at Maybell, with average annual flow minima of about 130–140 cfs during an 83-year period (1916–1998). Base-flow augmentation is a key measure of the proposed action to minimize the impacts of depletions, allowing for base flows to be augmented 33–50 cfs depending on hydrologic conditions. In summer and fall, augmentation will provide minimum flows of 33–138 cfs, the upper limit of which would curtail augmentation until unaugmented flows again dropped to 78 cfs or less. In winter, base flows would be augmented to provide minimum flows of 33–169 cfs, at which upper point augmentation would be curtailed until flows again fell to 109 cfs. Base-flow augmentation should improve habitat conditions for the endangered fishes during this critical period. Elkhead Reservoir was selected to serve as the augmentation water supply largely because of its proximity to critical habitat, thereby minimizing transit losses and lag time, and its ability to deliver the full 7,000 AF (including transit losses) every year that augmentation is needed without significantly impacting peak flows in the Yampa River.

Without implementing the proposed augmentation plan, recommended summer/fall base-flow targets for the Yampa River would not be met in drier-than-average years in the face of current or projected future depletions. With the base-flow augmentation plan, base-flow targets for August–October (93 cfs) and November–February (124 cfs) in their historical context will be met in all but the extremely dry years. Base-flow recommendations are intended to maintain habitats of sufficient quality and quantity to sustain populations of adult Colorado pikeminnow and humpback chub within the Yampa River. Razorback sucker do not use the Yampa River during this period, and there is too little information about the distribution and habitat preferences of the bonytail to ascertain its flow needs. However, the recommended flows are intended to maintain riffle habitats that are important for production of macroinvertebrates, the basis of a food web on which all four endangered fishes rely. Osmundson et al. (1995) found that adult Colorado pikeminnow mostly use pools and backwaters during winter in the 15-Mile Reach of the Colorado River. Although there is less certainty with respect to the winter flow needs of Yampa River fishes, winter flows with the proposed action should provide adequate depth in these habitats for overwinter survival.

The proposed action is not designed to offset the adverse impacts of Flaming Gorge Dam on peak flows in the Green River system. However, peak-flow recommendations for the Green River at Jensen, Utah, "were developed in part, on the basis of the assumption that future changes in flow temperature, and sediment regimes of the Yampa River and other Green River tributaries will be consistent with existing or known pending biological opinions (Muth et al. 2000). To maximize peak flows in the Green River, these recommendations call for water to be released from Flaming Gorge Dam to coincide with and reinforce peak flows from the Yampa River. Habitat restoration measures underway or proposed in the Green River floodplain should improve habitat conditions for drifting larvae of Colorado pikeminnow and razorback sucker.

The benefits of these measures will be enhanced if Flaming Gorge peak-flow recommendations are met, which is an assumption underlying this biological opinion.

The proposed action included implementation of the *Green River Subbasin Floodplain Management Plan.* The Service believes that providing floodplain habitats in the Green River with adequate depth and reduced nonnative predators and/or competitors will likely increase survival of young Colorado pikeminnow and, in particular, razorback sucker, thereby potentially resulting in stronger year classes and enhanced levels of recruitment.

*Biological Environment*

The fish communities of most rivers in the Upper Colorado River Basin are dominated by nonnative fishes; these fishes have been identified as contributing to reductions in distribution and abundance of native fishes (Carlson and Muth 1989). Because introduced species vary in body size, environmental tolerances and habitat preferences, and have wide distributions, high abundance, and diets ranging from herbivory to piscivory, they are potential competitors with or predators on nearly all life stages of native fishes, but particularly young life stages in nursery habitats. Lentsch et al. (1996) and Tyus and Saunders (1996) emphasized the need for nonnative fish control to achieve recovery of the endangered fishes and presented options for controlling nonnative fishes in the Upper Basin that included more restrictive stocking protocols, more liberalized harvest regulations, mechanical removal, chemical eradication, and management of flows to benefit native fishes and suppress the abundance of nonnative fishes.

Nonnative fishes are considered to pose the greatest threat to the endangered fishes in the Yampa River. Nonnatives of greatest concern in the Yampa River Basin are channel catfish, northern pike, and smallmouth bass, because of known or suspected negative interactions with native fishes (Hawkins and Nesler 1991; Nesler 1995). Tyus and Saunders (1996; 2001) recommended several strategies and actions for the Yampa River to deal with these issues including development of a fisheries and conservation management plan emphasizing public relations and acceptable alternative fishing opportunities, and controlling the escapement of nonnative fishes from Elkhead Reservoir.

The following nonnative fish control measures are part of the proposed action: 1) implementing nonnative fish stocking procedures; 2) removing angler bag and possession limits in Colorado; 3) removing and translocating northern pike and smallmouth bass; 4) controlling escapement of nonnative fishes from Elkhead Reservoir 5) lethally removing channel catfish from Yampa Canyon. Effective implementation of these actions will depend on the support of the CDOW and local citizens. Ongoing Recovery Program projects to actively control nonnative fishes in the Yampa River include lethal removal of channel catfish from Yampa Canyon and removal and translocation of northern pike and smallmouth bass upstream from Yampa Canyon to Hayden, Colorado. The purpose of the September 1996 *Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin* (USFWS 1996) is to ensure that all future stocking of nonnative fishes will be consistent with recovery of the endangered fishes. Relaxation of bag limits for nonnative sportfish in critical habitat is intended to increase harvest by anglers. Nonnative fish control activities implemented by the Recovery Program should improve the quality of habitat for all endangered fishes by reducing predation and competition for food and space, resulting in enhanced native fish population abundance.

The proposed action also includes monitoring populations of both the endangered fishes and nonnative fishes. A reduction in nonnative fish populations may not produce an immediate, measurable positive response in endangered fish populations due to the longevity of the endangered fishes, as well as the co-occurrence of other confounding factors affecting their populations. However, a decline in targeted nonnative fish populations would be considered evidence of the potential beneficial effect of nonnative fish management on endangered fish populations by reducing competition and predation by these nonnative species. Population response criteria will be developed as described in the terms and conditions of the incidental take statement in this biological opinion to determine, among other things, whether a decline in nonnative fish populations has occurred and the likely benefit of that decline on endangered and other native species.

Species Response to the Proposed Action

Ongoing or planned Recovery Program actions for the endangered fishes in the Yampa River include augmentation of base flows, implementing control measures for nonnative fishes, restoring floodplain habitat in the Green River, and augmenting endangered fish populations through stocking to assist in reestablishing viable populations (particularly bonytail and razorback sucker). The Service has concluded that although the flow-related recovery actions will not be sufficient to fully offset all the adverse effects of historic and new water depletions, it is expected that a combination of flow and non-flow management activities will provide suitable habitat for increasing numbers of the endangered fishes and likely restore, maintain and protect critical habitat to adequately offset such depletions and to minimize take, including harm. The life history of the endangered fishes suggests that populations are recruitment-limited (Wydoski and Wick 1998); therefore, ensuring adequate levels of recruitment appears to be the key for their recovery. The expected long-term response of the endangered fishes to habitat restoration and population augmentation (where needed) will be a function of the enhancement of populations through increases in abundance, expansion of current distributions, and restoration of viable population structure (i.e., all life stages present and successful recruitment of young to adult stocks).

Criteria to determine positive or negative fish population responses based on Colorado pikeminnow will be developed as described in the terms and conditions of the incidental take statement in this biological opinion. When population estimates for wild adult humpback chub are finalized, they will also be used to determine population response. Colorado pikeminnow and humpback chub will serve as surrogates for razorback sucker and bonytail, until population estimates for those species are possible.

Habitat restoration and augmentation of populations through stocking to provide sufficient numbers of fish to take full advantage of restored habitats are key elements for recovery of the endangered fishes. Floodplain habitats inundated and connected to the main channel by high spring flows are typically warmer and substantially more productive than the adjacent river and have abundant vegetative cover. These habitats apparently are important growth and conditioning areas for all life stages of razorback sucker (also used by adult Colorado pikeminnow), but are critical for survival of early life stages (Wydoski and Wick 1998; Muth et al. 1998). The decline of razorback sucker in the Upper Colorado River Basin has been linked to recruitment failure, and recovery of the species seems unlikely without restoration of floodplain habitats. Enhanced growth of young razorback suckers in warm, food-rich floodplain habitats may increase overall survival by reducing the effects of size-dependent processes on survival, such as shortening the period of vulnerability to predation by nonnative fishes (Muth et al. 1998).

The Service concludes that the effect of implementation of the recovery actions will be an increase in the populations of all four species of endangered fish. The Service believes the above recovery actions must be accomplished on schedule to halt further habitat degradation and promote restoration of important habitats and enhancement of endangered fish populations. The Service anticipates that the combination of flow and non-flow recovery actions will increase populations of endangered fishes and restore critical habitat. The Service will use fish population responses to determine if the recovery actions are producing the desired positive results, but, because the endangered fishes are long-lived, detection of responses to recovery actions may take several years. Ultimately, the anticipated long-term species response to the recovery actions is attainment of recovery goals.

## CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Endangered Species Act. The Service is not aware of any future non-Federal actions not included in this action under consultation involving water depletions that are reasonably certain to occur in the action area.

## CONCLUSION

After reviewing the current status of the endangered fishes, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Colorado pikeminnow, razorback sucker, bonytail, or humpback chub and is not likely to destroy or adversely modify the designated critical habitat of these species. The implementation of the Yampa Plan and its associated Recovery Action Plan elements are expected to result in beneficial effects to critical habitat on the Yampa River and Green River downstream from its confluence with the Yampa River and induce a positive species response. These beneficial effects include:

- augmentation of late summer/fall base flows in the Yampa River that will provide improved habitat quantity and quality for adult endangered fishes

- restoration of bottomland habitat in the Green River that will provide nursery habitat for razorback sucker

- implementation of measures to prevent endangered fishes from being lost to the river system in diversion canals

- implementation of nonnative fish management to reduce competition and predation with endangered fishes

- propagation and stocking of endangered fishes to increase numbers of endangered fishes in the Green and Yampa rivers

Water depletions included in the Yampa Plan will cause adverse effects to the subject endangered fishes and their designated critical habitat. However, with the implementation of the Recovery Action Plan elements the adverse effects are not likely to jeopardize the continued existence of the species. Implementation of the subject elements will avoid direct or indirect alteration of critical habitat that appreciably diminishes the value of critical habitat for the conservation of the endangered fishes.

## INCIDENTAL TAKE

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are nondiscretionary, and must be undertaken so that they become binding conditions of any Federal discretionary activity, for the exemption in section 7(o)(2) to apply. The participating Federal Agencies have a continuing duty to monitor the activity covered by this incidental take statement. If the Recovery Program 1) fails to assume and implement the terms and conditions or 2) fails to retain oversight to ensure compliance with the terms and conditions, the protective coverage of section 7(o)(2) may lapse for the projects covered by this incidental take statement.

The Service anticipates that take in the form of harm will occur in association with current and future water depletions. Colorado pikeminnow, humpback chub, bonytail, and razorback sucker are harmed from the reduction of water in their habitats resulting from the project in the following manner: 1) individuals using habitats diminished by the proposed water depletions could be more susceptible to predation and competition from nonnative fish; 2) habitat conditions may be rendered unsuitable for breeding and raising of young because reduced flows would impact habitat formulation and maintenance as described in the biological opinion.

In addition, take is anticipated to occur when water is diverted from the river for irrigation, municipal, and industrial water systems addressed in this biological opinion. This incidental take is expected to be in the form of mortality because any fish that enter canals or other water diversions that serve agricultural areas or irrigation, municipal, and industrial facilities may not survive if they are stranded when water is no longer diverted. Take is also anticipated from predation and/or competition by nonnative fishes with the four listed fishes, if nonnative fishes escape from Elkhead Reservoir during or after construction of reservoir enlargement. The purpose of the reservoir enlargement is to provide flows for endangered fishes in the Yampa River during low water periods. Any incidental take associated with other recovery actions has been or will be addressed during project specific environmental compliance. The Recovery Program will be responsible for providing any required reasonable and prudent measures to minimize incidental take.

AMOUNT OR EXTENT OF TAKE

Water depletions cause incidental take in the form of harm by reducing habitat availability and habitat maintenance capability of the Yampa and Green rivers as described in the "effects of the action" section in the accompanying biological opinion. Estimating the number of individuals of these species that would be taken as a result of water depletions is difficult to quantify for the following reasons: 1) determining whether an individual failed to breed as a result of water depletions versus natural causes would be extremely difficult to determine; 2) finding a dead or injured listed fish would be difficult, due to the large size of the project area and because carcasses are subject to scavenging; 3) natural fluctuations in river flows and species abundance may mask project effects, and 4) effects that reduce fecundity are difficult to quantify. According to Service policy, as stated in the Endangered Species Consultation Handbook (March 1998) (Handbook), some detectable measure of effect should be provided, such as the relative occurrence of the species or a surrogate species in the local community, or amount of habitat used by the species, to serve as a measure for take. Take also may be expressed as a change in habitat characteristics affecting the species, such as water quality or flow (Handbook, pp. 4-47 to 4-48). Because estimating the number of individuals of the four listed fishes that could be taken by the water depletions addressed in this biological opinion is difficult, we have developed a surrogate measure to estimate the amount of anticipate take to listed fish in the form of harm. The surrogate we are using is the reduction of water that would occur from the proposed action. We exempt all take in the form of harm that would occur from an average annual 167,854 AF of existing water depletions and an average annual 53,532 AF of future water depletions. Water depletions above the amount addressed in this biological opinion would exceed the anticipated level of incidental take and are not exempt from the prohibitions of section 9 of the ESA. The method for determining the actual level of new depletions is described in Appendix D.

> Adult Colorado pikeminnow may be taken by entrainment in unscreened irrigation diversions on the reach of the Yampa River from Deerlodge Park upstream to Craig. In the Grand Valley of the Colorado River, endangered fishes have been found in irrigation canals. However, these canals divert considerably more volume than any diversion on

> the Yampa River, therefore fewer fish are anticipated to be entrained in irrigation canals on the Yampa River than on the Colorado River. Adult Colorado pikeminnow may also be taken by entrainment in irrigation canals or through municipal or industrial water delivery systems from Craig, Colorado, downstream to Dinosaur National Monument. The Service does not anticipate incidental take of larval or young-of-the-year Colorado pikeminnow in irrigation, municipal, or industrial water delivery systems, because these life stages do not occur above Dinosaur National Monument. Razorback sucker, humpback chub and bonytail are unlikely to occur upstream from Yampa Canyon and therefore, unlikely to be incidentally taken. However, Green River populations of razorback sucker are being augmented with hatchery-raised fish. In addition, bonytail also are being stocked near the mouth of the Yampa River. Therefore, at such time as there are sufficient numbers of adult razorback sucker and/or bonytail in the middle Green/Yampa rivers to disperse upstream into the Yampa River, incidental take of these species by entrainment may need to be re-evaluated.

The Service finds that the anticipated amount of incidental take associated with irrigation, municipal, and industrial water delivery systems will be difficult to detect because finding a dead or impaired specimen is unlikely; the water may be very turbid, making it difficult for fish of any size to be easily observed, and any stranded fish will be susceptible to predators and scavengers. However, the anticipated incidental take for Colorado pikeminnow >300 mm was estimated as follows.

> Numerous diversions and pumps occur the Yampa River from Craig to Lily Park, mostly for agricultural purposes. Many of these diversions and pumps are very small and pose little threat to fish >300 mm, because fish of this size are not likely to enter small canals or be impinged on pump screens. Large municipal and industrial diversions are located upstream from critical habitat. However, at least one major irrigation diversion below Craig, the Maybell Canal, is large enough for adult pikeminnow to enter.
>
> The Service anticipates an annual incidental take of less than one percent of the current adult Colorado pikeminnow population below Craig. Recent preliminary populations estimates for Colorado pikeminnow in the Yampa River below Craig are 253 adults (Bestgen et al. 2004). Therefore, the current level of anticipated incidental take is less than 3 adult Colorado pikeminnow per year. As population estimates change (either up or down), the level of anticipated incidental take would change proportionately.

Incidents of predation by northern pike on endangered fishes have been observed in both the Yampa and Green rivers. Other nonnative predators, such as smallmouth bass and channel catfish, also present a threat to endangered fishes due to both predation and competition for food and space. Evidence of attempted predation includes bite marks observed on Colorado pikeminnow that escaped from northern pike and remains of Colorado pikeminnow and razorback sucker found in the stomachs of northern pike (J. Hawkins, pers. comm.; K. Christopherson, pers. comm.). There has been no direct observation of predation on humpback chub or bonytail, but given their smaller adult sizes it is highly likely that these species also suffer predation by northern pike, as well as smallmouth bass and channel catfish. Smallmouth bass and channel catfish are not considered capable of preying on large adult Colorado pikeminnow or razorback sucker. However, they could prey upon smaller life stages of these species, as well.

Quantification of take due to predation by nonnative fishes is difficult. Only recently ingested endangered fishes are likely to be found in nonnative predators. The two endangered fishes that were directly observed to be taken by northern pike were found only serendipitously. The Colorado pikeminnow was so large that its caudal fin protruded from the mouth of the northern pike, and the razorback sucker was found only because it had been stocked and its implanted PIT tag was detected through the gut of the northern pike.

Incidental take could result from nonnative fish management activities sponsored by the Recovery Program. Injury or mortality can result from capturing fish by electrofishing, netting, and angling. Take associated with research and fishery management activities are addressed under ESA section 10(a)(1)(A) permits (scientific collecting permits).

In addition, actions taken by anglers in accordance with state fishing regulations can result in injury or mortality of endangered fishes. The State of Colorado relaxed bag and possession limits for nonnative sportfish taken from the Yampa River, and is encouraging anglers to participate in an activity that could harm the endangered fishes, particularly the Colorado pikeminnow due to inadvertent capture and subsequent handling prior to release. This provision is applicable only to take that is incidental to the otherwise lawful activity of sportfishing; it confers no protection from the prohibitions of section 9 of the ESA due to willful, malicious acts that result in injury or death to protected species. The relaxed bag and possession limits are considered part of the Yampa Plan and part of the State of Colorado's commitment to nonnative fish management within critical habitat of the endangered fishes. Therefore, harming or killing endangered fishes by angling in the Yampa River is exempt from the prohibitions of section 9 of the ESA.

If Elkhead Reservoir is enlarged, take may occur during construction, when the reservoir would be drawn down to facilitate construction. Northern pike were originally stocked in Elkhead Reservoir in 1977 and have escaped into the Yampa River (T. Nesler, pers.comm.). When Elkhead Reservoir was drawn down in the early 1980s it is thought that large numbers of northern pike escaped the reservoir. Results of recent studies indicate black crappie and bluegill are the dominant species escaping over the Elkhead Reservoir spillway (Nesler and Miller 2003). These species are predominantly lake dwelling fish and are rarely captured in the Yampa River. Nonnative fishes potentially could escape from the reservoir during the construction period. However, to minimize escapement, the existing controlled outlet would be screened prior to initially drawing down the reservoir, and the spillway would also be screened prior to the 2005 spring runoff. After construction, the new spillway would not be screened; therefore, escapement of nonnative fishes from the reservoir would be possible over the new spillway. Part of the proposed action includes screening the new outlet works at Elkhead Reservoir, operating the controlled outlet(s) to minimize spillway discharge, and monitoring fish escapement over the spillway.

## REASONABLE AND PRUDENT MEASURES

The implementation of the Recovery Program and the specific actions outlined in the Yampa Plan are intended to recover the listed species and minimize impacts of water depletions, therefore, the recovery action items outlined in the biological opinion will also serve as reasonable and prudent measures for minimizing the take that results from the water depletions addressed in the biological opinion. To reduce the level of incidental take of adult and subadult Colorado pikeminnow, the following reasonable and prudent measures have been developed to minimize take:

1. The Recovery Program will monitor all new water depletion projects over 100 AF/year to determine impacts to peak flows on the Yampa River.

2. The Recovery Program will evaluate the level of incidental take due to entrainment of Colorado pikeminnow by diversion canals within critical habitat on the Yampa River.

3. If found appropriate in the evaluation, the Recovery Program will implement measures to reduce take at diversion canals within critical habitat on the Yampa River.

4. The Recovery Program will continue efforts to minimize the impacts of nonnative fishes on the four listed fish species.

5. The Recovery Program will continue to coordinate a targeted public outreach program to inform local stakeholders of the nonnative fish management activities and to educate anglers.

6. Within one year of the issuance of this biological opinion, the Recovery Program will develop criteria to determine positive or negative population responses for Colorado pikeminnow. When population estimates for wild humpback chub are finalized, they will be used to determine population response. These two species will serve as surrogates for bonytail and razorback sucker until population estimates for those species are possible. In addition, the status of nonnative fish populations will be used to assess the effectiveness of nonnative fish control activities in reducing the abundance of nonnative fishes, and the status of native fish populations will be used to assess any response of the native fish community to reductions in the abundance of nonnative fishes.

7. The Recovery Program will provide an annual assessment of Yampa River recovery actions.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that the anticipated level of incidental take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat with full implementation of recovery actions.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the following terms and conditions, which implement the reasonable and prudent measures described above, must be satisfied. These terms and conditions are nondiscretionary.

1. The Recovery Program will use the CRDSS hydrologic model to track and analyze all new water depletion projects over 100 AF/year to determine impacts to peak flows on the Yampa River in critical habitat. The Recovery Program will provide the results of the analysis to the Service.

2. The Recovery Program will develop a plan to monitor the amount of take due to entrainment by December 31, 2005, and add it to the Recovery Action Plan. Specific implementation elements and timing will be determined in the plan. At a minimum, and as an initial effort, this assessment will involve a survey of the Maybell Canal, following the end of the irrigation season. Such a survey will serve a dual purpose of evaluating take and, if any endangered fishes are found, salvaging surviving individuals and returning them to the river alive. Because endangered fishes are rare upstream from Yampa Canyon, other native species >300 mm in length may serve as surrogates for the endangered fishes. The rate of entrainment would be determined based on the number of individuals of endangered or surrogate species recovered from the canal versus an estimate of population densities in the river. The evaluation of take will include recommendations for minimization of take at diversion canals in critical habitat.

3. If found appropriate in the evaluation and after approval by the Service, the Recovery Program will implement one or both of the following:

   i. Design and construct fish preclusion devices to prevent or reduce adult and subadult fish (>300 mm TL) from entering diversion canal(s).

   ii. Undertake annual fish salvage activities to recover any endangered fish that may be trapped in diversion canals and return these fish to the river alive.

4. The CDOW is in the process of developing a Lake Management Plan for Elkhead Reservoir. The Recovery Program will ensure completion of a Final Lake Management Plan for Elkhead Reservoir, that has been approved by the Service, prior to stocking fish in the reservoir.

5. The Recovery Program will strategically place and maintain signs and implement public outreach on the following: how to identify the endangered fishes; proper handling prior to and during release back to the river; and the legal ramifications for failing to exercise due caution and care with respect to these species. The Recovery Program will maintain an active public outreach program to inform local stakeholders of Recovery Program activities in the Yampa River basin.

6. The population response criteria will be based on the following factors. Factors a and b will be used as an interim assessment of the status of the species.

    a. One major element of the proposed action is to implement nonnative fish control measures in the Yampa River. Therefore the Service is anticipating a significant reduction in the nonnative fishes in the Yampa River, especially small mouth bass and northern pike. Data from the nonnative control program will be examined annually with the first data synthesis expected in 2006 to determine if there has been a depletive effect in nonnative fish populations in the Yampa River.

    b. The Yampa River has seen recent declines in populations of all native fish species. In 2006, the Recovery Program will examine the results of the ongoing the native fish population response study and determine if there has been an increase or decrease in native fish populations in the Yampa River associated with ongoing nonnative fish control actions.

    c. The Recovery Program is conducting Colorado pikeminnow population estimates for the years 2000–2003 for the Green River subbasin. This includes population estimates for the Lower Green, Middle Green, White and Yampa rivers. These population estimates will be used to determine existing conditions for the purposes of a population response. The Recovery Program is also conducting estimates of the Desolation-Gray and Yampa Canyon populations of humpback chub in the Green River subbasin. The next population estimate will be conducted for the years 2006–2008. The population response criteria will use these population estimates to determine a positive response or a significant decline. Evaluations of stocked razorback sucker and bonytail will be used to develop population criteria for these species.

    d. The Yampa River contains one of two major spawning areas for the Colorado pikeminnow documented by collection of larval fish. Any indication that reproduction has ceased to occur or has been significantly diminished in the Yampa River would be a factor in determining population response.

    e. Recruitment to the adult population is an important factor in determining population trends. Therefore, recruitment rates will be incorporated into the population response criteria.

7. The Recovery Program shall provide an annual report on the status of recovery actions in the Green and Yampa River Basins. This will include a report on nonnative fish removal,

its impact on the status of the four listed fish and plans for future management. Based on these annual reports, the Recovery Program will continue native fish monitoring in accordance with Colorado's Aquatic Management Plan and determine a native fish response. Non-endangered native fishes serve as a surrogate for endangered fishes as an indicator of aquatic ecosystem health.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize incidental take at existing facilities in the action area from depletions from the Yampa River above its confluence with the Green River that might otherwise result from the proposed action. Incidental take statements exempt those actions covered by the incidental take statement from the ESA's section 9 prohibitions if the reasonable and prudent measures and the implementing terms and conditions of incidental take statements are satisfied. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation to review of the reasonable and prudent measures provided. The Service will consider the causes of the taking and review the need for possible modification of the reasonable and prudent measures.

## INDIVIDUAL CONSULTATIONS UNDER THE UMBRELLA OF THIS PROGRAMMATIC BIOLOGICAL OPINION

This programmatic consultation is on the *Management Plan for Endangered Fishes in the Yampa River Basin*. The Service determined that the Recovery Action Plan items included in the Yampa Plan are sufficient to avoid the likelihood of jeopardy and/or adverse modification of critical habitat for depletion impacts for existing depletions (estimated average annual 168,000 AF/year) and future depletions (53,000 AF/year), as defined in the Yampa Plan. Individual section 7 consultation is required on all future specific Federal actions pursuant to the ESA, to determine if they fit under the umbrella of this programmatic biological opinion. Non-Federal projects with existing depletions (as of the date of this biological opinion) are not required to consult under section 7 until there is a Federal nexus, at which time it will be determined if the project fits under the umbrella of this programmatic biological opinion. The following criteria must be met at the time of individual project consultation to rely on the Recovery Program and be considered under the umbrella of this programmatic consultation:

1. A Recovery Agreement must be offered and signed for individual projects depleting more than 100 acre/feet, prior to conclusion of section 7 consultation. An example of a Recovery Agreement is provided in Appendix E.

2. For projects involving water depletions less than 100 AF/year, the Federal agency must document the project location, the amount of the water depletion, identify if the depletion is new or historic, and provide the information to the Service when consultation is initiated.

3. A fee to fund recovery actions will be submitted as described in the proposed action for new depletion projects greater than 100 AF/year. The current fee is $16.30 per acre-foot and is adjusted each year for inflation.

4. Reinitiation stipulations, described below, will be included in all individual consultations under the umbrella of this programmatic.

5. The Service and project proponents will request that discretionary Federal control be retained for all consultations under this programmatic.

Under this opinion, future consultations that meet the criteria would avoid the likelihood of jeopardy and/or adverse modification of critical habitat from depletion impacts. Projects that don’t meet the criteria are not part of the proposed action, and therefore will require consultation outside of the Recovery Program.

## CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service is recommending the following conservation actions:

1. As part of the annual assessment of the nonnative fishes control program the Recovery Program should evaluate the need to implement lethal removal of nonnative fishes in and upstream from critical habitat in Colorado. The program already includes this feature in Utah and in Yampa Canyon in Colorado. Lethal removal of nonnative fishes makes nonnative fish control much more efficient and cost effective. The Recovery Program should also evaluate the need for screening other reservoirs upstream from critical habitat that may contribute nonnative fishes to critical habitat and evaluate expanding the river miles of nonnative fish control.

2. Install additional SNOTEL sites in the headwater reaches of the Yampa River, Upper Green River and Little Snake River. These will serve to better predict the timing and magnitude of peak flows in these basins and inform the operators of Flaming Gorge Dam to time releases from the dam for maximum effect.

3. Install additional stream flow gages in appropriate locations on the Yampa River. These would serve the dual purpose of 1) enhancing the ability of water managers to track water released from storage to augment instream flows and 2) providing information to the CRDSS to better determine the magnitude, timing, and potential impacts of future depletions.

4. Evaluate the temporary spillway net proposed for Elkhead Reservoir for potential use of similar technology for nonnative fish control on a permanent or temporary basis at Elkhead Reservoir or other facilities in the Upper Colorado River Basin.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

## REINITIATION NOTICE

This concludes formal consultation on the subject action. The Recovery Action Plan is an adaptive management plan because additional information, changing priorities, and the development of the States' entitlement may require modification of the Recovery Action Plan. Therefore, the Recovery Action Plan is reviewed annually and updated and changed when necessary and the required time frames include changes in timing approved by means of the normal procedures of the Recovery Program, as explained in the description of the proposed action. Every 2 years, for the life of the Recovery Program, the Service and Recovery Program will review implementation of the Recovery Action Plan actions that are included in this biological opinion to determine timely compliance with applicable schedules. As provided in 50 CFR sec. 402.16, reinitiation of formal consultation is required for new projects where discretionary Federal Agency involvement or control over the action has been retained (or is authorized by law) and under the following conditions:

1. The amount or extent of take specified in the incidental take statement for this opinion is exceeded. The implementation of the Recovery actions contained in this opinion will further decrease the likelihood of take caused by water depletion impacts.

2. New information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion. In preparing this opinion, the Service describes the positive and negative effects of the action it anticipates and considered in the section of the opinion entitled "EFFECTS OF THE ACTION." New information would include, but is not limited to, not achieving one or more response criteria that will be developed as part of the terms and conditions to minimize incidental take. The Service retains the authority to determine whether a significant decline in population has occurred, but will consult with the Recovery Program's Biology Committee prior to making its determination. In the event that one or more population criteria have not been achieved, the Service is to first rely on the Recovery Program to take timely actions to correct the deficiency.

3. The section 7 regulations (50 CFR 402.16 (c)) state that reinitiation of consultation is required if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion. It would be considered a change in the action subject to consultation if the Recovery Action Plan items listed as part of the proposed action (Green River Action Plan: Yampa and Little Snake rivers) in this opinion are not implemented within the required timeframes. Also, the analysis for this biological opinion assumed implementation of the Green River Mainstem Action Plan of the RIPRAP because the Colorado pikeminnow and razorback sucker that occur in the Yampa River use the Green River and are considered one population. The essential elements of the Green River Plan are as follows: 1) provide and protect instream flows; 2) restore floodplain habitat; 3) reduce impacts of nonnative

fishes; 4) augment or restore populations; and 5) monitor populations and conduct research to support recovery actions. The analysis for the non-jeopardy determination of the Yampa Plan that includes about 53,000 AF/year of new water depletions from the Yampa River Basin relies on the Recovery Program to provide and protect flows on the Green River. Specifically, the analysis for this biological opinion assumed operation of Flaming Gorge Dam to meet the flow recommendations according to the upcoming Record of Decision on the Flaming Gorge Dam Operations environmental impact statement (EIS).

The Service recognizes that the RIPRAP is an adaptive management plan that is modified according to additional information and changing priorities. The plan is reviewed annually and updated when necessary. The required timeframes include changes in timing approved by means of normal procedures of the Recovery Program. In 2006, and every 2 years thereafter, for the life of the Recovery Program, the Service and the Recovery Program will review implementation of the RIPRAP actions to determine timely compliance with applicable schedules.

Also, the analysis for this biological opinion assumed impacts to peak flows based on anticipated future uses of water, if water is used in a substantially different timing regime that adversely affects endangered fishes in a way not considered in this opinion, then reinitiation of consultation is required. The Recovery Program will monitor all new water projects that deplete more than 100 AF/year to determine their impacts to peak flows on the Yampa River. In addition, the Recovery Program will monitor projects individually depleting 100 AF/year or less in cumulative increments of 3,000 AF/year to determine their impacts to peak flows.

4. The Service lists new species or designates new or additional critical habitat, where the level or pattern of depletions covered under this opinion may have an adverse impact on the newly listed species or habitat. If the species or habitat may be adversely affected by depletions, the Service will reinitiate consultation on the programmatic biological opinion as required by its section 7 regulations. The Service will first determine whether the Recovery Program can avoid such impact or can be amended to avoid the likelihood of jeopardy and/or adverse modification of critical habitat for such depletion impacts. If the Recovery Program can avoid the likelihood of jeopardy and/or adverse modification of critical habitat no additional recovery actions for individual projects would be required, if the avoidance actions are included in the Recovery Action Plan. If the Recovery Program is not likely to avoid the likelihood of jeopardy and/or adverse modification of critical habitat then the Service will reinitiate consultation and develop reasonable and prudent alternatives.

If the annual assessment indicates that either the recovery actions specified in this opinion have not been completed or that the status of all four fish species has not sufficiently improved, the Service intends to reinitiate consultation on the Yampa Plan to specify additional measures to be taken by the Recovery Program to avoid the likelihood of jeopardy and/or adverse modification of critical habitat for depletions. If other measures are determined by the Service or the Recovery Program to be needed for recovery prior to the review, they can be added to the

Recovery Action Plan according to standard procedures, outlined in that plan. If the Recovery Program is unable to complete those actions which the Service has determined to be required, consultation on projects with a Federal nexus may be reinitiated in accordance with ESA regulations and this opinion's reinitiation requirements. The Service may also reinitiate consultation on the Recovery Program if fish populations do not improve according to the population response criteria to be developed within one year of the issuance of this biological opinion. Failure to maintain a positive response, whenever achieved, will be considered a negative response and subject to reinitiation.

If the Service reinitiates consultation, it will first provide information on the status of the species and recommendations for improving population numbers to the Recovery Program. Only if the Recovery Program does not implement recovery actions to improve the status of the species, will the Service reinitiate consultation with individual projects. The Service intends to reinitiate consultations simultaneously on all depletions.

All individual consultations conducted under this programmatic opinion will contain language requesting the applicable Federal agency to retain sufficient authority to reinitiate consultation should reinitiation become necessary. The recovery agreements to be signed by non-Federal entities who rely on the Recovery Program to avoid the likelihood of jeopardy and/or adverse modification of critical habitat for depletion impacts related to their projects will provide that such non-Federal entities also must request the Federal agency to retain such authority. Non-Federal entities will agree by means of recovery agreements to participate during reinitiated consultations in finding solutions to the problem which triggered the reinitiation of consultation.

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