United States Department of the Interior
FISH AND WILDLIFE SERVICE
UTAH FIELD OFFICE
2369 WEST ORTON CIRCLE, SUITE 50
WEST VALLEY CITY, UTAH 84119
June 11, 2010

In Reply Refer To:

FWS/R6
ES/UT
09-F-0157
UT-10-F-011

Memorandum

To: Mr. Bruce C. Barrett, Area Manager, Bureau of Reclamation, 302 East 1860 South, Provo, Utah 84606-7317

From: Utah Field Supervisor, Ecological Services, U.S. Fish and Wildlife Service, West Valley City, Utah

Subject: Biological Opinion for Green River Pumping Project (PRO-EA-10-002)

This document transmits our biological opinion based on our review of the proposed Green River Pumping Project (Project), located in Uintah County, Utah, and its effects on bonytail (*Gila elegans*), Colorado pikeminnow (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), razorback sucker (*Xyrauchen texanus*), and designated critical habitat for these four fish species in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.). We received your request for formal consultation on April 19, 2010.

This biological opinion is based on information provided in the April 2010 draft Environmental Assessment (EA) and Biological Assessment (BA), project descriptions received by our office, personal communications between our offices, project engineers, and other sources of information.

CONSULTATION HISTORY

This section summarizes significant steps in the consultation process.

PROPOSED ACTION

May 13, 2009; our office met with the Uintah Water Conservancy District (UWCD), project engineers, and your office to begin early coordination for the Project. At this meeting we received an initial project purpose and description, and discussed the consultation process, potential wildlife impacts, and conservation measures. Over the next few months (approximately June to August), biologists from our office researched potential impacts to terrestrial and aquatic species from specific project actions and worked with the project engineers to develop conservation measures.

May 14, 2009; UWCD filed a Utah Stream Alteration Permit Application (under Army Corps of Engineers (ACOE) General Permit 40) for riverbank and riverbed alterations to the Green River (Stream

Alteration Application # 09-43-05SA). We responded to this application on June 1, 2009, indicating that the permit should be remanded to the ACOE because the project impacts federally listed species and designated critical habitat. The State Engineer approved the application on June 29, 2009 but responded in agreement to our letter, determining that the ACOE 'will likely require separate permitting'.

August 6, 2009; we visited the proposed Project site along with the ACOE (Grand Junction Office), UWCD, project engineers, and your office. We toured the entire project alignment, including the reservoir site, pipeline route, road locations, and river bank position of the pumping plant. We discussed local vegetation structure and potential changes during construction (clearings, tree preservation, and wetland delineations), channel morphology, construction methods, and water depletion impacts.

At this meeting, the ACOE indicated that the Project may qualify for an exemption from regulation under section 404 of the Clean Water Act. In a follow-up email dated August 10, 2009, the ACOE confirmed this and exempted both the road and pipeline portions of the project under the Farm and Forest Road Exemption and Irrigation Exemption, respectively.

August 25, 2009; our office met with Project engineers and UWCD to discuss impacts to federally listed fish from pumping operations (timing and approach velocities). Henrie Engineering provided initial analysis of pumping operations for the entire operational period. The analysis tracked demand and operations to determine plant operational needs during peak electrical rate hours and specifically during the larval fish drift[1]. Bowen & Collins Engineering requested that we determine the allowable underwater fish approach velocity for the intake structure because this velocity is also key to the project design. We also communicated the requirement of a 3/32 inch fish screen mesh size for the Project.

Over the next few months (August to January) we researched the approach velocity requirements of the fish by talking with biologists and engineers, reading published literature, and reviewing requirements on other structures. During the same time, we worked with project engineers to design operational criteria to minimize impacts to larval fish by refining the water operational model.

September, 2009; we received an acoustical evaluation of the project from Spectrum Engineering, data on the presence of yellow-billed cuckoo from the Utah Division of Wildlife Resources (UDWR) (via project engineers), and data on raptor presence from Ouray National Wildlife Refuge (NWR).

Based on a channel morphology study, UWCD changed the proposed location of the Project in October, 2009. Therefore, we met with UWCD, Ouray NWR, and your office on October 28, 2009 and visited the new site. We determined that the new site will reduce entrainment of fish because of increased sweeping river flows (flows parallel to the intake structure) near the structure. Ouray NWR expressed concern over downstream impacts to channel structure.

December 22, 2009; we met with project engineers and the Utah Division of Forestry, Fire, and State Lands to discuss streambank restoration and revegetation.

January 15, 2010; we finalized approach velocity requirements in discussions with your office and project engineers.

January and February 2010; we reviewed and edited draft sections of the Environmental Assessment/Biological Assessment (EA/BA).

April 2, 2010; we performed a complete review of the EA/BA and submitted comments to your office.

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[1] This model was refined many times over the next six months as project specifics changed, and completed model results are found in the draft Environmental Assessment/Biological Assessment.

April 19, 2010; we received your completed draft EA/BA and request for initiation of formal consultation under section 7 of the Endangered Species Act.

COLORADO RIVER FISH RECOVERY PROGRAM

To address the ecological effects from depletions and aid in the recovery of the four species, the Secretary of the Department of the Interior; the Governors of Wyoming, Colorado, and Utah; and the Administrator of the Western Area Power Administration signed a Cooperative Agreement to implement the "Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin"[2] (Recovery Program) on January 21-22, 1988. Since that time, the Recovery Program was extended with newly signed agreements twice: first in 2001, extending the Recovery Program until September 30, 2013[2]; and more recently in 2009, extending the Recovery Program to September 30, 2023[2]. The objective of the Recovery Program is to recover the listed species while water development continues in accordance with Federal and State laws and interstate compacts.

In order to further define and clarify processes outlined in sections 4.1.5, 4.1.6, and 5.3.4 of the Recovery Program, a section 7 Agreement (Agreement) and a Recovery Implementation Program Recovery Action Plan (RIPRAP) was developed[3]. The Agreement establishes a framework for conducting all future section 7 consultations on depletion impacts related to new projects and all impacts associated with historic projects in the Upper Basin. Procedures outlined in the Agreement are used to determine if sufficient progress is being accomplished in the recovery of the endangered fishes to enable the Recovery Program to serve as a reasonable and prudent alternative (RPA) to avoid jeopardy. The RIPRAP was finalized on October 15, 1993, and reviewed and updated annually[3].

In accordance with the 1993 Agreement, the Service annually assesses progress of the implementation of recovery actions to determine if progress toward recovery has been sufficient for the Recovery Program to serve as a RPA for projects that deplete water from the Colorado River. In the last review (2009) the Service determined that the Program made sufficient progress to offset water depletions from individual projects up to 4,500 acre feet per year[4] (af/yr). Therefore, it is appropriate for the Recovery Program actions to serve as conservation measures in the project description for projects up to 4,500 af/yr.

After many years of successful implementation of the Recovery Program and Agreement, federal action agencies now anticipate Recovery Program activities and the requirement of a financial contribution (for new depletions greater than 100 af) toward these activities serving as RPAs that must be included in their project planning to avoid jeopardy to listed species. Thus, the RPA has essentially become part of the proposed action. The Recovery Program activities will now serve as conservation measures within the proposed action and minimize adverse effects to listed species or critical habitat. The following excerpts summarize portions of the Recovery Program that address depletion impacts, section 7 consultation, and Project proponent responsibilities:

> "All future section 7 consultations completed after approval and implementation of this program (establishment of the Implementation Committee, provision of congressional funding, and initiation of the elements) will result in a one-time contribution to be paid to

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[2] Original Document and extensions are available online at: http://www.coloradoriverrecovery.org/documents-publications/foundational-documents/cooperative-agreement.html

[3] Original Document and annual reviews are available online at: http://www.coloradoriverrecovery.org/documents-publications/foundational-documents/recovery-action-plan.html

[4] Sufficient progress determinations, including the 2009 determination, are available at: http://coloradoriverrecovery.org/documents-publications/section-7-consultation/sufficient-progress-letters.html

> the Service by water project proponents in the amount of $10.00 per acre-foot based on the average annual depletion of the project . . . This figure will be adjusted annually for inflation [the current figure is $18.99 per acre-foot] . . . Concurrently with the completion of the Federal action which initiated the consultation, e.g., . . . issuance of a 404 permit, 10 percent of the total contribution will be provided. The balance . . . will be . . . due at the time the construction commences . . . ."

It is important to note that these provisions of the Recovery Program were based on appropriate legal protection of the instream flow needs of the endangered Colorado River fishes. The Recovery Program further states:

> ". . . it is necessary to protect and manage sufficient habitat to support self-sustaining populations of these species. One way to accomplish this is to provide long term protection of the habitat by acquiring or appropriating water rights to ensure instream flows. Since this program sets in place a mechanism and a commitment to assure that the instream flows are protected under State law, <u>the Service will consider these elements under section 7 consultation as offsetting project depletion impacts</u>."

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BIOLOGICAL OPINION

DESCRIPTION OF PROPOSED ACTION

The goal of the Project is to develop Green River water for municipal, industrial, and agricultural purposes on the west side of Uintah County. The Project will initially provide supplemental irrigation water to the Ouray Park, Uintah River, and Whiterocks Irrigation Companies (OPIC, URIC, and WIC, respectively). The Project design will allow for expansion of the delivery system which could provide water to other users in the future. As the holder of the Green River water right, the UWCD is overseeing the design, implementation, and operation of the Project. An overview showing the GRPP facilities and lands to be served is shown in Figure 1 of the EA[5], and further described below.

GREEN RIVER PUMPING PLANT

The Green River Pumping Plant (GRPP) is a pumping station on the Green River designed to pump up to 10,000 acre feet (af) of water annually. The pump station will be constructed on an approximately 0.6 acre site adjacent to the Green River as shown in Figures 2 and 3 of the EA. The pump station will be composed of a deep sump and inlet structure, trash rack, stop logs, fish screens, four main pumps, pump manifold piping, electrical transformers, power transmission line, pipeline drain, parking area, electrical control building, and a short section of pipeline.

The pump station's trash rack, stop logs, and traveling fish screens will prevent the station from entraining debris (limbs, leaves, etc) and fish. The outermost filter will be a vertically oriented trash rack with horizontal bars spaced 1 inch apart (Figure 5 of the EA). The trash rack will prevent larger floating debris from entering the intake structure. It will also serve as a deterrent to fish entering the intake. The stop logs will provide a method for isolating portions of the structure, primarily for cleaning purposes.

Traveling, continuous, stainless-steel fish screens will collect debris and fish trapped inside the intake and convey them back to the river. The screens will be designed with 3/32 inch mesh openings and installed 22.5° from vertical. The traveling, continuous screens will be motor-driven and automatically cleaned via high pressure spray. Debris and fish removed from the screens will be sluiced back into the river, downstream from the station via a collection trough (Figure 4 of the EA). The pressure of the cleaning spray can be adjusted to minimize fish injury.

The station is designed with maximum approach velocity criteria, measured three inches in front of the trash rack, to allow fish to escape via natural swimming ability. Project approach velocity criteria are based on criteria established for other species, but were modified to meet listed species' ecological characteristics. The approach velocity varies based on river height and intake velocity (a product of the number of pumps operating), so a constant approach velocity is not possible. Therefore, predicted approach velocities were created using operational models and historic flow patterns. A more thorough explanation of approach velocity criteria and expected approach velocity values can be found in the Effects of the Action: Interaction with Pump Facility by Juveniles & Adults section of this biological opinion.

Because of operational flexibility afforded by the Valley View Pond, the pump station can provide water to users on a continuous basis without having to operate continuously. In order to minimize impacts from the operation of the pump station, a pumping plant and pond operations model was developed to analyze different operating scenarios and develop the most efficient operating plan. In the model, hydrological variables are tracked hourly for typical operations each month. In turn, this determines how many pumps

[5] Figures from the EA are found in Appendix B.

are operated at a time, and how many hours a day (for each half month period) pumping operations will need to take place to meet demand. The hourly pumping operations are then compared to 'blackout' hours requested by us and the UWCD. The UWCD's recommended blackout hours are those with peak electrical power rates (avoided to reduce costs) and our recommended blackout hours are those in which larval endangered fish are most abundant in the water column (avoided to reduce impacts to endangered fish). A more thorough explanation of the operations model can be found in the **Effects of the Action**: Interaction with the Pump Facility by Larval Fish section of this biological opinion.

A Supervisory Control and Data Acquisition (SCADA) system will be used to operate the pump station and pond. This allows UWCD to maximize the use of existing water rights on the Uinta and Whiterocks Rivers and limit pumping from the GRPP (as described in the previous paragraph). The SCADA system will be tied to and become a part of the existing West Side Combined Canals Salinity Control Project SCADA system. Storage and flow data from the Uinta and Whiterocks Rivers system will be transmitted to the SCADA system for use in operating the GRPP. Also, real-time larval drift data will be provided by our office annually to help optimize operations for the mutual benefit of Green River endangered fish and the water users. In summary, the SCADA system will allow remote operation of the pump station based on the real-time data provided from throughout the system.

Three 900 horsepower vertical turbine pumps will lift water from the Green River via the intake structure and pump it into a pipeline transmission system. A fourth pump, if installed in the future, will be used for redundancy purposes only. The station will be capable of pumping rates of 20 to 53 cubic feet per second (cfs), depending on the number of pumps (one to three) in operation. Depending on budget constraints, either two or three of these pumps will be installed initially, with the remaining pump(s) added as required and as funds are available.

An all-weather gravel road and parking area will be constructed to provide reliable access to the station for inspection, operation, maintenance, and repair. Much of the road and all of the parking area and pump site will be raised to an elevation of between 4681.0 to 4682.0 feet (ft) (above mean sea level), which is about one to two feet above the maximum expected water surface occurring during the 100-yr return interval flood event. As shown on Figure 2 of the EA, this finish elevation is about four feet above the existing ground surface elevation of 4677.5 ft. The pump building and control building finish floor elevations are at 4682.3 ft.

CONVEYANCE PIPELINE AND VALLEY VIEW POND

A 42 inch diameter pipeline will convey flows of up to 53 cfs from the Green River pumping station approximately three miles to the Valley View Pond. An additional approximately 1400 ft of 42 inch pipe will be installed to convey water from Valley View Pond to the existing Ouray Park Pipeline. A plan view of the pipeline and pond is shown in Figure 7 of the EA.

Valley View Pond will be constructed to a capacity of 30 af with an average depth of about 7 ft and a surface area of about 5.5 acres (approximately 390 ft by 600 ft). The pond will be lined with clay to minimize seepage. The 4,984 ft maximum water surface elevation of the pond is lower than the existing ground surface elevation to eliminate potential overtopping and failure of the structure. The entire pond area will be enclosed by a 6 foot fence. Water will enter the pond from the Green River Pipeline and exit through the connection pipeline that transports water from the pond to the existing Ouray Park Pipeline. A plan view of the Pond is shown in Figure 8 of the EA.

RELOCATION OF NIELSON PUMP STATION

The Nielson pump station is an existing private pump station that draws water from the Green River for local agriculture fields. The Nielson pump station is located about 400 ft upstream of the proposed GRPP. It has a water right to divert up to 1,440 af/yr (1,236 af/yr proof submitted to the Utah Division of Water Rights) at a peak monthly flow rate of about 6.0 cfs from the Green River to serve the full irrigation demands of about 360 acres of land adjacent to the Green River. As shown in the photos in Figure 6 of the EA, there is significant bank erosion at the original site since the pump was installed. This has undercut the bank to the point that the pump facilities are being supported by a crane, creating the potential for pollution events to occur.

Currently, water is diverted from the Green River without adequate screening for endangered fish. The current intake screen consists of a 36 inch diameter cylinder screen about 14 inch deep on the end of the 12 inch intake pipeline. The screen mesh size is 1/8 inch for the purpose of keeping debris from entering the pump and plugging irrigation lines and sprinkler nozzles. There is no screen cleaning mechanism.

The existing pump and intake will be removed from this site by simply lifting the pipe and intake out of the water without the need to enter the river or disturb the bank. The pump will then be relocated and installed at the GRPP site as shown in Figure 4 of the EA (top, center). It will draw water downstream from the trash racks and fish screens and pump to the agricultural fields, but will not utilize the GRPP turbines or GRPP water rights. Therefore, the relocated pump will be screened and operated under appropriate fish screening and approach velocity criteria.

Once the pumping structures (including pump and crane) are removed, the existing site will be re-contoured and re-seeded to natural conditions. The station currently is in poor habitat condition with mostly weed species present in the area.

BUREAU OF RECLAMATION WATER SERVICE CONTRACT

The UWCD has requested a temporary contract from Reclamation for water service from Flaming Gorge Reservoir, an initial unit of the Colorado River Storage Project. This temporary contract will be for up to 10,000 af/yr of water for a period not to exceed 5 years. While the immediate contract being considered is only for a maximum of 5 years, the UWCD has indicated its intent to request a long-term contract in the future. This long term contract will be for 40 years, the maximum contract term Reclamation can offer. Thus, this BO will consider impacts for a 45 year period.

Project water will be released by Reclamation from Flaming Gorge Reservoir. The 10,000 af/yr total depletion was estimated as a future depletion for the State of Utah in the 1999 Upper Colorado River Commission's Official Depletion Schedule (UCRC Depletion). The UCRC Depletion was included in the modeling process for the Action Alternative of The Operation of Flaming Gorge Dam Environmental Impact Statement (FGEIS), although the site-specific diversion details were unknown at the time. The Proposed Action is tiered, as defined in 40 C.F.R. 1508.28, from the Action Alternative of the FGEIS.

The United States and the State of Utah are currently meeting to determine administrative policy and criteria requirements for the delivery and use of water from Flaming Gorge Reservoir.

ACTION AREA

Considering these components cumulatively, the action area of the Project includes: the construction footprints of the GRPP, the pipeline, and Valley View Pond, including access roads and staging areas; the area surrounding the GRPP that encounters increased noise levels from pump operations; the existing Nielson pump station site; and the Green and Colorado Rivers from Flaming Gorge Dam downstream to Lake Powell.

The construction footprints of the Project include direct impacts to upland, riparian, riverbank, and riverbed habitat, some of which are permanent. Permanent disturbances include alteration of the riverbed and riverbank in designated critical habitat for listed fish species, including the bank hardening structures used to protect Project facilities. Bank hardening to protect Project facilities may have additional downstream effects through channel morphology modifications, such as increased erosion in downstream reaches. Some construction footprints, such as staging areas and a large portion of the pipeline route will be revegetated and therefore represent temporary disturbances. Both Project construction and operation will produce noise disturbances that will impact nearby wildlife.

The stretch of the Green and Colorado Rivers from Flaming Gorge Dam to Lake Powell is considered the action area because changes in the quantity of water alter habitat conditions downstream. Water depletions in the Green River Basin reduce habitat quantity and quality (described in detail in Effects of the Action: Changes in River Flow from Project Operations section). This Project will constitute a water depletion in the Green River Basin by using water for agricultural purposes. By entering into a Water Services Contract with Reclamation, this depletion will come from stored water in Flaming Gorge Reservoir. Reclamation will operate Flaming Gorge in accordance with the FGEIS Record of Decision, meaning that in some scenarios this Project will represent a depletion from the system (when Reclamation considers this depletion as part of the UCRC Depletion), but in others this Project will require additional water be released from Flaming Gorge. When water is released specifically for this Project, there will be increased flows upstream of the Project facility. Therefore, impacts both to upstream and downstream flows may occur as part of Project operations.

The relocation of the Nielson pump station and the restoration of the current site represent beneficial impacts to both terrestrial and aquatic wildlife.

APPLICANT COMMITTED CONSERVATION MEASURES

Conservation measures are included as part of the proposed action to further the recovery of species under review. As described in the EA/BA, the applicant has committed to the following conservation measures:

REDUCTIONS IN IMPACTS TO FEDERALLY LISTED FISH SPECIES

1. The Project will install fish screening structures that meet our requirements for mesh size and approach velocity, allowing fish to return to the river either naturally or via a collection trough. Specifically:
    a. Fish screen size is 3/32 inch; and
    b. Approach velocities will exceed 0.33 feet per second (ft/s) only in rare cases, as explained in the Effects of the Action section.

2. During project operation, the actual approach velocity at the structure will be measured using up-to-date scientific methodology, such as those used in the Yakima River Basin (Carter et al. 2003). We will coordinate the exact time and methods of the study with UWCD and biologists from our office may participate in the study. Monitoring events will be performed during full facility operation at least three times:
    a. The first monitoring event will take place within the first full year after construction and after peak flows have subsided, most likely in August. If the operational capacity of the structure is increased, another monitoring event will take place.
    b. A second monitoring event will occur within 5 years if flows in the Green River fall below 5000 cfs as measured at the USGS Green River at Ouray, Utah gauge; and
    c. A third monitoring event will occur within 5 years if flows in the Green River fall below 2000 cfs as measured at the USGS Green River at Ouray, Utah gauge.

3. To the most practical amount possible, the pumps will be shut off during the midnight period (10 pm to 2 am) during the expected periods of larvae drift for both razorback sucker and Colorado pikeminnow (consistent with the operating criteria described in section 2.3.3.3 of the EA and the Effects of the Action section of this BO).

   a. The District will send a letter to both the Recovery Program and our Utah Ecological Services Office every April, requesting to be informed when the larval drift periods begin and end.

4. The Nielson pumping station will be relocated behind Project fish screen facilities and the current site will be rehabilitated to as near natural condition as practicable (consistent with the methods and requirements of the Bureau of Reclamation's Disturbed Areas Environmental Commitment #10 of the EA).

5. UWCD will maintain responsibility for possible downstream hardening from Project operations. Bank hardening caused by the installation of the sheet piles to protect the pump station has the potential for altering erosion patterns of the Green River immediately downstream of the pump station. If additional erosion occurs as a result of hardening the bank for the pump station, additional bank protection will be provided by the UWCD at their expense.

6. Reclamation will continue to meet the Flow and Temperature Recommendations for Endangered Fishes in the Green River Downstream of Flaming Gorge Dam (Flow Recommendations) (Muth et al. 2000). Meeting the Flow Recommendations is essential for endangered fish recovery in the Green River basin. Development of Green River basin water may impact Reclamation's ability to meet the Flow Recommendations, even if the developed water is Flaming Gorge storage water.
   a. In order to work towards meeting the Flow Recommendations in the future, Reclamation will analyze the long-term, cumulative effects of water development and delivery in the Green River basin, including water service contracts. Specifically, Reclamation is working on a modeling effort to determine how the interaction of Flaming Gorge releases, tributary inflows, and water development impacts the Flow Recommendations. This modeling effort is concurrent with interagency efforts to create a mechanism to protect flows in the Green River, as described in the Recovery Program's RIPRAP.
   b. Until these efforts are complete, special focus must be made on meeting the Flow Recommendations in dry and moderately dry years (as classified in Muth et al. 2000). In years classified as dry or moderately dry, Reclamation will use the best available information to compensate for the Project depletion in the Basin. If the Service has reason to believe that the Flow Recommendations, specifically, the baseflow targets for Reach 2 established by the Flaming Gorge Technical Workgroup are not being met, extra releases (up to the amount of Project depletions) from Flaming Gorge will be provided

CONSTRUCTION METHODS

As part of Project construction, the contractors will implement the following conservation measures:

1. Construction activities will avoid, to the extent feasible, fish habitat such as backwaters and side channels;

2. Best Management Practices (BMPs) will be used to minimize sedimentation, temporary erosion of stream banks, and needless damage or alteration to the streambed. BMPs should also ensure construction related byproducts do not enter the riverine ecosystem that will cause negative impacts to aquatic organisms;

3. Construction activities will be timed to reduce impacts to seasonal fish movements, spawning activity, and rearing activity (April 1 through August 31) depending on the water year;

4. Construction activities that occur in the river will be coordinated to minimize impacts to fish:
    a. The construction contractor will contact the UDWR to complete a fish survey and clearance immediately prior to and following:
        i. Construction of the proposed cofferdam;
        ii. Removal of the cofferdam; and
        iii. Any other occasion when activities occur in the river or in the exposed river channel.
    b. The contractor will be responsible for reporting any observed take of fish (stressed or dying) immediately to our office. After placement of the cofferdam, a report will be submitted to our office that summarizes activities;
    c. The construction contractor will coordinate with the UDWR to have a federally permitted crew on site to translocate fish stranded behind the constructed cofferdam to the Green River prior to dewatering the work areas;
    d. Pumps used to dewater the work area will be screened (1/4’’ mesh) to minimize entrainment of fish;
    e. The contractor will minimize the time that the cofferdam is in the river;
    f. As practicable, sections of the coffer dam will be placed gently in the channel to minimize disturbance to fish and the river substrates; and
    g. All non-permanent materials placed in the river will be removed from the river after completion of the in channel portion of project.

5. Construction activities should be confined to previously disturbed areas where possible for such activities as work, staging, and storage; waste areas; and vehicle and equipment parking areas. Vegetation disturbance should be minimized as much as possible;

6. Standard Reclamation management practices will be applied during construction activities to minimize environmental effects and will be implemented by construction forces or included in construction specifications. These are elaborated and explained in Environmental Commitment #1 in the EA;

7. All disturbed areas resulting from the project will be smoothed, shaped, contoured, and rehabilitated to as near their pre-project construction condition as practicable. After completion of the construction and restoration activities, disturbed areas will be seeded at appropriate times with weed-free, native seed mixes having a variety of appropriate species (especially woody species where feasible) to help hold the soil around structures, prevent excessive erosion, and to help maintain other riverine and riparian functions. The composition of seed mixes will be coordinated with wildlife habitat specialists. Weed control on all disturbed areas will be required. Successful revegetation efforts must be monitored and reported to Reclamation along with photos of the completed project; and

8. UWCD will acquire a State Stream Alteration Permit, Utah Pollutant Discharge Elimination System Permit, and Water Quality Certification and Storm Water Discharge Permit. UWCD will follow all requirements therein.

OTHER CONSERVATION MEASURES

1. A survey of ground nesting birds (especially neotropical migrants) and raptor nests will be conducted prior to any ground disturbing activities in order to avoid any negative impacts to these birds to the extent possible. These surveys will be conducted by a biologist.

STATUS OF THE SPECIES & CRITICAL HABITAT

The purpose of this section is to summarize the best available information regarding the current range wide status of the listed fish species. Additional information regarding listed species may be obtained from the sources of information cited for these species[6].

COLORADO PIKEMINNOW (*Ptychocheilus lucius*)

SPECIES 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. Individuals begin consuming other fish for food at an early age and rarely eat anything else (Sigler and Sigler 1996). It is a long, slender, cylindrical fish with silvery sides, greenish back, and creamy white belly (Sigler and Sigler 1996). Historically, individuals may have grown as large as 6 ft long and weighed up to 100 pounds (estimates based on skeletal remains) (Sigler and Miller 1963), but today individuals rarely exceed 3 ft or weigh more than 18 lbs (Osmundson et al. 1997).

The species is endemic to the Colorado River Basin, where it was once widespread and abundant in warm-water rivers and tributaries from Wyoming, Utah, New Mexico, and Colorado downstream to Arizona, Nevada, and California (multiple citations in U.S. Fish and Wildlife Service 2002b). Currently, wild populations of pikeminnow occur only in the Upper Colorado River Basin (above Lake Powell) and the species occupies only 25 percent of its historic range-wide habitat (U.S. Fish and Wildlife Service 2002b). Colorado pikeminnow are long distance migrators, moving hundreds of miles to and from spawning areas, and requiring long sections of river with unimpeded passage. They are adapted to desert river hydrology characterized by large spring peaks of snow-melt runoff and low, relatively stable base flows.

The Office of Endangered Species first included the Colorado pikeminnow (as the Colorado squawfish) in the List of Endangered Species on March 11, 1967 (32 FR 4001). It is currently protected under the Endangered Species Act of 1973 as an endangered species throughout its range, except the Salt and Verde River drainages in Arizona. The Service finalized the latest recovery plan for the species in 2002 (U.S. Fish and Wildlife Service 2002b), but is currently drafting an updated revision.

The Service designated six reaches of the Colorado River System as critical habitat for the Colorado pikeminnow on March 21, 1994 (59 FR 13374). These reaches total 1,148 miles (mi) as measured along the center line of each reach. Designated critical habitat makes up about 29 percent of the species' historic range and occurs exclusively in the Upper Colorado River Basin. Portions of the Colorado, Green, Yampa, White, and San Juan Rivers are designated critical habitat. The primary constituent elements of the critical habitat are water, physical habitat, and the biological environment (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 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. This includes oxbows, backwaters, and other areas in the 100-year floodplain that provide access to spawning, nursery, feeding, and rearing habitats when inundated. The biological environment includes food supply, predation, and competition from other species.

[6] The latest recovery goals for all four endangered fish, which provide information on species background, life history, and threats, can be found on the internet at: http://www.coloradoriverrecovery.org/documents-publications/foundational-documents/recovery-goals.html

Recovery of Colorado pikeminnow in the Colorado River Basin is considered necessary only in the Upper Colorado River Basin (above Glen Canyon Dam, including the San Juan, and Green River sub-basins) because of the present status of populations and because existing information on Colorado pikeminnow biology support application of the metapopulation concept to extant populations (U.S. Fish and Wildlife Service 2002b). As a result, this biological opinion will focus on the status of the Colorado pikeminnow in that unit.

LIFE HISTORY

The Colorado pikeminnow requires relatively warm waters for spawning, egg incubation, and survival of young. Males become sexually mature at approximately 6 years of age, which corresponds to a length of about 400 millimeters (mm) (17 inches (in.)), and females mature 1 year later (Sigler and Sigler 1996). Mature adults migrate to established spawning areas in late spring as water temperatures begin to warm, with migration events up to 745 river kilometers round-trip on record (463 mi) (Bestgen et al. 2005). Spawning typically begins after peak flows have subsided and water temperatures are above 16° Celsius (°C) (60.8° Fahrenheit (°F)) (multiple references in Bestgen et al. 2005). Mature adults deposit eggs over gravel substrate through broadcast spawning and eggs generally hatch within 4 to 6 days (multiple references in Bestgen et al. 2005). River flows then carry emerging larvae fish (6.0 to 7.5 mm long (0.2 to 0.3 in.)) downstream 40 to 200 km to nursery backwaters (25 to 125 km), where they remain for the first year of life (U.S. Fish and Wildlife Service 2002b).

Colorado pikeminnow reach lengths of approximately 70 mm by age 1 (juveniles) (2.8 in.), 230 mm by age 3 (subadults) (9 in.), and 420 mm by age 6 (adults) (16.5 in.), with mean annual growth rates of adult and subadult fish slowing as fish become older (Osmundson et al. 1997). The largest fish reach lengths between 900 and 1000 mm (35 to 39 in.); these fish are quite old, likely being 47 to 55 years old with a minimum of 34 years (Osmundson et al. 1997).

Reproductive success and recruitment of Colorado pikeminnow is pulsed, with certain years having highly successful productivity and other years marked by failed or low success (U.S. Fish and Wildlife Service 2002b). The most successful years produce a large cohort of individuals that is apparent in the population over time. Once individuals reach adulthood, approximately 80 to 90 percent of adults greater than 500 mm (20 in.) survive each year (Osmundson et al. 1997; Osmundson and White 2009). Strong cohorts, high adult survivorship, and extreme longevity are likely life history strategies that allow the species to survive in highly variable ecological conditions of desert rivers.

POPULATION DYNAMICS

We measure population dynamics of Colorado pikeminnow separately in the Green, upper Colorado, and San Juan River basins because distinct recovery criteria are delineated for each of these three basins (U.S. Fish and Wildlife Service 2002b). In the 2002 recovery plan, preliminary abundance estimates for wild adults in the basins were: upper Colorado River, 600 to 900; Green River, 6000 to 8000; and San Juan River, 19 to 50 (circa 2000 references for individual rivers found in U.S. Fish and Wildlife Service 2002b).

UPPER COLORADO RIVER

To monitor recovery of the Colorado pikeminnow, the Recovery Program conducts multiple-pass, capture-recapture sampling on two stretches of the upper Colorado River which are roughly above and below Westwater Canyon (Osmundson and White 2009). The latest analysis concluded that point estimates for populations of fish greater than 450 mm (adults) (18 in.) had increased from the early 1990s to the mid 2000s, but confidence intervals were overlapping, so differences among annual estimates were not statistically significant (Osmundson and White 2009). In the last year of analysis (2005), river-wide estimates of adult fish were 889 (412 in the lower reach below Westwater Canyon; 477 in the upper reach above Westwater Canyon), up from 440 in 1992 (Osmundson and White 2009). In addition, annual recruitment of fish (based on number of 400 to 450 mm fish (16 to 18 in.) appeared to exceed annual mortalities of fish greater than 450 mm (18 in.) in six of the nine years of study (Osmundson and White 2009). Evidence of pulsed recruitment was found in the length frequency analysis, with only two years out of the last fourteen producing strong cohorts of fish (Osmundson and White 2009). Finally, the researchers concluded that this stretch of river is able to support more pikeminnow individuals, that is, the river is not at carrying capacity (Osmundson and White 2009).

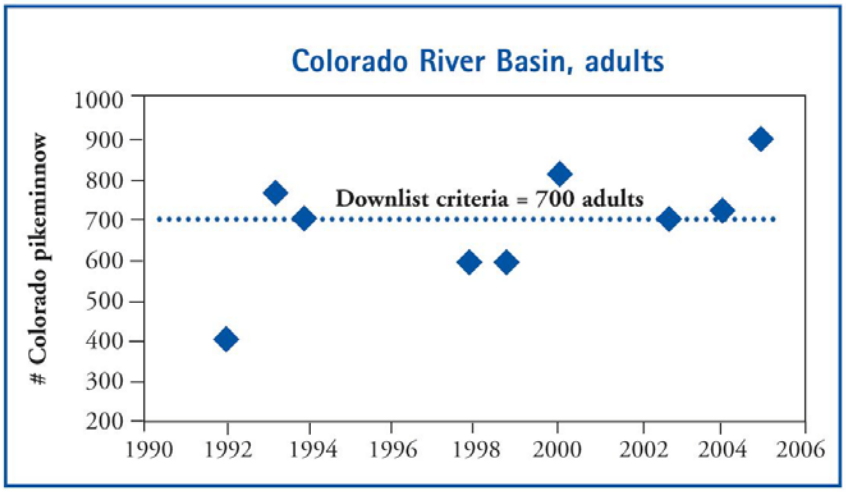

Figure 1. Population trend of Colorado pikeminnow in the Upper Colorado River Basin

Population monitoring efforts in the upper Colorado River are ongoing, with researchers collecting population monitoring data in 2008 and 2009. Total pikeminnow captured in 2008 and 2009 were both approximately 40 percent less than total captured in 2005 (Osmundson and Shaughnessy 2009). However, this data was not statistically analyzed for population abundance and therefore caution should be used when interpreting the data[7].

GREEN RIVER

The Recovery Program conducts population monitoring on five river reaches in the Green River Basin: (1) the Yampa River; (2) the White River; (3) the middle Green River (16 km downstream of the Yampa confluence to upstream of the White River confluence); (4) the Desolation-Gray Canyon stretch of the Green River; and (5) the lower Green River (near the town of Green River downstream to the Colorado River confluence) (Bestgen et al. 2005). Population estimates demonstrated an apparent decline in fish greater than 400 mm in all reaches from 2000 to 2003 (Bestgen et al. 2005). Declines were greatest in river reaches that supported the highest numbers of individuals (59 and 63 percent decline in the middle Green and White Rivers, respectively), but declines were still evident in the other three reaches (29, 11, and 36 percent declines in the Yampa River, Desolation-Gray Canyon, and lower Green River, respectively) (Bestgen et al. 2005). Basin-wide adult Colorado pikeminnow abundance estimates apparently declined from 4,084 in 2000 to 2,142 in 2003, an apparent reduction of 48 percent (Bestgen et al. 2005).

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[7] To produce reliable population estimates, researchers must analyze the data using computer software that accounts for other variables, such as the ability to catch fish, effort exerted in sampling efforts, and environmental factors.

The apparent decline in abundance was likely caused, in part, by low recruitment rates which were not able to offset adult mortality (Bestgen et al. 2005). Low recruitment may be a product of weak year-classes of age-0 fish produced in nursery areas of the middle and lower Green River over previous years (Bestgen et al. 2005). However, survival rates for adult fish from 2000 to 2003 were only approximately 65 percent, which was lower than historic estimates (82 percent) or estimates from the upper Colorado River (~85 percent) (Bestgen et al. 2005). Therefore, apparent declines in populations were also tied to higher adult mortality. While mechanisms are unknown, it seems that low, drought-related base flows were related to apparent reductions in adult and recruit-sized fish, resulting in an overall decline in abundance (Bestgen et al. 2005).

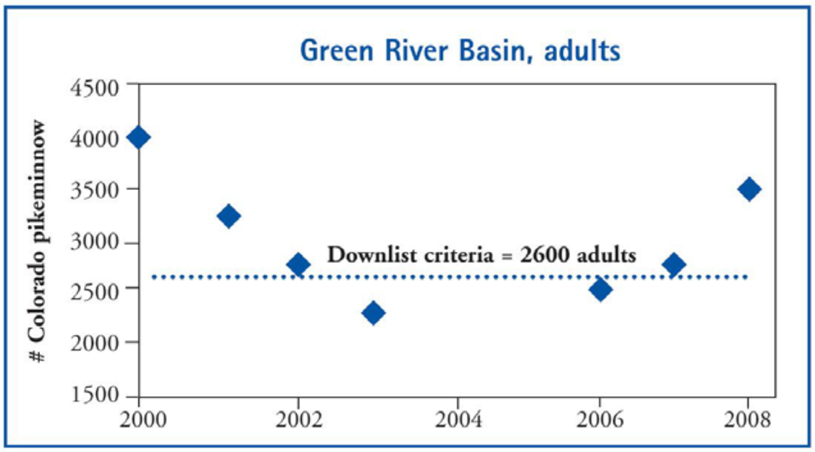

Figure 2. Population trend of Colorado pikeminnow in the Green River Basin in the 2000s

The Recovery Program continued population sampling efforts from 2006 to 2008 and found a 50 percent increase in abundance of adult Colorado pikeminnow throughout the Green River Basin over the study period, and about a 70 percent increase over 2003 estimates (Bestgen et al. 2010). Annual point estimates from 2006 to 2008 indicate highest apparent abundance increases in Desolation-Gray Canyon, the middle Green River, and the White River (Bestgen et al. 2010). Abundance of adult Colorado pikeminnow was stable and low in the Yampa River during the 2006 to 2008 period, but populations showed continued decline since 2003 (Bestgen et al. 2010). Abundance of adult Colorado pikeminnow in the lower Green River declined over the study period, but abundance levels were higher than in the 2000 to 2003 period (Bestgen et al. 2010). Basinwide, adult Colorado pikeminnow abundance increased each year of the study, from 2,454 fish in 2006, 2,718 in 2007, and 3,672 in 2008 (Table 1) (Bestgen et al. 2010).

Abundance estimates for recruit-sized fish during 2006 to 2008 were relatively high in the Green River Basin, and averaged 22 percent of estimated adult Colorado pikeminnow abundance (Bestgen et al. 2010). Recruitment rates were more than sufficient to offset mortality rates of adults, with most of the recruits apparently being produced in 2000 in the lower Green River when a large year-class of age-0 Colorado pikeminnow was produced by abundant adults (Bestgen et al. 2010). Survival rates from 2006 to 2008 averaged 80 percent, which are much greater than 2000 to 2003 (65 percent), and are in line with historic (82 percent) and upper Colorado River (~85 percent) estimates (Bestgen et al. 2010).

River Reach	Prior to 2000	2000	2001	2002	2003	2006	2007	2008
middle Green River		1613 1359-1948	1184 986-1441	834 593-1192	663 491-918	674 350-1422	1026 575-1901	1109 520-2444
Desolation-Gray Canyon			699 527-963	757 504-1166	621 423-942	519 350-813	484 307-793	1296 669-2580
lower Green River			355 270-496	261 184-388	227 154-352	791 617-1025	604 476-783	467 301-752
Yampa River		317 184-623	320 245-438	277 157-512	224 123-434	149 71-409	153 74-354	140 75-297
White River		1100 767-1653	746 586-973	643 491-864	407 300-573	321 207-548	451 309-691	660 355-1278
Entire Green River Basin	6000 to 8000	3030 2467-3592	3303 2900-3707	2771 2216-3325	2142 1686-2598	2454 1920-3185	2718 2055-3656	3672 2397-5715

Table 1. Colorado pikeminnow population estimates in the Green River Basin from 2000 to 2008

SAN JUAN RIVER

Unlike the Green and upper Colorado River Basins, wild Colorado pikeminnow are extremely rare in the San Juan River. The majority of individuals come from hatchery reared stocks supported by the San Juan River Recovery Implementation Program. This program has stocked more than 2 million age 0 and age 1+ fish in the San Juan River since 2002 (Furr and Davis 2009). No wild adults were collected since 2000 (Elverud 2008) and only five wild-spawned pikeminnow larvae were collected since 2002 (two in 2004; three in 2007) (Brandenburg and Farrington 2009).

In addition, adult Colorado pikeminnow collections in the San Juan River are extremely rare (Elverud 2008), indicating that many stocked fish do not reach sexual maturity. From 2002 to 2004, sampling conducted by UDWR revealed low numbers of Colorado pikeminnow adults, presumably from the 1996-1997 stocking efforts, using the lower San Juan River in the spring and summer (Elverud 2008). No adult Colorado pikeminnow were collected between 2005 and 2008 in the lower San Juan River despite yearly sampling efforts (Elverud 2008).

We do not have river-wide population estimates for Colorado pikeminnow (personal communication, Scott Durst 2009), but population estimates of individuals greater than 150 mm were generated after 2004 for the lower San Juan River (Elverud 2008). However, the observed variation in the population estimates within and among years makes identifying trends in the number Colorado pikeminnow difficult (Elverud 2008). In 2008, population estimates of Colorado pikeminnow greater than 150 mm in the lower San Juan River ranged from 270-572, depending on the model used (Elverud 2008).

BASIN-WIDE STATUS AND DISTRIBUTION

The Colorado pikeminnow was designated as an endangered species prior to enactment of the ESA, and therefore a formal listing package identifying threats was not assembled. Construction and operation of mainstem dams, nonnative fish species, and local eradication of native minnows and suckers in advance of new human-made reservoirs in the early 1960's were recognized as early threats (references in U.S. Fish and Wildlife Service 2002b). According to the 2002 Recovery Goals for the species, the primary threats to Colorado pikeminnow populations are streamflow regulation and habitat modification (including cold-water dam releases, habitat loss, and blockage of migration corridors); competition with and predation by nonnative fish species; and pesticides and pollutants (U.S. Fish and Wildlife Service 2002b). No new threats have emerged since the completion of this document.

As described in previous sections, Colorado pikeminnow are restricted to a portion of their historical range. Within currently occupied habitat, population trends are variable, with periods of noticeable decline, such as the early 2000s, and periods of population increase, such as the late 2000s. The current estimated population numbers in all three upper Colorado sub-basins are below estimates from the late 1990s, indicating that populations have not fully rebounded from the early 2000 population decline.

RAZORBACK SUCKER (*Xyrauchen texanus*)

SPECIES DESCRIPTION

The largest native sucker to the western United States, the razorback sucker is a robust, river catostomid endemic to the Colorado River Basin (Sigler and Sigler 1996; U.S. Fish and Wildlife Service 2002d). The species feeds primarily on algae, aquatic insects, and other available aquatic macroinvertebrates using their ventral mouths and fleshy lips (Sigler and Sigler 1996). Adults can be identified by olive to dark brown coloration above, with pink to reddish brown sides and a bony, sharp-edged dorsal keel immediately posterior to the head, which is not present in the young (Sigler and Sigler 1996). The species can reach lengths of 3 ft and weights of 16 pounds (7.3 kg), but the maximum weight of recently captured fish is 11 to 13 pounds (5 to 6 kg) (Sigler and Sigler 1996; U.S. Fish and Wildlife Service 2002d). Taxonomically, the species is unique, belonging to the monotypic genus *Xyrauchen*, meaning that razorback sucker is the only species in the genus (U.S. Fish and Wildlife Service 2002d).

Historically, the razorback sucker occupied the mainstem Colorado River and many of its tributaries from northern Mexico through Arizona and Utah into Wyoming, Colorado, and New Mexico (U.S. Fish and Wildlife Service 2002d). In the late 19th and early 20th centuries, it was abundant in the Lower Colorado River Basin and common in parts of the Upper Colorado River Basin, with numbers apparently declining with distance upstream (references in U.S. Fish and Wildlife Service 2002d). Distribution and abundance of razorback sucker declined throughout the 20th century across its historic range, and the species now exists naturally only in a few small, unconnected populations or as dispersed individuals. Specifically, razorback sucker are currently found in small numbers in the Green River, upper Colorado River, and San Juan River sub-basins; the lower Colorado River between Lake Havasu and Davis Dam; Lakes Mead and Mohave; in small tributaries of the Gila River sub-basin (Verde River, Salt River, and Fossil Creek); and in local areas under intensive management such as Cibola High Levee Pond, Achii Hanyo Native Fish Facility, and Parker Strip (U.S. Fish and Wildlife Service 2002d).

The razorback sucker is listed as endangered under the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 *et. seq.*), under a final rule published on October 23, 1991 (56 FR 54957). The Service finalized the latest recovery plan for the species in 2002 (U.S. Fish and Wildlife Service 2002d), but is currently drafting an updated revision.

We designated 15 reaches of the Colorado River system as critical habitat for the razorback sucker on March 21, 1994 (59 FR 13374). These reaches total 2,776 km (1,724 mi) as measured along the center line of the river within the subject reaches. Designated critical habitat makes up about 49 percent of the species' original range and occurs in both the Upper and Lower Colorado River Basins. In the Upper Basin, critical habitat is designated for portions of the Green, Yampa, Duchesne, Colorado, White, Gunnison, and San Juan Rivers. Portions of the Colorado, Gila, Salt, and Verde Rivers are designated in the Lower Basin. The primary constituent elements are the same as those described for Colorado pikeminnow.

Separate, objective recovery criteria were developed for each of two recovery units (the Upper Colorado and Lower Colorado River Basins as delineated at Glen Canyon Dam) to address unique threats and site-specific management actions necessary to minimize or remove those threats. This biological opinion's focus is on the Upper Colorado River Basin recovery unit and will therefore describe the status of the razorback sucker in that unit.

LIFE HISTORY

Except during periods before and after spawning, adult razorback sucker are thought to be relatively sedentary and have high fidelity to overwintering sites (U.S. Fish and Wildlife Service 2002d). Adults become sexually mature at approximately 4 years and lengths of 400 mm (16 in.) (Zelasko et al. 2009), at which time they travel long distances to reach spawning sites (U.S. Fish and Wildlife Service 2002d). Mature adults breed in spring (mostly April–June) on the ascending limb of the hydrograph, congregating over cobble/gravel bars, backwaters, and impounded tributary mouths near spawning sites (multiple references in U.S. Fish and Wildlife Service 2002d; Snyder and Muth 2004; Zelasko et al. 2009). Flow and water temperature cues may play an important role prompting razorback adults to aggregate prior to spawning (Muth et al. 2000).

Razorback sucker have high reproductive potential, with reported average female fecundity of approximately 50,000 to 100,000 eggs per fish (U.S. Fish and Wildlife Service 2002d). They are broadcast spawners that scatter adhesive eggs over gravel-cobble substrate (Snyder and Muth 2004). High springs flows are important to egg survival because they remove fine sediment that can otherwise suffocate eggs. Hatching is limited at temperatures less than 10°C (50° F) and best around 20°C (68° F) (Snyder and Muth 2004). Eggs hatch 6 to 11 days after being deposited and larval fish occupy the sediment for another 4 to 10 days before emerging into the water column. Larval fish occupy shallow, warm, low-velocity habitats in littoral zones, backwaters, and inundated floodplains and tributary mouths downstream of spawning bars for several weeks before dispersing to deeper water (U.S. Fish and Wildlife Service 2002d; Snyder and Muth 2004). It is believed that low survival in early life stages, attributed to loss of nursery habitat and predation by non-native fishes, causes extremely low recruitment in wild populations (Muth et al. 2000).

Razorback sucker in the Upper Basin tend to be smaller and grow slower than those in the Lower Basin, reaching 100 millimeters (4 in.) on average in the first year (U.S. Fish and Wildlife Service 2002b). Based on collections in the middle Green River, typical adult size centers around 510 mm (20 in.) (Modde et al. 1996). Razorback suckers are long-lived fishes, reaching 40+ years via high annual survival (U.S. Fish and Wildlife Service 2002d). Adult survivorship was estimated to be 71 to 73 percent in the Middle Green River from 1980-1992 (Modde et al. 1996; Bestgen et al. 2002) and 76 percent from 1990 to 1999 (Bestgen et al. 2002).

POPULATION DYNAMICS

In the Upper Colorado River Basin, the razorback sucker has declined in distribution and abundance until it is now found in small numbers only in the middle Green River, between the confluences of the Duchesne and Yampa rivers, and in the lower reaches of those two tributaries (U.S. Fish and Wildlife Service 2002d). Population estimates during the 1980 to 1992 period were on average between 300 and 600 wild fish (Modde et al. 1996). By the early 2000s, the wild population consisted of primarily aging adults, with steep decline in numbers caused by extremely low natural recruitment (U.S. Fish and Wildlife Service 2002d). Although reproduction was occurring, very few juveniles were found (U.S. Fish and Wildlife Service 2002d). Population estimates from sampling efforts in the Middle Green River had declined to approximately 100 by 2002, with researchers hypothesizing that wild fish in the Green River Basin could become extirpated because of lack of recruitment (Bestgen et al. 2002).

In the upper Colorado River, razorback sucker are exceedingly rare. In the 2002 recovery plan, razorback sucker were considered extirpated in the Gunnison River, where fish were last captured in 1976 (U.S. Fish and Wildlife Service 2002d). Similarly, in the Grand Valley, only 12 fish were collected from 1984 to 1990, despite intensive sampling (Osmundson and Kaeding 1991 in U.S. Fish and Wildlife Service 2002d). No young razorback sucker were captured in the Upper Colorado River since the mid-1960s (Osmundson and Kaeding 1991 in U.S. Fish and Wildlife Service 2002d).

In the San Juan River we know of only two wild razorback suckers that were captured in 1976 in a riverside pond near Bluff, Utah, and one fish captured in the river in 1988, also near Bluff (Ryden 2006). No wild razorback sucker were found during the 7-year research period (1991–1997) of the San Juan River Basin Recovery Implementation Program (Ryden 2006).

Because of the low numbers of wild fish, we believe that augmenting the remaining wild populations with hatchery-raised fish is a key step to creating self-sustaining populations. In fact, the first management action for recovery of the species was to re-establish populations with hatchery-produced fish (U.S. Fish and Wildlife Service 2002d; Zelasko et al. 2009). Fish stocking programs (administered separately for the Upper Colorado and San Juan River Basins) have introduced thousands of fish into various river reaches in the San Juan, Colorado, and Green River sub-basins (Table 2). We are working to evaluate and improve the survival of these stocked fish (Zelasko et al. 2009). Until survival of stocked fish is improved and natural recruitment takes place, populations or razorback sucker in the Upper Colorado River Basin will not be considered stable.

Location	San Juan River	Colorado River Basin			Green River	
		Westwater Canyon upstream to Price-Stubb diversion	Price-Stubb diversion upstream to Rifle	Gunnison River upstream of Redlands Diversion	Colorado River confluence upstream to Desolation Canyon	Desolation Canyon upstream to Whirlpool Canyon
Fish Stocked (approximate)		44,550	16,740	18,390	12,570	26,900
Total	13,000	79,680			39,470	
Stocking Period	1994 to 2005	2000 to 2005	1999 to 2003	1995 to 2003	2003 to 2005	1995 to 2005
Reference	(Ryden 2006)	(Zelasko et al. 2009)				

Table 2. Razorback sucker stocking efforts in the Upper Colorado River Recovery Unit .

BASIN-WIDE STATUS AND DISTRIBUTION

The razorback sucker was designated as endangered under a final rule published on October 23, 1991 (56 FR 54957). Population conditions cited in the rule include little evidence of natural recruitment over the previous 30 years and a downward trend relative to historic abundance over the previous 10 years. Threats to species centered on significant changes to natural habitat conditions, including diversion and depletion of water, introduction of nonnative fishes, and construction and operation of dams.

Monitoring of wild razorback sucker in the Upper Colorado River Basin shows continued declines in abundance, hypothesized to be from a lack of recruitment. Therefore, recovery of the species has focused on augmentation of populations through hatchery-raised fish and habitat improvements.

According to the 2002 Recovery Goals for the species, the primary threats to razorback sucker populations are streamflow regulation and habitat modification (including cold-water dam releases, habitat loss, and blockage of migration corridors); competition with and predation by nonnative fish species; and pesticides and pollutants (U.S. Fish and Wildlife Service 2002d). No new threats have emerged since the completion of this document.

HUMPBACK CHUB (*Gila cypha*)

SPECIES DESCRIPTION

The humpback chub is a medium-sized freshwater fish of the minnow family endemic to the Colorado River basin. The species evolved around 3 to 5 million years ago (Sigler and Sigler 1996). The pronounced hump behind its head gives the humpback chub a striking, unusual appearance. It has an olive-colored back, silver sides, a white belly, small eyes, and a long snout that overhangs its jaw (Sigler and Sigler 1996). This fish can grow to nearly 500 mm (20 in.) and may survive more than 30 years in the wild (U.S. Fish and Wildlife Service 2002c). The humpback chub does not have the swimming speed or strength of species such as the Colorado pikeminnow. Instead, it uses its large fins to "glide" through slow-moving areas, feeding on insects.

Historic distribution is surmised from various reports and collections that indicate the species inhabited canyons of the Colorado River and four of its tributaries: the Green, Yampa, White, and Little Colorado Rivers. Presently the species occupies about 68 percent of its historic habitat (U.S. Fish and Wildlife Service 2002c). Historic to current abundance trends are unclear because historic abundance is unknown (U.S. Fish and Wildlife Service 2002c).

Currently, five wild populations occur upstream of Glen Canyon Dam (Figure 3) and two downstream (U.S. Fish and Wildlife Service 2002c). In the Upper Colorado River Basin the two most stable populations are found near the Colorado/Utah border: one at Westwater Canyon in Utah; and one in an area called Black Rocks, in Colorado (Upper Colorado River Endangered Fish Recovery Program and San Juan River Basin Recovery Implementation Program 2010). Smaller numbers in the Upper Basin were found in the Yampa and Green Rivers in Dinosaur National Monument, Desolation and Gray Canyons on the Green River in Utah, and Cataract Canyon on the Colorado River in Utah (U.S. Fish and Wildlife Service 2002c). The two populations in the Lower Colorado River Basin occur in the mainstem Colorado and Little Colorado Rivers. The Little Colorado River population, found in the Grand Canyon, is the largest known population, harboring up to 10,000 fish (U.S. Fish and Wildlife Service 2002c).

The Office of Endangered Species first included the humpback chub in the List of Endangered Species on March 11, 1967 (32 FR 4001). Subsequently, it was considered endangered under provisions of the Endangered Species Conservation Act of 1969 (16 U.S.C. 668aa) and was included in the United States List of Endangered Native Fish and Wildlife issued on June 4, 1973 (38 FR No. 106). It is currently protected under the Endangered Species Act of 1973 as an endangered species throughout its range (ESA; 16 U.S.C. 1531 *et. seq.*). The Service finalized the latest recovery plan for the species in 2002 (U.S. Fish and Wildlife Service 2002d), but is currently drafting an updated revision.

The Service designated seven reaches of the Colorado River System as critical habitat for the humpback chub on March 21, 1994 (59 FR 13374). These reaches total 610 km (379 mi) as measured along the center line of each reach. Designated critical habitat makes up about 28 percent of the species' original range and occurs in both the Upper and Lower Colorado River Basins. In the Upper Colorado River Basin, critical habitat includes portions of the Yampa, Green, and Colorado Rivers, primarily including canyon habitats, such as Yampa, Desolation and Gray, Westwater, and Cataract Canyons. Although humpback chub life history and habitat use differs greatly from the other endangered Colorado River fish, the primary constituent elements (water, physical habitat, and biological environment) of their critical habitat are the same (see above).

Figure 3. Locations of humpback chub populations in the Upper Colorado River Basin. Taken from Page 12 of (Upper Colorado River Endangered Fish Recovery Program and San Juan River Basin Recovery Implementation Program 2010)

Separate, objective recovery criteria were developed for each of two recovery units (the Upper Colorado and Lower Colorado River Basins as delineated at Glen Canyon Dam) to address unique threats and site-specific management actions necessary to minimize or remove those threats. This biological opinion's focus is on the Upper Colorado River Basin recovery unit and will therefore describe the status of the humpback chub in that unit.

LIFE HISTORY

Like other large desert river fishes, the humpback chub is an obligate warm-water species that requires relatively warm temperatures for spawning, egg incubation, and survival of larvae. Unlike Colorado pikeminnow and razorback sucker, which are known to make extended migrations of up to several hundred miles to spawning areas, humpback chubs do not appear to make extensive migrations. Instead, humpback chub live and complete their entire life cycle in canyon-bound reaches of the Colorado River mainstem and larger tributaries characterized by deep water, swift currents, and rocky substrates (U.S. Fish and Wildlife Service 2002c). Individuals show high fidelity for canyon reaches and move very little.

Mature humpback chub typically spawn on the descending hydrograph between March and July in the Upper Basin (Karp and Tyus 1990). Humpback chub are broadcast spawners who may mature as young as 2 to 3 years old. Eggs incubate for three days before swimming up as larval fish (U.S. Fish and Wildlife Service 2002c). Egg and larvae survival are highest at temperatures close to 19 to 22°C (U.S. Fish and Wildlife Service 2002c). Unlike larvae of other Colorado River fishes (e.g., Colorado pikeminnow and razorback sucker), larval humpback chub show no evidence of long-distance drift (Robinson et al. 1998).

Recruitment appears to be successful in all known Upper Basin populations (U.S. Fish and Wildlife Service 2002c). Survival of humpback chub during the first year of life is low, but increases through the first 2 to 3 years of life with decreased susceptibility to predation, starvation, and environmental changes. Survival from larvae to adult life stages was estimated at 0.1 percent (0.001) (Valdez and Ryel 1995, 1997 in U.S. Fish and Wildlife Service 2002c). Survival of adults is high, with estimates approximating 75 percent based on Grand Canyon adults (U.S. Fish and Wildlife Service 2002c).

Growth rates of humpback chub vary by population, with fish in the Upper Basin growing slower than those in the Grand Canyon (U.S. Fish and Wildlife Service 2002c). Individuals in Cataract Canyon were

50, 100, 144, 200, 251, and 355 mm total length from 1 to 6 years, respectively (Valdez 1990 in U.S. Fish and Wildlife Service 2002c). Based on sexual maturity and age-to-length ratios, adults are classified as those fish 200 mm or longer. Maximum life span is estimated to be 30 years in the wild.

Humpback chub move substantially less than other native Colorado River fishes, with studies consistently showing high fidelity by humpback chub for specific riverine locales occupied by respective populations. Despite remarkable fidelity for given river regions, individual humpback chub adults are known to move between populations. Movement by juveniles is not as well documented as for adults, but is also believed to be limited in distance. For example, no out-migration by young fish is seen from population centers such as Black Rocks and Westwater Canyon.

POPULATION DYNAMICS

Five wild populations of humpback chub inhabit canyon-bound sections of the Colorado, Green, and Yampa Rivers: Yampa Canyon; Desolation and Gray Canyons; Cataract Canyon; Black Rocks; and Westwater Canyon. The largest population in the Upper Colorado River Basin is the Black Rocks and Westwater Canyon core population, comprised of two local populations. The population size for this core population is greater than 3,000 adults, which exceeds the recovery goal of 2,100 fish for this combined population (Upper Colorado River Endangered Fish Recovery Program and San Juan River Basin Recovery Implementation Program 2010). Individually, the population estimates for Black Rocks and Westwater Canyons were documented over the past decade. Estimates for the Westwater Canyon population from 2003 to 2005 indicated a significant decline from approximately 3,000 in 2003, to 1,700 in 2004, and 1,200 in 2005 (Jackson 2010). More recent estimates were not available. In the Black Rocks area catch rates in 2003 and 2004 were similar to those in 2000 with population estimates having wide confidence intervals because of a lack of recaptured individuals (McAda 2007). Estimates for 2007 and 2008 had smaller confidence intervals, approximated 300 to 350 adults, and indicated the population size is relatively stable from 2003-2004 estimates (McAda 2009).

Population estimates for Desolation and Gray Canyons have shown an apparent decrease in abundance over the past decade. Estimates from 2001 to 2003 approximately ranged from 1,000 to 2,600 (Jackson and Hudson 2005), while more recent estimates in 2006 and 2007 were approximately 400 and 200 respectively. Simultaneously, the relative proportion of first year humpback chub (200 to 220 mm) in the population has dropped from 11 to 14 percent in the early 2000s (Jackson and Hudson 2005) to 9 and 5 percent in 2006 and 2007, respectively, indicating recruitment is declining. This decline spurred the Recovery Program to bring individuals into captivity for a captive breeding program to maintain genetic material.

The most recent population estimates for Cataract Canyon indicate that the population is relatively stable. From 2003 to 2005, population estimates centered around 100 individuals (Badame 2008). However, because individuals have high site fidelity, population estimates may be spatially biased and could approach 250 to 450 adults if individuals are evenly distributed across available habitat (Badame 2008). Sampling in 2008 and 2009 indicates that the population remains stable, with similar catch rates as previous efforts (Badame and Lund 2009). This sampling effort also produced encouraging results, such as individuals measuring 150 and 416 millimeters, indicating a broader age distribution and reproductive success (Badame and Lund 2009).

Sampling in Yampa Canyon in 2003 and 2004 resulted in dramatically lower catch rates of humpback chub which precluded population estimates (Finney 2006). Like the Desolation and Gray Canyons population, this decline spurred the Recovery Program to bring individuals into captivity for a captive breeding program to maintain genetic material.

Overall, population stability of humpback chub in the Upper Basin is mixed, with two populations declining to levels requiring captive breeding (Yampa and Desolation Canyons), one remaining stable but low in abundance (Cataract Canyon), and two comprising a large, stable core population that exceeds the recovery goal (Westwater Canyon and Black Rocks). Some populations show signs of reproduction, but others indicate an aging population. Site fidelity of this species requires management of each population as a distinct unit, which has led to captive breeding programs to preserve each population.

BASIN-WIDE STATUS AND DISTRIBUTION

The humpback chub was designated as an endangered species prior to enactment of the ESA, and therefore a formal listing package identifying threats was not assembled. Construction and operation of mainstem dams, nonnative fish species, and local eradication of native minnows and suckers in advance of new human-made reservoirs in the early 1960's were recognized as early threats (U.S. Fish and Wildlife Service 2002c). According to the 2002 Recovery Goals for the species, the primary threats to humpback chub are streamflow regulation, habitat modification, predation by non-native fish species, parasitism, hybridization with other native *Gila* species, and pesticides and pollutants (U.S. Fish and Wildlife Service 2002c). No new threats have emerged since the completion of this document.

As described in previous sections, humpback chub are restricted to a portion of their historical range. Within currently occupied habitat in the Upper Basin, population trends are variable, with one core population remaining quite robust, but other populations threatened with extirpation.

BONYTAIL (*Gila elegans*)

SPECIES DESCRIPTION

The bonytail is a medium-sized freshwater fish in the minnow family, endemic to the Colorado River Basin. The species is evolved around 3 to 5 million years ago (Sigler and Sigler 1996). Individuals have large fins and a streamlined body that typically is very thin in front of the tail. They have a gray or olive-colored back, silver sides, and a white belly (Sigler and Sigler 1996). 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. A very close relative to the roundtail chub (*Gila robusta*), bonytail can be distinguished by counting the number of rays in the fins, with bonytail having 10 dorsal and anal fin rays (Sigler and Sigler 1996). The fish can grow to be 600 mm (24 in.) and are thought to live as long as 20 to 50 years (Sigler and Sigler 1996). Little is known about the specific food and habitat of the bonytail because the species was extirpated from most of its historic range prior to extensive fishery surveys, but it is considered adapted to mainstem rivers, residing in pools and eddies, while eating terrestrial and aquatic insects (U.S. Fish and Wildlife Service 2002a).

Bonytail were once widespread in the large rivers of the Colorado River Basin (multiple historic references in U.S. Fish and Wildlife Service 2002a). The species experienced a dramatic, but poorly documented, decline starting in about 1950, following construction of mainstem dams, introduction of nonnative fishes, poor land-use practices, and degraded water quality (U.S. Fish and Wildlife Service 2002a). Population trajectory over the past century and reasons for decline are unclear because lack of basin-wide fishery investigations precluded accurate distribution and abundance records.

Bonytail are now rarely found in the Green and Upper Colorado River sub-basins and are the rarest of all the endangered fish species in the Colorado River Basin. In fact, no wild, self-sustaining populations are known to exist upstream of Lake Powell, this fish is nearly extinct. In the last decade only a handful of bonytail were captured on the Yampa River in Dinosaur National Monument, on the Green River at Desolation and Gray canyons, and on the Colorado River at the Colorado/Utah border and in Cataract Canyon. In the lower basin, bonytail exist in Lake Mohave and Lake Havasu.

The bonytail is currently listed as endangered under the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 *et. seq.*), under a final rule published on April 23, 1980 (45 FR 27710). The

Service finalized the latest recovery plan for the species in 2002 (U.S. Fish and Wildlife Service 2002a), but is currently drafting an updated revision.

The Service designated seven reaches of the Colorado River as critical habitat for the bonytail on March 21, 1994 (59 FR 13374). These reaches total 499 km (312 mi) as measured along the center line of each reach. Portions of the Green, Yampa, and Colorado Rivers are designated as critical habitat, representing about 14 percent of the species' historic range. The primary constituent elements are the same as those described for Colorado pikeminnow, razorback sucker, and humpback chub.

Separate, objective recovery criteria were developed for each of two recovery units (the Upper Colorado and Lower Colorado River Basins as delineated at Glen Canyon Dam) to address unique threats and site-specific management actions necessary to minimize or remove those threats. This biological opinion's focus is on the Upper Colorado River Basin recovery unit and will therefore describe the status of the humpback chub in that unit.

LIFE HISTORY

Natural reproduction of bonytail was last documented in the Green River in 1959, 1960, and 1961 at water temperatures of 18°C (U.S. Fish and Wildlife Service 2002a). Similar to other closely related *Gila* species, bonytail in rivers probably spawn in spring over rocky substrates. While age at sexually maturity is unknown, they are capable of spawning at 5 to 7 years old. Recruitment and survival estimates are currently unknown because populations are not large enough for research to occur. Individuals in Lake Mohave have reached 40 to 50 years of age (U.S. Fish and Wildlife Service 2002a), but estimates for river inhabiting fish are not available.

POPULATION DYNAMICS

Bonytail are so rare that it is currently not possible to conduct population estimates. In response to the low abundance of individuals, the Recovery Program is implementing a stocking program to reestablish populations in the Upper Basin; stocking goals were met or exceeded the past three years (Upper Colorado River Endangered Fish Recovery Program and San Juan River Basin Recovery Implementation Program 2010). To date, stocked bonytail do not appear to be surviving as well as stocked razorback sucker. Researchers continue to experiment with pre-release conditioning and exploring alternative release sites to improve their survival. On a positive note, in 2009, biologists working on the Green River in the Uintah Basin, Utah, captured in excess of 40 bonytail stocked more than a year earlier.

BASIN-WIDE STATUS AND DISTRIBUTION

The bonytail was designated as an endangered species under a final rule published April 23, 1980 (45 FR 27710–27713). Reasons for decline of the species were identified as the physical and chemical alteration of their habitat and introduction of exotic fishes. The 1990 Bonytail Chub Recovery Plan further stated that the decline of the bonytail chub is attributed to stream alteration caused by construction of dams, flow depletion from irrigation and other uses, hybridization with other Gila, and the introduction of nonnative fish species. Hence, the primary threats to bonytail populations are streamflow regulation and habitat modification (including cold-water dam releases, habitat loss, and blockage of migration corridors); competition with and predation by nonnative fish species; hybridization; and pesticides and pollutants (U.S. Fish and Wildlife Service 2002a). No new threats have emerged since the 2002 recovery goals was published.

No known wild, self-sustaining populations of bonytail exist in the Upper Basin. Since listing, bonytail were stocked in the Upper Basin to augment populations, but recruitment and natural reproduction have not been documented. Recent recaptures of bonytail in the Green River a year after stocking provide promising results that individuals are surviving.

DESIGNATED CRITICAL HABITAT FOR LISTED COLORADO RIVER FISHES

HABITAT DESCRIPTION

In the Upper Colorado River Basin, portions of the White, Yampa, Gunnison, Green, Colorado, and San Juan Rivers and their 100-year floodplain are designated as critical habitat for one or more of the federally listed species described above (Figure 6 in Appendix C). Critical habitat is defined as specific geographic areas, whether occupied by a listed species or not, that are essential for its conservation and that are formally designated by rule. In the State of Utah, many of these critical habitat reaches overlap (Figure 7 in Appendix C). Critical habitat for the humpback chub and bonytail are primarily canyon-bound reaches, while critical habitat for the Colorado pikeminnow and razorback sucker include long stretches of river required for migration corridors and larval fish drift.

Concurrently with designating critical habitat, the Service identified primary constituent elements (PCEs) of the habitat. PCEs are physical or biological features essential to the conservation of a species for which its designated or proposed critical habitat is based on, such as: space for individual and population growth, and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and habitats that are protected from disturbance or are representative of the species historic geographic and ecological distribution.

The Service has identified water, physical habitat, and the biological environment as the primary constituent elements of critical habitat for listed Colorado River fish species (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.

HABITAT USAGE

The four listed fish species are adapted to a hydrologic cycle characterized by large spring peaks of snow-melt runoff and low, relatively stable base flows (U.S. Fish and Wildlife Service 2002b). 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 (U.S. Fish and Wildlife Service 2002b).

Throughout most of the year, juvenile, subadult, and adult Colorado pikeminnow use relatively deep, low-velocity eddies, pools, and runs that occur in near-shore areas of main river channels (multiple references in U.S. Fish and Wildlife Service 2002b). Adults require pools, deep runs, and eddy habitats maintained by high spring flows. In spring, however, adults use floodplain habitats, flooded tributary mouths, flooded side canyons, and eddies that are available only during high flows (multiple references in U.S. Fish and Wildlife Service 2002b). Newly hatched larval fish drift downstream to backwaters in sandy, alluvial regions, where they remain through most of their first year of life (multiple references in U.S. Fish and Wildlife Service 2002b). Because of their mobility and environmental tolerances, adult Colorado pikeminnow are more widely distributed than other life stages.

Similar to Colorado pikeminnow, razorback sucker use a variety of habitats throughout their life cycle. 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 (U.S. Fish and Wildlife Service 2002d). In spring and winter adult razorback sucker require deeper, low-velocity habitat, but are known to occupy shallow sandbars in summer (McAda and Wydoski 1980 in Zelasko et al. 2009). Reproductive activities are believed to take place in off-channel habitats and tributaries because razorback sucker aggregations were reported in these areas. Off-channel habitats are much warmer than the mainstem river and razorback suckers presumably move to these areas for spawning and other activities, such as, feeding, resting, or sexual maturation.

Off channel and floodplain habitat is also important to young razorback sucker. After hatching, razorback sucker larvae drift downstream to low-velocity floodplain or backwater nursery habitat. The absence of seasonally flooded riverine habitats is believed to be a limiting factor in the successful recruitment of razorback suckers in their native environment. 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 larvae food is one of the most important factors limiting recruitment.

Unlike Colorado pikeminnow and razorback sucker, humpback chub show high site fidelity for canyon-bound reaches of mainstem rivers. Past captures of adults were associated with large boulders and steep cliffs. Reproductive habitat is not defined because 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. It is believed that upon emergence from spawning gravels, humpback chub larvae remain in the vicinity of bottom surfaces near spawning areas. As larval fish mature, backwaters, eddies, and runs were reported as common capture locations for young-of-year humpback chub.

While bonytail are closely related to humpback chub, their habitat usage may be slightly different. It is observed in pools and eddies in mainstem rivers, but recent information collected by the Recovery Program suggests that floodplain habitats may be more important to the survival and recovery of the bonytail than originally thought. Although spawning events in river habitat has not been documented, bonytail probably spawn in rivers over rocky substrates because spawning is observed in reservoirs over rocky shoals and shorelines. Recent hypotheses surmise that flooded bottomlands may provide important bonytail nursery habitat.

ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed State or Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation process.

The action area is defined to mean "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action". The action area also depends on the species being discussed. Because the Project alters water quantity in the Green River, the Service defines the action area for the four Colorado River endangered fish and their designated critical habitat to include the Green and Colorado Rivers between Flaming Gorge Dam and Lake Powell for the purposes of this consultation (see Proposed Action, Action Area).

STATUS OF THE SPECIES IN THE ACTION AREA

The Project occurs on the mainstem Green River near Ouray, Utah. For all four endangered fish species the Project occurs within the Upper Colorado River Basin Recovery Unit. Within this Recovery Unit, specific recovery criteria are established for the Green River sub-basin for all four species, including population demographics. Self-sustaining and stable populations of these species in the Green River sub-basin are required for full species recovery (U.S. Fish and Wildlife Service 2002a, 2002b, 2002c, 2002d). The entire length of the Green River and its 100 year floodplain are designated as critical habitat for at least one species between the Yampa River confluence and the Colorado River confluence (Appendix A, Figure 6)[8]. The Project is located in critical habitat for the Colorado pikeminnow and razorback sucker, and directly upstream of Desolation Canyon, designated critical habitat for the all four species (Appendix A, Figure 7). Portions of the Colorado River downstream from the Project, including Cataract Canyon, are also designated critical habitat for all four species (Appendix A, Figure 7).

Currently, the Project action area includes:

- the largest, most productive, and most robust population of the Colorado pikeminnow;
- known, active spawning locations of the Colorado pikeminnow;
- known, active spawning locations of the razorback sucker;
- known population centers of humpback chub; and
- populations of stocked Colorado pikeminnow, razorback sucker, and bonytail individuals.

The largest, most productive, and most robust population of Colorado pikeminnow occurs in the mainstem Green River (combining the lower Green River, Desolation/Gray Canyon, and middle Green River populations). Higher abundance of Colorado pikeminnow juveniles and recruits in the 2006 to 2008 sampling period is attributed to a relatively strong year class of age-0 Colorado pikeminnow produced in the lower Green River in 2000 (Bestgen et al. 2010). Length frequency histograms, especially in the Desolation-Gray Canyon and lower Green River reaches, indicate that abundance of Colorado pikeminnow recruits was much higher in period 2006 to 2008 than from 2000 to 2003 (Bestgen et al. 2010). The importance of Green River populations is also evident because increased abundance of adult Colorado pikeminnow in the White River and middle Green River through 2008 almost certainly derived from upstream movement (high transition rates) of large numbers of juvenile and recruit-sized Colorado pikeminnow that originated in downstream reaches of the Green River in 2006 and 2007 (Bestgen et al. 2010).

Colorado pikeminnow spawn in two principal sites: Gray Canyon in the lower Green River; and the lower Yampa River (U.S. Fish and Wildlife Service 2002b). Known spawning sites for razorback sucker are located in the lower Yampa River and in the Green River near Escalante Ranch, but other, less-used sites are probable (U.S. Fish and Wildlife Service 2002d). Both of these species are migratory spawners whose young emerge as larval fish from spawning locations and drift downstream. Because spawning locations occur upstream of the Project and known populations occur downstream of the Project, both adults and larval fish must pass the Project during reproductive cycles.

Although humpback chub are primarily resident fish, some movement between populations is expected. The Project is downstream of the Yampa Canyon population and upstream of both Cataract Canyon and Desolation/Gray Canyon populations. Therefore any movement to or from the Yampa Canyon population must pass the Project.

To augment natural populations, the Recovery Program produces genetically diverse fish in hatcheries and stocks them in the river system. The stocking program is guided by an integrated stocking plan and utilizes at least seven fish hatcheries for propagation. In most years the Recovery Program was successful at meeting stocking goals. In addition, the Recovery Program is working on research projects that elucidate ways to improve the survivorship of stocked fish. Currently all four species except humpback chub are stocked into the Green River, both upstream and downstream of the Project.

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[8] For a detailed description of the critical habitat reaches, please see the Federal Register: 59 FR 13374

Project construction, operation, and maintenance are expected to impact the wild and stocked populations both directly and indirectly, depending upon the population being discussed. While this Project will not directly affect tributary populations of these species, such as those in the Yampa River, it will impact individual fish movement to and from spawning locations, and emigration and immigration between populations. Therefore, populations not in the immediate upstream or downstream area of influence of the Project will be impacted and must be considered in this Biological Opinion. In addition, the use of water from the Green River affects the habitat quantity and quality both upstream and downstream of the Project location, for many miles.

STATUS OF CRITICAL HABITAT IN THE ACTION AREA

Historically, the Green River produced high spring turbid flows that maintained critical habitat by inundating floodplains, maintaining side channels, flushing fine sediment, and creating backwaters (Muth et al. 2000). However, with the completion of Flaming Gorge Dam in 1962, the mainstem Green river became highly regulated. The dam and reservoir physically altered the Green River and surrounding terrain and modified the pattern of flows downstream (Muth et al. 2000). Most notably, the construction of the dam created a fish passage barrier and transformed miles of riverine habitat into lacustrine habitat. These two changes isolated fish populations and decreased the amount of native habitat.

Subsequent dam operation also results in effects to native fish communities. Historically, water releases from Flaming Gorge Dam did not mimic natural flow patterns and introduced colder water into the river from the deep pool behind the dam (Muth et al. 2000). Alteration of the natural flow regime affects stream vegetation communities and channel morphology, which modify native fish habitat (Muth et al. 2000). Natural flow regimes may also act as cues for important life history events, such as spawning. Life history events are similarly affected by water temperature, with colder temperatures disrupting the temporal spawning regime of native fish.

Additionally, Flaming Gorge Dam created new water resource impacts, such as irrigation potential, municipal use, and recreational fisheries of introduced non-native species. Water storage provided by the dam allowed local communities to increase water usage for agriculture and municipal purposes. Increased water depletion from the Green River decreases native fish habitat and limits the amount of backwater nursery habitat for juvenile fish. Furthermore, increased water supply for agriculture and municipal purposes increases the likelihood of degraded water quality from agricultural runoff (pesticides, fertilizers, etc.) and wastewater inputs.

All four federally listed species evolved in desert river hydrology, relying on high spring flows and stable base flows for habitat conditions essential to their survival (see Status of the Species & Critical Habitat). In addition to main channel migration corridors, Colorado pikeminnow and razorback sucker rely on floodplain and backwater habitats for various stages of their life history. High spring flows also act as spawning queues. In contrast, Bonytail and humpback chub rely more on canyon-bound reaches with swift currents and white water.

Currently, two primary reaches of Colorado pikeminnow nursery habitat are present in the Green River system. The lower reach occurs from near Green River, Utah, downstream to the Colorado River confluence. The upper reach occurs from near Jensen, Utah, downstream to the Duchesne River confluence. Larvae from the lower Yampa River are thought to mostly colonize backwaters in alluvial valley reaches between Jensen, Utah, and the Ouray NWR. Most floodplain habitat along the current-day Green River is concentrated in this reach. These backwaters are especially important during the Colorado pikeminnow's critical first year of life. The Project is located in the upper nursery habitat reach and occurs directly upstream of the Ouray NWR backwater habitats.

Bottomlands, low-lying wetlands, and oxbow channels flooded and ephemerally connected to the main channel by high spring flows appear to be important habitats for all life stages of razorback sucker. These areas provide warm water temperatures, low-velocity flows, and increased food availability. Many of these locations are found in the middle Green River near the Project location, including the Stirrup and Baesar Bend wetlands. Razorback sucker are stocked into the Stirrup wetland because of its suitable habitat.

Humpback chub occur in Yampa, Cataract, and Desolation/Gray Canyons in the action area. Adults require eddies and sheltered shoreline habitats maintained by high spring flows. These high spring flows maintain channel and habitat diversity, flush sediments from spawning areas, rejuvenate food production, and form gravel and cobble deposits used for spawning. Flow recommendations were developed that specifically consider flow-habitat relationships in habitats occupied by humpback chub in the upper basin, and were designed to enhance habitat complexity and to restore and maintain ecological processes.

The action area includes critical habitat units which are identified as essential for their recovery (U.S. Fish and Wildlife Service 2002a, 2002b, 2002c, 2002d). While Project water releases and depletions do not occur within all critical habitat units, the changes in water volume will nonetheless affect critical habitat by changing the amount of water flowing into these designated habitat units. The action area includes critical habitat units on the mainstem Green River and Colorado River below the Green River confluence.

All four of the listed Colorado River fish require the same Primary Constituent Elements (PCEs) essential for their survival. Water, physical habitat, and the biological environment are the PCEs of critical habitat. This includes a quantity of water of sufficient quality that is delivered to a specific location in accordance with a hydrologic regime that is 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.

PRIMARY CONSTITUENT ELEMENT - WATER

The quality and quantity of water in the action area of the Green River has decreased from water projects, most notably Flaming Gorge Dam. Peak spring flows in the Green River at Jensen, Utah, have decreased 13 to 35 percent and base flows have increased 10 to 140 percent due to regulation by Flaming Gorge Dam (Muth et al. 2000). However, since 2006 changes were made in the operation of Flaming Gorge Dam that provide flow and meet temperature requirements for native fish.

A number of tributaries to the Green river appear on the State of Utah’s 303(d) list of impaired streams for various reasons (Utah Division of Water Quality 2004). Tributaries and sections of the Price, San Rafael, and Duchesne Rivers are listed for elevated salinity, TDS, and chlorides, as are portions of Ashley and Pariette Draw Creeks. Brush, Pariette Draw, and Lower Ashley Creeks are listed for elevated Selenium. Willow and Indian Canyon Creeks are listed for elevated total dissolved solids. Ninemile Creek is listed for elevated temperature. Lake Fork Creek is listed for elevated sediments. And lastly, Pariette Draw Creek is listed for elevated Boron. These elevated pollutants pose a risk to this PCE. As these tributaries reach the main stem, these pollutants are introduced to the Green River as well. Currently the Green River acts as a dilution for these pollutants, as is evident by the Green River not appearing on the State of Utah’s impaired water list. However, these pollutants still occur in the river and as new water depletions occur, these pollutants will be found in higher concentrations.

PRIMARY CONSTITUENT ELEMENT - PHYSICAL HABITAT

As previously discussed, the completion of Flaming Gorge Dam created a fish passage barrier. Native Colorado pikeminnow, razorback sucker, humpback chub, and bonytail can no longer migrate into

Wyoming from the lower Green River. This barrier has isolated populations, decreasing the ability of individuals to interact and hindering the transfer of genetic material.

The quantity and timing of flows influence how the channel and various habitats are formed and maintained. Channel narrowing is a problem because as the channel width decreases, water velocity increases, and the amount of low velocity habitats, important to the early life stages of the fish, decreases. Habitat below Flaming Gorge Dam has historically been shaped by an artificial flow regime which decreased low flow habitats, disrupted vegetative communities, and altered channel morphology. However, recent operation changes have made this flow regime match more natural conditions. These changes affect temperature, channel morphology, and habitat conditions.

PRIMARY CONSTITUENT ELEMENT - BIOLOGICAL ENVIRONMENT

This PCE is impaired by the presence of non-native fishes common in the Green River. Non-native fishes occupy the same backwaters that are very important for young Colorado pikeminnow and razorback sucker. Specifically, largemouth and smallmouth bass are present in this system and predate upon juvenile native fish. Programs are ongoing to remove bass from this system. Other non-natives found in the Green River include catfish, centrarchids, northern pike, and non-native cyprinids.

FACTORS AFFECTING THE SPECIES ENVIRONMENT WITHIN THE ACTION AREA

This baseline includes State, tribal, local, and private actions already affecting the species or that will occur contemporaneously with the consultation in progress. Unrelated Federal actions affecting the same species or informal consultation are also part of the environmental baseline, as are Federal and other actions within the action area that may benefit listed species or critical habitat.

UPPER COLORADO RIVER ENDANGERED FISH RECOVERY PROGRAM

The Upper Colorado River Endangered Fish Recovery Program was established in 1988 to help recover the four endangered fish species (see Consultation History). The Recovery Program implements management actions within seven Program elements, as dictated from species' recovery goals, with the focus of down-listing and de-listing the species. Five of these actions impact the species in the action area: instream flow identification and protection; habitat restoration; non-native fish management; propagation and stocking; and research and monitoring.

Current management actions performed by the Recovery Program in the Project action area include, but are not limited to:

- Overseeing non-native fish removal activities in the Green River Basin, including the Green River upstream of the Project. Nonnative fishes of immediate primary concern and currently explicitly targeted for management are northern pike (*Esox lucius*), smallmouth bass (*Micropterus dolomieu*), and channel catfish (*Ictalurus punctatus*). These nonnative fish species pose significant threats to the endangered fishes because of their high or increasing abundance and range expansion, their habitat and resource requirements overlap with those of the endangered fish species, and they are known fish predators;
- Stocking of bonytail and razorback sucker into the middle and lower Green River;
- Coordinating research projects, such as the Recovery Program Study Number C6 RZ-RECR: *Razorback emigration from the Stirrup floodplain*. This study is designed to assess emigration rates to the river of razorback suckers stocked in to the Stirrup floodplain wetland located at river mile 276 of the Green River; and
- Participating in the Flaming Gorge Technical Workgroup, which manages releases from Flaming Gorge Dam to benefit endangered fish species while meeting other legal purposes of the dam.

This technical team establishes base flow and spring peak release criteria from Flaming Gorge that meet the Flow Recommendations (Muth et al. 2000).

FLOW PROTECTION IN THE GREEN RIVER

Recovery cannot be accomplished without securing, protecting, and managing sufficient habitat to support self-sustaining populations of the endangered fishes. Identification and protection of instream flows are key elements in this process. The first step in this process, identifying instream flows needed for recovery, was completed for the action area with the publication of the Flow Recommendations (Muth et al. 2000). However, there is no legal protection of flows in the Utah portion of the Green River. The process for meeting this recovery goal is ongoing, as described below.

Several approaches may be taken under Utah water law to protect instream flows, including: 1) acquiring existing water rights and filing change applications to provide for instream flow purposes; 2) withdrawing unappropriated waters by governor's proclamation; 3) approving presently filed and future applications subject to minimum flow levels; and 4) with proper compensation, preparing and executing contracts and subordinating diversions associated with approved and perfected rights.

Although Utah water law may not fully provide for all aspects of instream-flow protection, the State believes they can provide an adequate level of protection. Utah examined available flow protection approaches in the 1990’s and determined that the strategy they would use most commonly will be to condition the approval of presently filed and new applications, making them subject to predetermined streamflow levels. To accomplish this, the State Engineer adds a condition of approval to water right applications (within the area) filed after the policy is adopted. The condition states that whenever the flow of the Green River (or other streams) drops below the predetermined streamflow level, then diversions associated with water rights approved after the condition is imposed are prohibited. Based on past legal challenges to the State's authority to impose conditions associated with new approvals, it was determined that this is within the authority of the State Engineer. This approach does not specifically recognize an instream-flow right; however, it does protect the flows from being diverted and used by subsequently approved water rights. This approach was adopted as policy by the State Engineer. The policy requires that presently filed and new applications to be approved are subject to the summer and fall flow recommendations. As flow recommendations are finalized and accepted, Utah will review options for protecting the recommended flows. In 2009, Utah determined that the aforementioned “subordination” method of flow protection may not be feasible. The Recovery Program’s Water Acquisition Committee formed a task force to develop other options for protecting fish flows on the Green River. This task force has joined with Reclamation to conduct modeling that will incorporate hydrology and future water right claims to use as a planning and policy tool. In 2010, Utah will identify the legal and technical process and schedule to protect recommended year-round flows for the endangered fishes in the Utah.

EFFECTS OF THE ACTION

This biological opinion considers the following effects to the four federally listed fish species and their designated critical habitat:

1. Interaction with the pumping facility by juveniles and adults;
2. Interaction with the pumping facility by larval fish drifting downstream;
3. Alteration to habitat and displacement of fish from construction activities;
4. Alteration of habitat from the permanent pump station structure;
5. Water depletions/additions to the system for agricultural water development; and
6. Remediation of the existing Nielson pumping site.

1. INTERACTION WITH PUMP FACILITY BY JUVENILES & ADULTS

Individuals of all four federally listed species will encounter the GRPP intake structure on the Green River because these fish inhabit and migrate through the area. Razorback sucker and Colorado pikeminnow have the highest risk of exposure because these species migrate past the site to reach spawning areas; use nearby backwater reaches for early life stage development; and occupy mainstem reaches in the area as adults. Humpback chub have the lowest risk of exposure because they will encounter the intake structure only as they emigrate and immigrate between populations, primarily Yampa and Desolation Canyons. Bonytail have an intermediate risk of exposure, primarily from stocked individuals encountering the intake structure.

The location of the GRPP places it downstream of both nursery and spawning habitat of Colorado pikeminnow and razorback sucker, specifically the Colorado pikeminnow spawning site in the lower Yampa River (U.S. Fish and Wildlife Service 2002b) and razorback sucker spawning sites in the Yampa and Green Rivers (U.S. Fish and Wildlife Service 2002d). Therefore all life stages of these species are expected to be present at the GRPP intake, including larval fish (newly hatched), juvenile (a few months to ~age 6), and adult (~age 6). Presence of juvenile pikeminnow upstream and downstream of the site was confirmed through annual monitoring efforts conducted under the Upper Colorado River Endangered Fish Recovery Program, including 2008 (Badame et al. 2008) and 2009 (Badame et al. 2009).

Fish encountering unscreened irrigation intake structures will be harassed, injured, or killed, primarily through entrainment, the process by which aquatic organisms are diverted into irrigation structures (Zydlewski and Johnson 2002; Gale et al. 2008). Screening intake structures is the most common method to minimize entrainment of fish (Zydlewski and Johnson 2002; Moyle and Israel 2005; Gale et al. 2008). However, screening facilities must be designed to meet individual criteria at each location, taking into account the fish that will encounter the structure, as summarized below:

> “The effectiveness of screens depends on several biological and physical factors, among them the swimming ability of the fish. Fish swimming ability is dependent on species, size, stamina, developmental stage, and migrational stage. Dissolved oxygen concentration, water temperature, and lighting also influence swimming ability and therefore the fate of fish at diversion screens. Two of the more important factors to be considered are (1) the time of emergence of the smallest life stage, and (2) low water temperatures. The smallest life stages will have the highest probability of entrainment based on size; low water temperatures result in lower metabolic activity that may, in turn, result in poor swimming performance and slower escape responses at intake screens. Together these factors increase the probability of impingement on and entrainment through diversion screening.” (Zydlewski and Johnson 2002)

The National Marine Fisheries Service (NMFS) established approach velocity recommendations for salmonid species in "Fish Screening Criteria for Anadromous Salmonids" (National Marine Fisheries Service Southwest Region 1997). These criteria differed based on the presence or absence of fry sized (less than 60 mm or ~2 inch) fish encountering the screen. Using this document and applying GRPP conditions (presence of fry sized fish and structure located in the river channel), NMFS guidelines would require a 0.33 ft/s approach velocity.

While this recommendation seemed legitimate for use at this station, both the project proponent and we wanted to acquire more specific data that quantified the swimming speeds of juvenile native fishes in order to set a truly appropriate approach velocity. According to the State of Washington, appropriate approach velocities must be

> “set at a level that is less than the **sustained swimming** speed of juvenile fish. Juvenile fish must be able to swim at a speed equal to the approach velocity for an extended length

of time to avoid impingement on the screen. They must be able to swim at a speed greater than that to escape the screen and return to the channel upstream." (Washington Department of Fish and Wildlife 2000; with emphasis added)

For the GRPP structure, setting an appropriate approach velocity (see below, Colorado Pikeminnow Swimming Speed) at the intake structure is most important for minimizing impacts to juvenile (a few months to one year old) Colorado pikeminnow and razorback sucker because these fish are smaller (~20 to 60 mm in length) and have lower swimming speeds than larger, older individuals (Berry and Pimentel 1985; Childs and Clarkson 1996). Fish smaller than ~20 mm are considered larval fish and have highly reduced swimming ability (see Interaction with the Pump Facility by Larval Fish below). Based on a literature review and design negotiations, the GRPP as designed uses both adequate fish screen size and adequate approach velocity to minimize impacts to these species.

COLORADO PIKEMINNOW SWIMMING SPEED

We reviewed the literature concerning swimming abilities of native Colorado River basin fish species and determined that there are a number of studies that investigated the swimming speed of adult native fishes, but very few studies tested the swimming speeds of juveniles. Fortunately, one study did test the swimming speeds of three classes of juvenile Colorado pikeminnow under differing temperatures. The classes were based on size, with "larval" fish being approximately 13 to 14 mm, "young juvenile" being approximately 22 mm, and "older juvenile" being approximately 28 mm in length (Childs and Clarkson 1996). The swimming speeds of all three classes were tested at temperatures of 10, 14, and 20 °C, which are "typical of spring-summer water temperatures in modified Colorado River and its tributaries" (Childs and Clarkson 1996). The study measured the fatigue velocity value (FV50) in centimeter per second velocities, indicating the velocity at which half of the fish fail to maintain swimming, over a period of thirty minutes (Table 3) (Childs and Clarkson 1996).

Because sustained speed is the most important swimming metric for the purposes of our investigation, FV50 values need to be converted to sustained speeds. We applied a conversion factor of 0.8 to the FV50 values, which follows Beamish's description that sustained speed is approximately 80 percent of FV50 values (Childs and Clarkson 1996). Table 3 summarizes the conversion of FV50 to ft/s and then the conversion of FV50 values to sustained swimming speed values. The results in Table 3 indicate that young pikeminnow can be expected to have a mean sustained swimming speed approximately between 0.27 and 0.5 feet per second, depending on size and temperature conditions.

Approach velocity criteria for the Project were established using the "young juveniles" swimming ability because those fish are comparable in size to smallest fish most likely to encounter the intake structure and be able to swim away. It is important to note that these numbers are mean values and do not incorporate the variance found in the study. Therefore, a portion of individual fish will be expected to have swimming speeds below the mean values. To attempt to account for some of the variance of the swimming speeds and protect the slower swimming fish, we also calculated sustained swimming speed based on the lower limits of the 95 percent confidence interval as well (Table 3).

Data from Childs and Clarkson (1996)			Conversion performed as part of this project	
Total Length (mm)	**Water Temperature (°C)**	**FV 50 (cm/s)**	**Converted FV50 (ft/s)**	**Approximate sustained speed (80% of FV50) (ft/s)**
Larval fish				
14.1 ± 0.5	10	10.5	0.344	0.276
13.4 ± 0.4	14	13.5	0.443	0.354
13.0 ± 0.6	20	16.1	0.528	0.423
Young Juveniles				
22.3 ± 1.2	10	13.3 CI: (12.4 – 14.2)	0.436 Low CI: (0.407)	0.349 Low CI: 0.325
21.5 ± 1.2	14	14.7 CI: (13.8 – 15.6)	0.482 Low CI: (0.453)	0.386 Low CI: 0.362
21.7 ± 1.2	20	17.4 CI: (16.5 – 18.4)	0.571 Low CI: (0.541)	0.457 Low CI: 0.433
Older juveniles				
28.4 ± 1.5	10	14.2	0.466	0.373
28.8 ± 1.8	14	15.2	0.499	0.399
27.7 ± 1.7	20	19.2	0.630	0.504

Table 3. Conversion of Childs and Clarkson's results to sustained swimming speed in feet per second.

As mentioned earlier, and demonstrated by the results in Table 3, swimming speed for Colorado pikeminnow varies based on water temperature. As water temperatures increase, Colorado pikeminnow are able to swim faster. Therefore, it behooves us to consider the expected water temperatures at the GRPP when we expect the station to be operating (the irrigation season). Because the researchers only tested swimming speeds at three different temperatures and we need to know an estimate of swimming speeds along the entire range of temperatures, we completed mathematical interpolations using the three known data points (Figure 4) and used the corresponding equations (displayed in Figure 4) to calculate swimming speeds at various temperatures. This interpolation was conducted using the mean and the lower 95 percent confidence interval point around the mean.

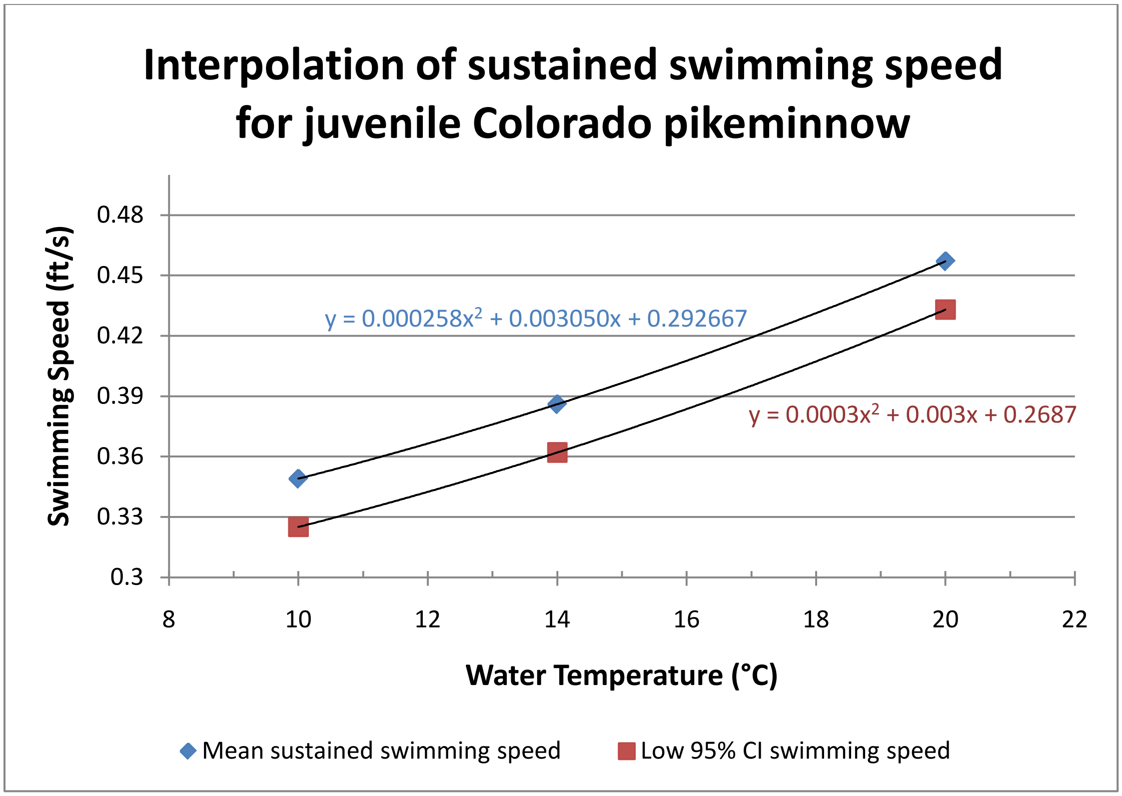


Figure 4. Interpolation of sustained swimming speed for juvenile Colorado pikeminnow using the mean and lower 95 percent confidence intervals values from Childs and Clarkson (1996) (Data point values found in Table 3)

Using these equations shown in Figure 4, we can calculate the expected sustained swimming speed for any water temperature of interest. For example, using the mean sustained swimming speed equation, we expect "young juvenile" Colorado pikeminnow to have sustained swimming speeds of 0.431 ft/s at a temperature of 18°C (Figure 5).

Sustained swimming speed = 0.000258*(water temperature)^2 + 0.00305*(water temperature) + 0.292667
Sustained swimming speed = 0.000258*(18)^2 + 0.00305*(18) + 0.292667
Sustained swimming speed = 0.083592 + 0.0549 + 0.292667
Sustained swimming speed = 0.4311

Figure 5. Calculating expected swimming speed using the interpolation equations from Figure 4.

It should be noted that Childs and Clarkson (1996) did not investigate swimming speeds of juvenile fish above water temperatures of 20°C. We did not calculate an extrapolation above 20°C because we have no basis to define the slope or threshold criteria in warmer waters. Without these criteria, our equation would predict fish to swim faster no matter the temperature in question, which is an erroneous assumption. Without empirical data that allows extrapolation of swimming speeds above 20°C swim speeds are capped at 0.433 ft/s (swimming speed seen at 20°C for the lower 95 percent CI equation). However, it is expected that swim speeds continue to improve up to at least ~25°C because other research has demonstrated that larval and juvenile Colorado pikeminnow have water temperature tolerance limits up to 30°C and are characterized as having an optimal thermal niche of 25°C (references in Lamarra 2007).

RAZORBACK SUCKER SWIMMING SPEED

A thorough literature review revealed studies investigating swimming speed of adult razorback sucker, but no information on swimming speeds of juveniles. Therefore, we investigated juvenile swim speeds of a surrogate species, the flannelmouth sucker. Flannelmouth and razorback suckers are both Catostomid (sucker) species that evolved in the Colorado River basin, making them ecologically similar. Using flannelmouth sucker as a surrogate for razorback sucker swimming ability was validated by research demonstrating that large, juvenile (~100 mm total length) razorback and flannelmouth suckers have generally similar swimming speeds (Ward and Hilwig 2004).

Similar to results for the Colorado pikeminnow, swimming ability of flannelmouth sucker increased directly with fish length and water temperature (Ward et al. 2002). More importantly, FV50s for comparable sized Colorado pikeminnow are 7 to 10 cm/s slower than flannelmouth sucker at comparable temperatures (Ward et al. 2002). As a result, after converting FV50 to sustained swimming speeds, flannelmouth in the 20 to 30 mm size class have superior swimming abilities. Therefore, designing the GRPP structure in relation to Colorado pikeminnow swimming speeds should sufficiently protect young flannelmouth and razorback suckers as well.

Additional research demonstrated that razorback sucker have sufficient escape performance (burst speed and acceleration) to survive encounters with the intake structure. Razorback sucker caudal fins reach adult morphology by approximately 15 mm total length, allowing for increased escape response (Gibb et al. 2005). In comparison to other fishes, small razorback suckers were faster (greater maximum velocity and acceleration) than small rainbow trout, while large larvae performed similarly (Wesp and Gibb 2003). This research also determined that razorback sucker larvae escape performance falls within the range reported for other fishes and concluded that razorback suckers do not have poor escape performance (Wesp and Gibb 2003).

APPRORIATE APPROACH VELOCITY

Based on the swimming speed analysis of Colorado pikeminnow and razorback sucker, we conclude that that the NMFS "Fish Screening Criteria for Anadromous Salmonids" (National Marine Fisheries Service Southwest Region 1997) sufficiently protects federally listed fish species. The majority of individuals of both Colorado pikeminnow and razorback sucker have sustained swimming ability greater than 0.33 ft/s by the time they reach approximately 20 mm in total length.

However, difficulties arise when setting a static approach velocity requirement for the GRPP because the plant is located within the Green River channel, a dynamic system. Approach velocities are directly related to intake surface area and intake flow rate. During dry years, the cross sectional area against the intake screens is reduced because the water surface elevation is below the top level of the intake screens. As a result, the velocity through this smaller screen area increases in order to deliver the required flow. Adding another set of complexity is the fact that the UWCD will operate the GRPP under a variety of conditions (number of pumps and hours per day) in order to meet water demands.

Therefore, approach velocities will change based on the hydrologic conditions of the Green River and the flow rate required by UWCD. To explain this, minimum and maximum intake approach velocities under 4 different hydrologic scenarios (2, 10, 50, and 90 percent Green River mean daily flow) are shown for three operational regimes (8500 af with two pumps, 8500 af with three pumps, and 10,000 af with three pumps) for each two week period of the irrigation season (Tables 2.9, 2.10, and 2.11 of the EA, respectively, reprinted below). Exceedance of the 0.33 ft/s criteria (shaded boxes) occurs only when three pumps are operating, during the peak of the irrigation season (primarily June to August), and at 50 percent mean daily flows or less.

The conditions that lead to exceedance of the 0.33 ft/s criteria, summer months and lower base flows, also lead to warmer water conditions in the Green River. As described earlier, Colorado pikeminnow swimming speed is related to water temperature. Therefore, the periods of increased approach velocity at the GRPP also correspond to faster swimming abilities for fish.

Table 2.9

Initial Phase (8,500 af/yr) - Two Pumps

Intake Approach Velocities

Units: feet per second (fps)

Period	2% MDF		10% MDF		50% MDF		90% MDF		Hr/day/pump			
	Min	Max	Min	Max	Min	Max	Min	Max	1	2	3	T
Apr 16-30	0.112	0.131	0.107	0.124	0.085	0.103	0.067	0.077	10			10
May 1-15	0.106	0.115	0.093	0.110	0.070	0.085	0.056	0.067	16			16
May 16-31	0.171	0.206	0.161	0.172	0.117	0.133	0.096	0.108		11		11
June 1-15	0.183	0.222	0.170	0.201	0.120	0.128	0.096	0.108		16		16
June 16-30	0.224	0.278	0.204	0.254	0.129	0.157	0.102	0.124		19		19
July 1-15	0.268	0.296	0.254	0.275	0.165	0.205	0.123	0.146		21		21
July 16-31	0.296	0.305	0.276	0.291	0.207	0.234	0.149	0.191		20		20
Aug 1-15	0.299	0.304	0.290	0.298	0.239	0.248	0.176	0.201		20		20
Aug 16-31	0.302	0.306	0.295	0.300	0.242	0.256	0.194	0.214	9	13		22
Sept 1-15	0.302	0.311	0.297	0.303	0.249	0.258	0.202	0.221	15	9		24
Sept 16-30	0.293	0.311	0.200	0.297	0.248	0.258	0.200	0.217	20	4		24
Oct 1-15	0.159	0.163	0.150	0.158	0.129	0.136	0.105	0.112	19			19

Indicates exceedence of 0.33 fps threshold during third pump operation

Table 2.10

Initial Phase (8,500 af/yr) - Three Pumps

Intake Approach Velocities

Units: feet per second (fps)

Period	2% MDF		10% MDF		50% MDF		90% MDF		Hr/day/pump			
	Min	Max	Min	Max	Min	Max	Min	Max	1	2	3	T
Apr 16-30	0.112	0.131	0.107	0.124	0.085	0.103	0.067	0.077	10			10
May 1-15	0.106	0.115	0.093	0.110	0.070	0.085	0.056	0.067	16			16
May 16-31	0.171	0.206	0.161	0.172	0.117	0.133	0.096	0.108		11		11
June 1-15	0.183	0.222	0.170	0.201	0.120	0.128	0.096	0.108		16		16
June 16-30	0.224	0.278	0.204	0.254	0.129	0.157	0.102	0.124		19		19
July 1-15	0.383	0.425	0.364	0.394	0.236	0.293	0.176	0.209	8		12	20
July 16-31	0.425	0.437	0.395	0.416	0.296	0.336	0.214	0.273	8		12	20
Aug 1-15	0.428	0.435	0.416	0.426	0.342	0.355	0.252	0.288	8		12	20
Aug 16-31	0.302	0.306	0.295	0.300	0.242	0.256	0.194	0.214	9	13		22
Sept 1-15	0.302	0.311	0.297	0.303	0.249	0.258	0.202	0.221	15	9		24
Sept 16-30	0.293	0.311	0.279	0.297	0.248	0.258	0.200	0.217	20	4		24
Oct 1-15	0.159	0.163	0.150	0.158	0.129	0.136	0.105	0.112	19			19

Indicates exceedence of 0.33 fps threshold during third pump operation

Table 2.11

Full Project (10,000 af/yr) - Three Pumps

Intake Approach Velocities

Units: feet per second (fps)

Period	2% MDF		10% MDF		50% MDF		90% MDF		Hr/day/pump			
	Min	Max	Min	Max	Min	Max	Min	Max	1	2	3	T
Apr 16-30	0.112	0.131	0.107	0.124	0.085	0.103	0.067	0.077	12			
May 1-15	0.196	0.213	0.172	0.203	0.130	0.158	0.104	0.124		11		
May 16-31	0.171	0.206	0.161	0.172	0.117	0.133	0.096	0.108		14		
June 1-15	0.263	0.319	0.243	0.288	0.172	0.183	0.137	0.154		13	4	17
June 16-30	0.320	0.398	0.293	0.364	0.185	0.225	0.146	0.177			16	16
July 1-15	0.383	0.425	0.364	0.394	0.236	0.293	0.176	0.209	10		12	22
July 16-31	0.425	0.437	0.395	0.416	0.296	0.336	0.214	0.273	10		12	22
Aug 1-15	0.428	0.435	0.416	0.426	0.342	0.355	0.252	0.288	10		12	22
Aug 16-31	0.432	0.438	0.423	0.430	0.346	0.367	0.277	0.307	9		12	21
Sept 1-15	0.302	0.311	0.297	0.303	0.249	0.258	0.202	0.221	8	16		24
Sept 16-30	0.293	0.311	0.279	0.297	0.248	0.258	0.200	0.217	15	9		24
Oct 1-15	0.159	0.163	0.150	0.158	0.129	0.136	0.105	0.112	24			24

Indicates exceedence of 0.33 fps threshold during third pump operation

To investigate how swimming speeds compared to worst case scenario approach velocities, Project engineers calculated daily approach velocities for three pump operations during 2 percent mean daily flow conditions. Then, they took daily average temperatures for the Green River (a conservative estimate because low river flows result in higher temperatures) and calculated swimming speeds using the lower 95 percent confidence interval equation above. The results show that expected swimming speeds exceed the intake velocities on all but 8 days (Table 2.12 from the EA, reprinted below). Further analysis reveals that approach velocity on these 8 days never exceeds predicted swimming speeds by more than 0.004 ft/s or 0.1 percent. Lastly, it must be noted that the Green River average daily temperature exceeds our 20°C cap for swimming speed predictions every day from June 22 to August 31. However, swimming speeds predictions stayed at a constant 0.433, which is likely a conservative estimate.

Table 2.12 Three pump operation – Green River 2 percent Mean Daily Flows
Swim Speed/Intake Approach Velocity Comparison

Day	June			July			August		
	Average Temp[9] °C	Swim Speed (fps)	Intake Vel (2%) (fps)	Average Temp[10] °C	Swim Speed (fps)	Intake Vel (2%) (fps)	Average Temp[10] °C	Swim Speed (fps)	Intake Vel (2%) (fps)
1	16.32	0.388	0.263	22.20	0.433	0.383	23.90	0.433	0.431
2	16.59	0.391	0.267	22.36	0.433	0.385	23.80	0.433	0.430
3	16.68	0.392	0.268	22.30	0.433	0.391	23.74	0.433	0.428
4	16.72	0.393	0.273	22.52	0.433	0.402	23.59	0.433	0.428
5	16.89	0.395	0.277	22.59	0.433	0.406	23.65	0.433	0.428
6	16.91	0.395	0.281	22.80	0.433	0.410	23.60	0.433	0.428
7	16.88	0.395	0.283	22.80	0.433	0.414	23.53	0.433	0.430
8	16.92	0.395	0.291	23.23	0.433	0.417	23.50	0.433	0.430
9	16.99	0.396	0.293	23.06	0.433	0.418	23.56	0.433	0.430
10	17.12	0.397	0.291	23.17	0.433	0.418	23.22	0.433	0.432
11	17.47	0.402	0.295	23.54	0.433	0.421	23.31	0.433	0.432
12	17.63	0.404	0.301	23.54	0.433	0.422	23.35	0.433	0.432
13	17.73	0.405	0.308	23.70	0.433	0.422	23.45	0.433	0.434
14	17.93	0.407	0.314	23.82	0.433	0.425	23.27	0.433	0.434
15	18.27	0.411	0.319	23.81	0.433	0.425	23.04	0.433	0.435
16	18.44	0.414	0.320	23.78	0.433	0.426	22.79	0.433	0.304
17	18.52	0.415	0.325	23.79	0.433	0.425	22.75	0.433	0.302
18	18.70	0.417	0.333	23.93	0.433	0.425	22.66	0.433	0.303
19	18.99	0.421	0.343	24.28	0.433	0.428	22.63	0.433	0.303
20	19.38	0.426	0.348	24.29	0.433	0.431	22.80	0.433	0.303
21	19.66	0.429	0.355	24.53	0.433	0.434	22.81	0.433	0.303
22	20.06	0.433	0.357	24.58	0.433	0.437	22.71	0.433	0.304
23	20.41	0.433	0.357	24.19	0.433	0.426	22.57	0.433	0.305
24	20.65	0.433	0.362	24.24	0.433	0.437	22.56	0.433	0.304
25	20.84	0.433	0.365	24.29	0.433	0.437	22.53	0.433	0.305
26	20.90	0.433	0.369	24.05	0.433	0.437	22.44	0.433	0.306
27	20.99	0.433	0.370	24.01	0.433	0.430	22.02	0.433	0.306
28	21.41	0.433	0.392	24.12	0.433	0.428	22.11	0.433	0.306
29	21.85	0.433	0.398	24.34	0.433	0.429	22.37	0.433	0.304
30	22.10	0.433	0.377	24.29	0.433	0.431	22.24	0.433	0.305
31				24.05	0.433	0.431	21.85	0.433	0.302

[9] Temperatures taken from Green River at Ouray Refuge USGS Gage (1991 to 2009 average)

Based on the swimming abilities of fish and the approach velocities present at the Project intake, we expect the majority of fish in the 20 to 60 mm size class will be able to escape under their own control. In addition, all fish that are greater than 60 mm in size should have the swimming ability to escape the structure. However, with or without the ability to swim out of the structure, we expect some fish to be unable to leave under their own control. Some fish in the 20 to 60 mm size class may not have the ability to leave the structure, and some fish greater than 60 mm may become disoriented and not be able to find the way out. These fish will be returned to the river via mechanical means.

FISH SCREENS AND SLUICING STRUCTURE

Individual fish that are not able to escape the intake structure through their own swimming ability will become impinged upon fish screens and sluiced back to the river. The mesh size for the fish screen is 3/32 inch, which prevents all but the smallest of fish from entering the intake pumps (see Interaction with the Pump Facility by Larval Fish section). Once impinged upon the fish screen underwater, the screens will carry the fish above the river surface, where a high-pressure spray nozzle will wash the fish off the screen into a colleciton trough that returns fish to the Green River downstream. Because the collection trough returns fish to the mainstem river downstream, fish are immediately returned to viable habitat with a low probability of returning to the intake structure.

The process of becoming impinged, sprayed off of the fish screen and sluiced through the collection trough will result in injury and possibly death for a portion of the individuals. However, it is expected that the injury and mortality rates of these fish will be low because the GRPP is designed to currently accepted fish screen standards. For example, the pressure of the cleaning spray can be adjusted to minimize fish injury. In addition, studies have shown that mesh sizes comparable to the GRPP do not create high impingement mortality rates. Tests on bull trout fry (~25 mm in length) in a worst case scenario of vertical screen orientation and no sweep velocity found no mortality from impingement on similar sized screens, even 24 hours after contact (Zydlewski and Johnson 2002).

The number of juvenile fish that will pass by the structure is dependent on yearly reproductive success and is highly variable. Based on this variability and the low mortality rates from the bull trout study, we expect less than 10 juveniles (less than 60 mm) to die from pumping operations each year and less than 20 be injured. We also expect less than 2 adults to die from pumping operations each year and less than 5 to be injured. We expect that injured fish will be able to survive returning to river for an extended period and will not die as a result of these injuries.

2. INTERACTION WITH THE PUMP FACILITY BY LARVAL FISH

Colorado pikeminnow and razorback sucker migrate to established spawning areas in response to flow conditions, where they fertilize and deposit eggs in gravel substrate. Within one to two weeks, the eggs hatch into larval fish. After another few days to a week, the larval fish emerge from the substrate and drift downstream to backwater areas, where they spend several weeks to months growing large enough to venture into deeper water. The GRPP is located downstream of known Colorado pikeminnow and razorback sucker spawning locations, indicating that larval fish will drift by the intake structure. In fact, razorback sucker and Colorado pikeminnow larvae were collected upstream of the GRPP during annual surveys from 2004 to 2007 (Bestgen et al. 2008), and occur in downstream backwaters at Ouray NWR, proving that larval fish are drifting downstream as expected.

Depending on the water year, larval fish may be present in the Green, Colorado, Gunnison, and Yampa Rivers from as early as April 1 to as late as August 31 (earlier in dry years; later in wet years). The beginning and duration of spawning periods for both species is variable, responding to spring runoff and water temperatures. Over the past seven years, razorback sucker larval drift periods began as early as

May 18 and as late as June 10, typically lasting a month, but with varying intensity (Bestgen et al. 2008). Over the same period, Colorado pikeminnow larval drift began as early as June 19 and as late as July 16, typically lasting a month and a half, also with varying intensity (Bestgen et al. 2008)

Endangered larval fish are very small (<0.5 inches total length) and incapable of directed swimming from the time of hatching through the first 2 to 4 weeks of their life. Larval endangered fish are the most susceptible to entrainment into pump intake structures because of their lack of swimming ability and small size. The most effective way to minimize entrainment is for pumps to be turned off. However, this also has the largest impact on project operations.

Recent data analysis by the Colorado State University Larval Fish Lab indicated that the highest abundance of larval fish was found at midnight, by nearly an order of magnitude (personal communication, Dr. Kevin Bestgen, Colorado State University 2009). Turning off pumps preferentially around the midnight hour will result in the largest conservation benefit to these species. As a result, we have requested that, if possible, pumps not operate during the midnight hours (10 pm to 2 am) while larval fish are known to be actively drifting.

To provide conservation benefit to larval endangered species, the UWCD developed an operational model that optimizes the GRPP pumps to run in the hours outside of peak power rates and, when possible, outside the midnight hours during endangered fish larval drift periods. Model results for each of the three possible operating scenarios are shown in Tables 2.5 through 2.7 in the EA (reprinted below). The tables show the anticipated hours the pumps will be operated during each two-week time increment from April 15 through October 15. The tables also indicate the number of pumps that will be operated during peak and off-peak electrical rate hours and larval drift hours.

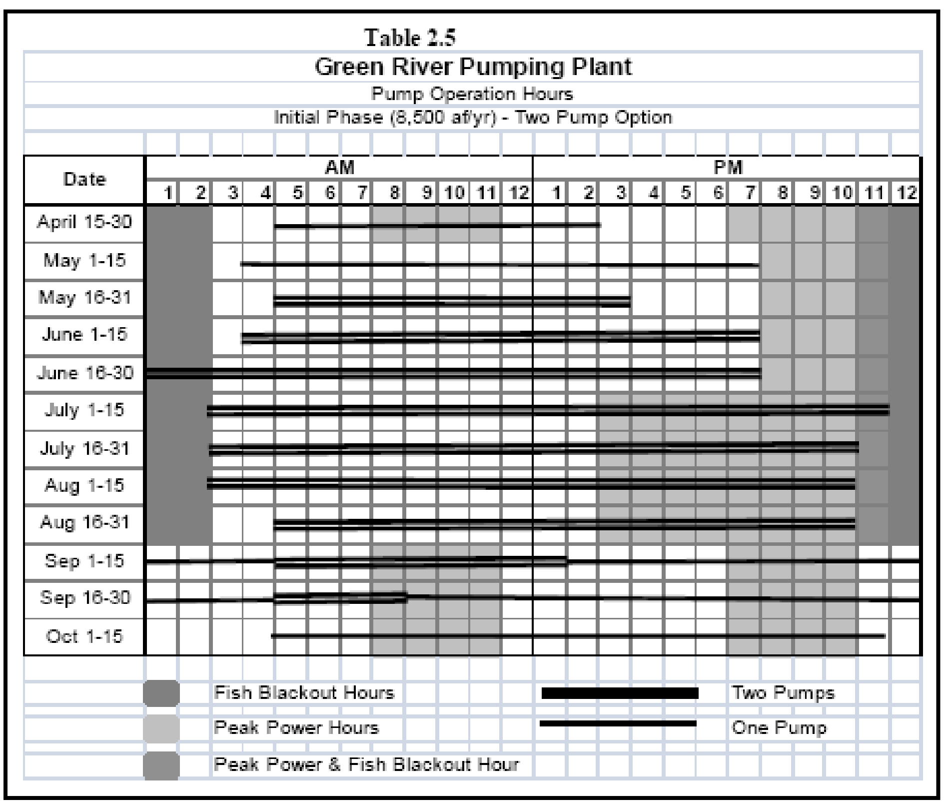


Table 2.6

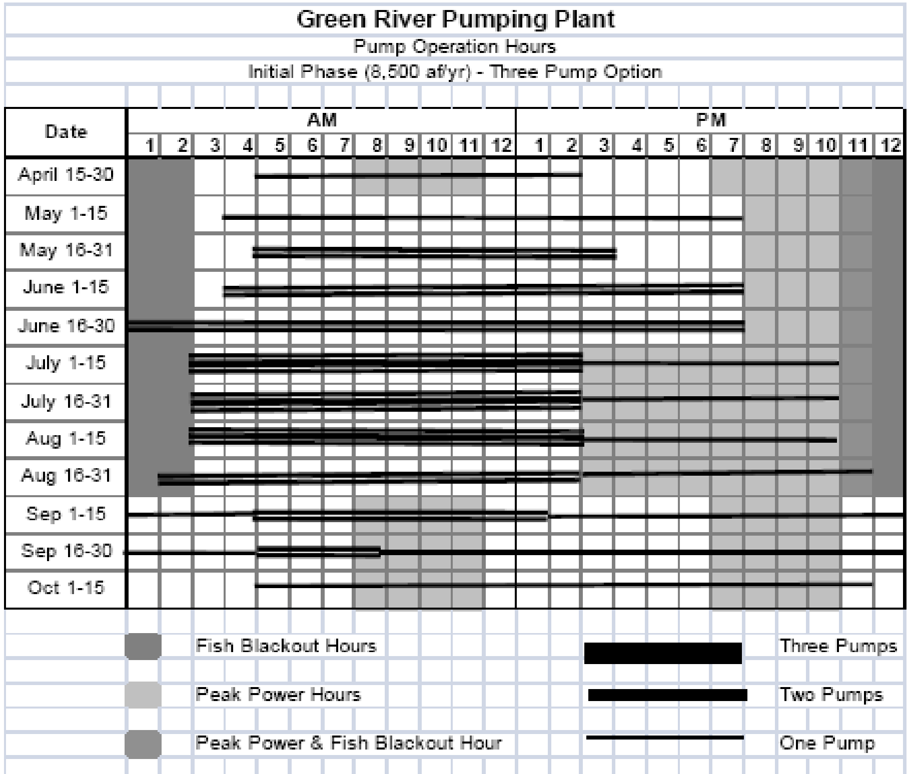
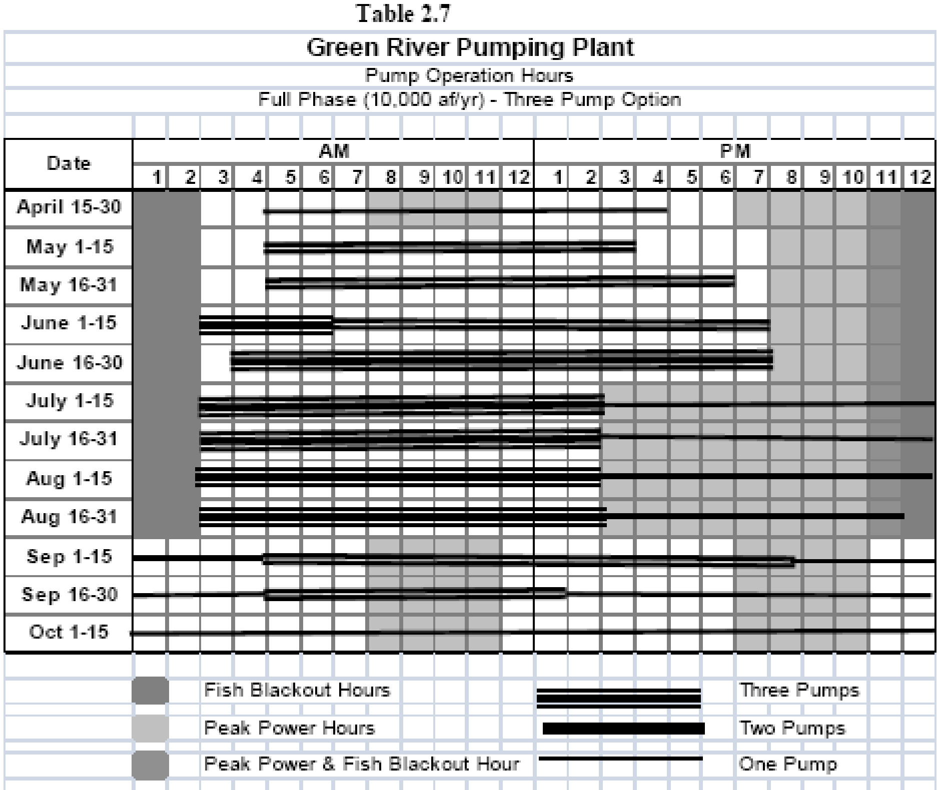


Table 2.7



By developing the operations model, the UWCD has limited the pumping during the midnight hours as much as possible while still meeting Project needs. At initial Project development of 8500 af, pumping will impact larval drift in 3 of 32 possible hours under a two pump scenario (representing 9.4 percent of the total yearly requested blackout hours), and 4 of 32 possible hours under a three pump scenario (12.5 percent) (Table 4). At full Project development of 10,000 af, pumping will impact 7 of 32 possible hours (21.9 percent), all primarily during the Colorado pikeminnow drift period (7 of 16 hours in July and August) (Table 4).

Typical Razorback sucker larval drift period

Typical Colorado pikeminnow larval drift

Fish “Blackout Hours Impacted			
Month	8,500 af/yr		10,000 af/yr
	Two Pump	Three Pump	Three Pump
May 1-15	0	0	0
May 16-31	0	0	0
June 1-15	0	0	0
June 16-30	**2**	**2**	0
July 1-15	**1**	0	2
July 16-31	0	0	2
August 1-15	0	0	2
August 16-31	0	**1** & 1	1

Table 4. Number of hours during the midnight period (10pm to 2am) that pumps will operate. Bold numbers indicate two pumps are operating, while non-bold numbers indicate one pump is operating.

Because larval drift periods for the two species are variable in initiation date and duration, the UWCD will coordinate with us to operate under real-time data each year (see Applicant Committed Measures). To this end, each year on or before April 1, the District will request to be informed of the beginning and end of both the Colorado pikeminnow and razorback sucker larval drift periods. Our office or the Recovery Program will provide this data to the District as soon as it is available. This will allow the UWCD to pump during the midnight hours if larval drift is not occurring and will also encourage the UWCD to operate during the midnight hours as little as possible when larval drift is occurring.

SPECIES RESPONSE

Because of their small size, fish screen mechanisms do not protect larval fish from entrainment. Entrainment of larval fish will result in mortality for all individuals. To calculate the impact mortality will have on total larval drift, we need to calculate the proportion of individuals expected to be entrained. Varying levels of reproductive success makes it difficult to quantify actual numbers of individuals.

Pumping operations will occur during the entire spawning period for both fish, so yearly exposure is 100 percent. In contrast, because monthly operations at the GRPP vary, exposure levels will vary by month. Mathematically, this can be represented by equations 1 and 2, where RZE is the number of razorback sucker entrained and CPE is the number of Colorado pikeminnow entrained.

1. $CPE_{yearly} = CPE_{June} + CPE_{July} + CPE_{August}$
2. $RZE_{yearly} = RZE_{May} + RZE_{June} + RZE_{July}$

Each monthly entrainment value is based on the daily operations schedule for the intakes, which are broken into two week intervals. So each month in equations 2 and 3 can be rewritten as:

$$3.\quad RZE_{May} = RZE_{May\ 1-15} + RZE_{May\ 16-31}$$

Entrainment rate is dependent on the numbers of hours the pumps are operating, the rate at which they are operating, the proportion of fish actively drifting, and the flow of the river. This relationship is shown in equation 4, where RZ is the number of razorback in actively drifting, and PD is the duration of pumping in hours.

$$4.\quad RZE = \left(\frac{Intake\ Rate}{Flow\ of\ Green\ River}\right) * PD * RZ$$

The highest abundance of drifting larval fish occurs around the midnight hour, by an order of magnitude, with equal abundance at dawn and noon, and abundance lowest at dusk. To summarize this information, we can assume that approximately 80 percent, 10 percent, and 10 percent of larval fish abundance occurs at midnight (10pm to 4am), dawn (4am to 10am), and noon (10am to 4pm) respectively. This information provides us with varying daily exposure, shown in equation 5.

$$5.\quad RZE = \left(\frac{Intake\ Rate}{Flow\ of\ Green\ River}\right) * (PD_{midnight} * RZ_{midnight} + PD_{dawn} * RZ_{dawn} + PD_{noon} * RZ_{noon} + PD_{dusk} * RZ_{dusk})$$

Because of the known proportions of daily larval drift, we can simply equation 5 by removing the dusk component (assuming $RZ_{dusk} = 0$) , combing the dawn and noon components into a 'day' component (equivalent razorback densities), shown in equation 6.

$$6.\quad RZE = \left(\frac{Intake\ Rate}{Flow\ of\ Green\ River}\right) * (PD_{midnight} * RZ_{midnight} + PD_{day} * RZ_{day})$$

The number of hours the pump operates each day dictates each two week period's exposure time. For example, under the two pump operation for May 1st to 15th (Table 2.5), this will be 16 hours, during 1 midnight hour of six possible (3 to 4 am) and 12 day hours of 12 possible (4 am to 4 pm). Inserting these known values, equation 6 can be rewritten as equation 7.

$$7.\quad RZE_{May\ 1-15} = \left(\frac{Intake\ Rate}{Flow\ of\ Green\ River}\right) * (\frac{1}{6} * 0.8 + \frac{12}{12} * 0.2)$$

$$8.\quad RZE_{May\ 1-15} = \left(\frac{Intake\ Rate}{Flow\ of\ Green\ River}\right) * ({}^{1}/_{3})$$

Equations 7 and 8 demonstrate that as 80 percent of the larval fish pass by, the pumps operate for 1/6 of the time, and as 20 percent of the larval fish pass by, the pumps operates for 100 percent of the time. This results in 1/3 of the larval fish passing by as the pumps are operating.

We can assume that the larval fish are equally distributed throughout the water column during their drift, that is they are unable to preferentially select habitats while they drift (personal communication with Tom Chart, Director, Recovery Program 2010). As a result, we can assume that the proportion of water taken in by the structure is equivalent to the proportion of individuals entrained. This relationship gives us the first term in equation 4.

To finish the equation, we insert the intake rate, which is 20 cfs for one pump[10], and the flow of the Green River during the period of interest. Green River flows are variable year to year, so we will test a 50 percent exceedance year, or average base flow. Using page 3 of Appendix D from the EA, the average daily flow of between May 1 and 15 in a 50 percent exceedance year is 8340 cfs.

$$9. \quad RZE_{May\ 1-15} = \left(\frac{20\ cfs}{8340\ cfs}\right) * \left({}^{1}/_{3}\right)$$

$$10. \quad RZE_{May\ 1-15} = \left(\frac{1}{417}\right) * \left({}^{1}/_{3}\right)$$

$$11. \quad RZE_{May\ 1-15} = \left(\frac{1}{1251}\right)$$

Equations 9 through 11 show that under a 8500 af two pump operation, during May 1st to May 15th, we would expect less than one of every thousand larval fish to be entrained, or 0.08 percent.

To calculate the expected number of larval fish entrained over the life of the Project, we could perform these calculations for a range of river flows across all 45 years, for each month. For example, we would expect a 2 percent exceedance year once (2 percent of 45 is 1), and a 50 percent exceedance year in each of 22 years. However, rather than calculate this cumulative total, it is more important to calculate a worst case yearly scenario to demonstrate the most larval fish that could be taken in a given year.

The conditions that will maximize larval fish entrainment are full Project development of 10,000 af with three pump operations, with Green River flows at 2 percent exceedance. Using a typical yearly distribution of larval drift[11], we calculated predicted yearly cumulative entrainment. This analysis demonstrated that even in the worst case scenario, less than 0.5 percent of razorback sucker and less than 2.2 percent of Colorado pikeminnow larvae will be entrained (Appendix B).

This worst case scenario is expected to only occur in one year across the 45 year life of the Project. In all other years, the losses of larvae will be less. In fact, in mean year flows, losses of larval fish will be less than 1 percent. Cumulatively, these loses to the population should not markedly reduce reproductive success of these species.

3. CONSTRUCTION ACTIVITIES

A large portion of the GRPP construction requires instream activities, and modifications to the riverbank and riverbed. Construction will take approximately one year, beginning in Spring 2010 and ending in Spring 2011, but those activities having the potential to affect the Green River directly will occur after peak river flows, estimated to occur June 1. Instream activities have the potential to both directly and indirectly impact individuals. Therefore, the applicant committed to conservation measures to avoid and minimize these impacts (see Applicant Committed ApPLICANT COMMITTED Conservation Measures: Construction Methods above).

Instream activities, especially construction, have the potential to harass, injure, or kill individuals through contact with equipment or materials. To minimize this impact, construction activities will be performed behind a temporary cofferdam that isolates the construction area from the river. Installation of the cofferdam itself may harass, injure, or kill individuals. Therefore, the UDWR will perform a fish clearance survey in the construction area immediately prior to installation of the cofferdam and transport

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10 Page 21 of the EA
11 Based on larval drift collections in 2004 and 2006

all fish that are found in the area to safe locations nearby. After the cofferdam is installed, but before the construction area is dewatered, the UDWR will perform another fish clearance and move all native fish in the area back to the river. Pumps used to dewater the cofferdam area will be screened with ¼ inch mesh to prevent fish entrainment. Similar clearance surveys will take place before the cofferdam is removed and any other occasions when activities occur in the river (e.g., when cofferdam repairs are needed).

Riverbank and riverbed construction activities will also alter designated critical habitat in the area. The Project will use BMPs to minimize water quality impacts from construction activities, including removing all non-permanent construction materials before the cofferdam is removed, installing the cofferdam in as gentle a manner as possible, and following all water quality permit requirements. In addition, excavated material and construction debris may not be wasted in any stream or river channel or placed in flowing waters. This includes material such as grease, oil, joint coating, or any other possible pollutant. Excess materials must be wasted at an upland site well away from any channel. Construction materials, bedding material, excavation material, etc. may not be stockpiled in riparian or water channel areas. Silt fencing will be appropriately installed and left in place until after revegetation becomes established, at which time the silt fence can then be carefully removed. Machinery must be fueled and properly cleaned of dirt, weeds, organisms, or any other possibly contaminating substances offsite prior to construction.

4. PERMANENT STRUCTURES IN CRITICAL HABITAT

Permanent structures will be built in designated critical habitat as part of the Project, including portions of the 100 year floodplain, riverbed, and riverbank, replacing functioning habitat with concrete, buildings, and roads. Bank hardening structures will be installed upstream and downstream of the intake structure to protect the GRPP. In total, less than one acre of floodplain habitat will be lost to the construction of new structures. In addition, approximately 300 ft of shoreline will be lost to bank hardening.

Once the structures are in place, they are not expected to harass, injure, or kill individuals, except through the intake effects discussed above. However, the structures will impact natural habitat conditions by modifying the channel morphology. Downstream impacts to nursery habitat could result from a modified channel morphology by increasing the sediment load deposited downstream. Nursery areas downstream in Ouray NWR are important for young Colorado pikeminnow and razorback sucker growth and survival.

5. CHANGES IN RIVER FLOW FROM PROJECT OPERATIONS

As written in the Draft Environmental Assessment and Biological Assessment:

> "Water for the GRPP would be provided by Reclamation from Flaming Gorge Reservoir under terms of a Water Service Contract between the [UWCD] and Reclamation. The Water Service Contract would grant the [UWCD] the right to use up to 10,000 af of Colorado River Storage Project water per year from Flaming Gorge Reservoir for commercial agriculture purposes for a term of 5 years. The [UWCD] has indicated its intent to seek a long term Water Service Contract for up to 10,000 af per year, for the maximum allowable contract period of 40 years. [p. 12]
>
> Water would be released from Flaming Gorge Dam in accordance with the provisions of the FGEIS Record of Decision (ROD) and at the request of the [UWCD], consistent with terms of the Water Service Contract. Reclamation can only release this water from Flaming Gorge Dam and cannot be responsible for losses or diversions of the water by others. Delivery of water within the river is a matter for the State Engineer's office. The maximum flow released

for the GRPP at any time would be 53 cfs or approximately 1 to 2.5 percent of the average Green River flow of between 2,000 cfs and 5,000 cfs during June through August. [p.12]

The 10,000 af per year total depletion was estimated as a future depletion for the State of Utah in the 1999 Upper Colorado River Commission's Official Depletion Schedule ([UCRC Depletion]). The [UCRC Depletion] was included in the modeling process for the Action Alternative of the FGEIS, although the site-specific diversion details were unknown at the time. The Proposed Action is tiered, as defined in 40 C.F.R. 1508.28, from the Action Alternative of the FGEIS. [p.7]

Review of the hydrology modeling performed for the FGEIS shows that flow and temperature recommendations implemented in accordance with the ROD would continue to be met while releasing water under the terms of the proposed 5 year Water Service Contract. Water quantities to be diverted are so small as to be insignificant relative to river stage. [p.12]"

Reclamation's operations for the 5 year temporary water service contract will be part of the UCRC Depletion, and the UWCD water right associated with this Project will be included in the current releases. Under this scenario, Reclamation will still meet the Flow Recommendations, but the flow of the Green River downstream of Project will be reduced by 8,500 to 10,000 af per year, depending on Project capacity.

Looking at the complete Project timeline, it is expected that demand for water service contracts will increase, requiring Reclamation to more clearly define how the cumulative amount of water under these contracts will be managed. To this end, Reclamation is currently working on a modeling effort to determine how the interaction of Flaming Gorge releases, tributary inflows, and water development impacts the Flow Recommendations. This modeling effort is concurrent with interagency efforts (Service, Reclamation, State of Utah and others) to create a mechanism to protect flows in the Green River, as described in the Recovery Program's RIPRAP.

Until these efforts are complete, special focus must be made on meeting the Flow Recommendations in dry and moderately dry years (as classified in Muth et al. 2000). In years classified as dry or moderately dry, Reclamation has committed[12] to use the best available information to compensate for the Project depletion in the Basin. If the Service has reason to believe that the Flow Recommendations, specifically, the baseflow targets for Reach 2 established by the Flaming Gorge Technical Workgroup are not being met, extra releases (up to the amount of Project depletions) from Flaming Gorge will be provided.

The water depletion associated with the Project will be managed by Reclamation with emphasis on meeting the Flow Recommendations. In the future, as more information becomes available, such as Reclamation's modeling efforts, Reclamation's long-term water service contract terms, and Green River flow protection mechanisms, the exact nature of the Project depletion may change. Because the UWCD has entered into a temporary water service contract, and plans on continuing with a long-term contract, mechanisms are in place to compensate for reductions to Green River flows. For example, in the future UWCD may call on its stored water right outside of the UCRC Depletion or Reclamation may manage a large block of water service contract water outside of the UCRC Depletion.

Because the UWCD has a water service contract, which is managed by Reclamation to meet the Flow Recommendations, and Reclamation has committed to pay particular attention to baseflow targets in Reach 2 during dry and moderately dry years, the water depletion under the temporary water service contract will not require that a depletion fee be paid to the Recovery Program. In addition, Project water

[12] As part of the environmental commitments section of the EA/BA

depletions managed under a permanent water service contract will also not require a depletion fee as long as terms found in that contract are compatible with endangered species recovery, such as meeting the Flow Recommendations. However, as the Project is currently planned, fish habitat downstream of the Project site will be impacted.

EFFECTS TO ENDANGERED SPECIES

The Project will adversely affect Colorado pikeminnow, razorback sucker, bonytail, and humpback chub by reducing the amount of water in the river system upon which they depend by up to 10,000 af/yr. The effects to all four species primarily result from the effects of the action upon their habitats. In general, the proposed action will adversely affect the four listed fish by reducing the amount of water available to them, increasing the likelihood of water quality issues, increasing their vulnerability to predation, and reducing their breeding opportunities by shrinking the amount of breeding habitat within their range.

The proposed depletions affect the water quality in the action area by increasing concentrations of heavy metals, selenium, salts, pesticides, and other contaminants. Increases in water depletions will cause associated reductions in assimilative capacity and dilution potential for any contaminants that enter the river. The project depletions will cause a proportionate decrease in dilution, which in turn will cause a proportionate increase in heavy metal, selenium, salts, pesticides, and other contaminant concentrations in the Green and Colorado Rivers to Lake Powell. Increased contaminant concentrations in the river will likely result in an increase in the bioaccumulation of these contaminants in the food chain, with negative effects to the endangered fishes, particularly the predatory Colorado pikeminnow. Selenium is 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 (Hamilton et al. 2005).

To the extent that it will reduce flows and contribute to further habitat alteration, the proposed project will contribute to an increase in nonnative fish populations. 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. Endangered fishes within the action area will experience increased competition and predation as a result.

EFFECTS TO CRITICAL HABITAT

All four of the listed Colorado River fish require the same PCEs essential for their survival. Therefore, we are combining our analysis of all four species into one section. Because the amount of designated critical habitat varies for each of the four species, the amount of habitat will vary; however, the effects will be the same for all critical habitat within the action area.

Water, physical habitat, and the biological environment are the PCEs of critical habitat. This includes a quantity of water of sufficient quality that is delivered to a specific location in accordance with a hydrologic regime that is required for the particular life stage for each species. The physical habitat includes areas of the Green and Colorado River systems 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.

PRIMARY CONSTITUENT ELEMENT - WATER

The subject action will deplete up to 10,000 af/yr from the Green River Basin. Removing water from the river system changes the natural hydrological regime that creates and maintains important fish habitats, such as spawning habitats, and reduces the frequency and duration of availability of these habitats of the four endangered fish. In addition, reduction in flow rates lessens the ability of the river to inundate bottomland, a source of nutrient supply for fish productivity and important nursery habitat for razorback sucker. Water depletions change flow and temperature regimes toward conditions that favor nonnative fish, thus adding to pressures of competition and predation by these nonnative fishes as discussed above.

Changes in water quantity will affect water quality, which is a PCE of critical habitat. Contaminants enter the Colorado River from various point and non-point sources, resulting in increased concentrations of heavy metals, selenium, salts, pesticides, and other contaminants. Increases in water depletions will cause associated reductions in assimilative capacity and dilution potential for any contaminants that enter critical habitat in the Green River, as discussed above.

PRIMARY CONSTITUENT ELEMENT - PHYSICAL HABITAT

The subject action will affect the physical condition of habitat for the four listed fish as a result of a reduction of water. This reduction will contribute to the cumulative reduction in high spring flows, which are essential for creating and maintaining complex channel geomorphology and suitable spawning substrates, creating and providing access to off-channel habitats, and possibly stimulating Colorado pikeminnow spawning migrations. Adequate summer and winter flows are important for providing a sufficient quantity of preferred habitats for a duration and at a frequency necessary to support all life stages of viable populations of all endangered fishes. To the extent that the subject action will reduce flows, the ability of the river to provide these functions will be reduced. This reduction of water affects habitat availability and habitat quality.

PRIMARY CONSTITUENT ELEMENT - BIOLOGICAL ENVIRONMENT

Over 40 nonnative fish species now occur in the Upper Colorado River Basin, compared to 14 native fish species. Nonnative fishes can be numerically predominant in riverine fish habitats and communities, and negative interactions with certain warmwater nonnative fish species (particularly sportfishes) have contributed to declines in native fish populations. The August 1, 2002, Humpback Chub *(Gila cypha),* Bonytail *(Gila elegans),* Colorado Pikeminnow*(Ptychocheilus lucius),* and Razorback Sucker *(Xyrauchen texanus)* Recovery Goals identified predation or competition by nonnative fish species as a primary threat to the continued existence or the reestablishment of self-sustaining populations of these endangered fishes. As described above, reduction in flows contributes to further habitat alteration that support non-native fish species.

REMEDIATION OF THE EXISTING NIELSON PUMPING SITE

The relocation of the Nielson pump station from its current upstream location to the GRPP structure will effectively upgrade the facility to meet current pumping standards. As part of the GRPP, the Nielson station will operate with correct fish screen and approach velocity criteria, neither of which is currently met. In addition, moving the pump station will allow the crane that currently holds the pipeline in place to be moved off of the riverbank. The crane poses a environmental contaminants risk through both continuous, low-level effects (oil & gas leaks) and low-probability, catastrophic effects (crane falls into river). Once the pump station is relocated, the existing site will be re-contoured and revegetated to native habitat conditions.

The relocation and rehabilitation of the Nielson pump station represents beneficial effects to the federally listed fish and other native wildlife. Less fish will be entrained and impinged once the existing pump station is moved and the risk of water quality degradation will no longer exist. In addition, native riparian vegetation will assist in ecological function of the river.

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 ESA.

Within the action area water development is expected to continue in accordance with Utah State Water Law. A large portion of this development will require federal consultation, but some projects will not. Larger projects reasonably expected to occur without federal approval include a 50,000 af diversion right near the town of Green River for agriculture (personal communication, Marc Stilson, Utah Division of Water Rights 2010).

The development of oil and natural gas resources in the general area (Uintah Basin) is increasing as industry expands operations. A limited amount of natural gas exploration and development is expected to occur without federal jurisdiction, such as evaporation pond construction and well drilling. Activities are not expected to occur in the floodplain, but could occur in watersheds that drain to the Green River, such as washes or tributary streams.

CONCLUSION

After reviewing the current status of the Colorado pikeminnow, humpback chub, bonytail, and razorback sucker, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the Project, as described in this biological opinion, is not likely to jeopardize the continued existence of endangered fish and the proposed project is not likely to adversely modify designated critical habitat. We have reached this conclusion based on the following reasons:

- Total habitat lost from the Project site will be less than one acre of floodplain and approximately 300 ft of shoreline. Approximately 0.2 acres of floodplain habitat of similar value will be revegetated at the Nielson site upstream, resulting in a total floodplain loss of about 0.8 acres or less;
- The pumping activities will not take more than 1 percent of razorback sucker larvae or 2.5 percent of Colorado pikeminnow larvae in any given year, with these levels expected only one out of every fifty years. In most years, the total larvae taken will be less than 1 percent for each species;
- The design of the pumping structure prevents the entrainment of non-larval fish. The approach velocity and fish screening structure allow non-larval fish the ability to escape either by natural or mechanical means. These structures meet established criteria for minimization of fish mortality and injury; and
- The water service contract allows UWCD to use stored Green River basin water rather than instream flow rights. This allows future flexibility for Reclamation and the Recovery Program to meet the Flow Recommendations.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without 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 USFWS to include significant habitat modification or degradation that results in death or injury of listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the USFWS 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, 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 prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures below are non-discretionary, and must be undertaken by Reclamation so that they become binding conditions of any grant or permit issued to the UWCD, as appropriate, for the exemption in section 7(o)(2) to apply. Reclamation has a continuing duty to regulate the activity covered by this incidental take statement. If Reclamation (1) fails to assume and implement the terms and conditions or (2) fails to require the UWCD to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impacts of incidental take, Reclamation or the UWCD must report the progress of the action and its impact on the species to us as specified in the incidental take statement.

We have developed the following incidental take statement based on the premise that the applicant committed conservation measures will be implemented.

AMOUNT OR EXTENT OF TAKE ANTICIPATED

Juvenile and adult Colorado pikeminnow, razorback sucker, bonytail, and humpback chub could be injured or killed through contact with the intake structure (trash racks, fish screens, high pressure spray, and return channel). We believe the current design of the structure minimizes these impacts. Therefore, we exempt the injury of up to 5 and the death of up to 2 fish greater than 60 mm, total for all species, per year. Smaller fish will not be able to escape as well as larger fish. Therefore we exempt the injury of up to 20 and the death of up to 10 fish between 20 mm and 60 mm, total for all species, per year.

Entrainment of larval fish will occur as pumps take water from the river. These small individuals cannot be screened out. However, because the UWCD has agreed to an operation schedule that will avoid the periods when larval fish are most dense in the water column, we believe that this impact is minimized as much as possible while still meeting Project demands. Measuring larval fish entrained in the pumps would be very difficult, as they are very small and will continually be entrained into pumps. Therefore, we exempt the take of all larval fish found in 10,000 af of water per year, pumped according to the criteria described in the operational model in the EA (both timing and intake rates).

Construction activities, most likely the installation of the coffer dam, have the ability to injure or kill fish as the structure is placed in the river. However, the fish clearance survey and construction BMPs will minimize these impacts. Therefore we exempt the injury or death of one individual of each species during the one year construction period.

Colorado pikeminnow, humpback chub, bonytail, and razorback sucker are harmed from the reduction of water in their habitats resulting from the subject action in the following manner--1) individuals using habitats diminished by the proposed water depletions could be more susceptible to predation and competition from non-native fish; 2) habitat conditions may be rendered unsuitable for breeding because reduced flows will impact habitat formulation and maintenance as described in the biological opinion.

Estimating the number of individuals of these species that will be taken as a result of water depletions is difficult to quantify for the following reasons--(1) determining whether an individual forwent breeding as a result of water depletions versus natural causes will be extremely difficult to determine; (2) finding a dead or injured listed fish will be difficult, due to the large size of the action area and because carcasses are subject to scavenging; (3) natural fluctuations in river flows and species abundance may mask depletion effects, and (4) effects that reduce fecundity are difficult to quantify. However, we believe the level of take of these species can be monitored by tracking the level of water reduction and adherence to the Recovery Program. Specifically, if the Recovery Program (and relevant RIPRAP measures) is not implemented, or if the current anticipated level of water depletion is exceeded, we fully expect the level of incidental take to increase as well. Therefore, we exempt all take in the form of harm that will occur from the removal of 10,000 af of water per year. Water depletions above the amount addressed in this biological opinion will exceed the anticipated level of incidental take and are not exempt from the prohibitions of section 9 of the Act.

The implementation of the Recovery Program and the signed water service contract is intended to minimize impacts of water depletions, therefore, support of Recovery Program activities by Reclamation and the continued existence of a water service contract exempts Reclamation and project proponent from the prohibitions of section 9 of the Act. Reclamation is responsible for reporting to the Service if the amount of average annual depletion is exceeded.

EFFECT OF THE TAKE

In the accompanying biological opinion, we determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES

The UWCD and Reclamation have committed to conservation measures described in the ApPLICANT COMMITTED Conservation Measures section of this Biological Opinion. In addition to those measures, we believe the following reasonable and prudent measure is necessary and appropriate to minimize the impacts of incidental take of Colorado pikeminnow, humpback chub, bonytail, and razorback sucker.

1. The UWCD must educate their employees responsible for operating the GRPP on the impacts to listed fish species from pumping activities and how to minimize these impacts.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the ESA, the UWCD must comply with the following terms and conditions, which implement the reasonable and prudent measure described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. The UWCD employees responsible for operating the GRPP must be familiar with the operations model and the larval fish drift commitments.

2. The UWCD employees responsible for cleaning and maintaining the GRPP must be familiar with fish identification in order to be able to identify a federally listed fish injured or killed during Project operations.

MONITORING

The implementing regulations for incidental take require that Federal agencies must report the progress of the action and its impact on the species (50 CFR 402.14(i)). To meet this mandate, the UWCD, on behalf of Reclamation, will monitor and report the progress of their action as follows.

Upon locating dead, injured, or sick listed species, immediate notification must be made to the Service's Salt Lake City Field Office at (801) 975-3330 and the Service's Division of Law Enforcement, Ogden, Utah, at (801) 625-5570. Pertinent information including the date, time, location, and possible cause of injury or mortality of each species shall be recorded and provided to the Service. Instructions for proper care, handling, transport, and disposition of such specimens will be issued by the Service's Division of Law Enforcement. Care must be taken in handling sick or injured animals to ensure effective treatment and care, and in handling dead specimens to preserve biological material in the best possible state.

CONCLUSION

The incidental take statement provided in this biological opinion satisfies the requirements of the Endangered Species Act of 1973, as amended. This statement does not constitute an authorization for take of listed migratory birds under the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act, or any other Federal statute.

We believe that no additional Colorado pikeminnow, humpback chub, bonytail, and razorback sucker will be incidentally taken as a result of the proposed action than what is described above. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. Reclamation must immediately provide an explanation of the causes of the taking and review with us the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA 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.

1. Reclamation or UWCD should minimize impacts to fish from the high pressure spray mechanism that cleans the fish screens. A first step for this conservation measure will be to determine the injury and mortality rate of fish being cleaned off the fish screen after Project operations begin. If mortality and injury rates are greater than zero, a study investigating the injury and mortality rates associated with differing high pressure velocities should be performed. Then the high pressure spray should be adjusted to levels that minimize fish injury and mortality.

   In the event that Reclamation or UWCD will not perform this study, they should allow us access to perform the study.

2. Reclamation or UWCD should investigate the interaction between fish and the intake structure. It is assumed, based on swimming speeds and approach velocity, that juvenile and adult fish will either avoid the trash rack area, escape the intake area back out through the trash rack, or exit via the fish screen mechanism. A study determining the relative success of these options should be performed. This data will provide insight into future intake design or future modifications to the GRPP that will minimize fish harassment.

3. UWCD should operate the fish screens and cleaning mechanisms at all times that any water intake is being performed, including the Nielson pumps. If the Nielson pumps operate without the rotating fish screens operating, then fish could become impinged on the mesh screen.

4. UWCD should request that the Nielson pumps operate outside of the midnights hours during the larval fish drift period so that the Nielson pumps do not entrain larval fish.

5. UWCD should investigate installing natural gas powered pumps as opposed to electrical pumps in order to have more flexibility with operations. Using natural gas pumps will allow UWCD to pump during the peak electrical rate hours, lessening impacts to fish (the density of larval fish in the flowing water column is lowest during the peak electrical rate hours). Also, UWCD will be able to turn pumps on and off without incurring power surges on the electrical grid.

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 action outlined in the request. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; 3) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or 4) a new species is listed or critical habitat designated that may be affected by the action.

Thank you for your cooperation in the formulation of this biological opinion and your interest in conserving endangered species. If we can be of further assistance, please contact Kevin McAbee of the Utah Field Office at 801-975-3330 ext. 143.

cc: Upper Colorado River Endangered Fish Recovery Program; Attn: Tom Chart
UDWR – Northeastern Region; Attn: Trina Hedrick
Ouray NWR; Attn: Ryan Mollnow

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Figure 6. Designated Critical Habitat for Colorado pikeminnow, humpback chub, bonytail, and razorback sucker in the Upper Colorado River Basin.

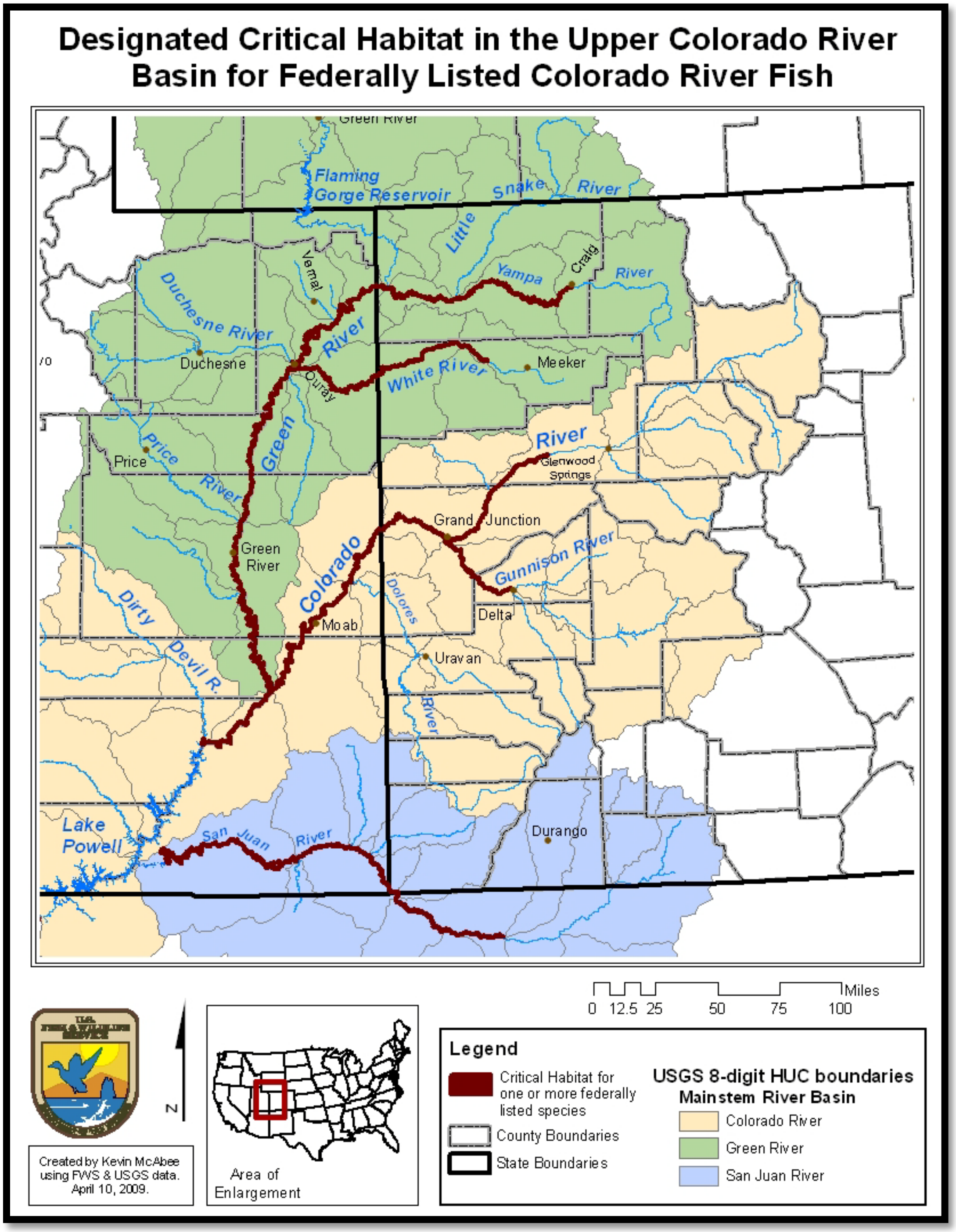
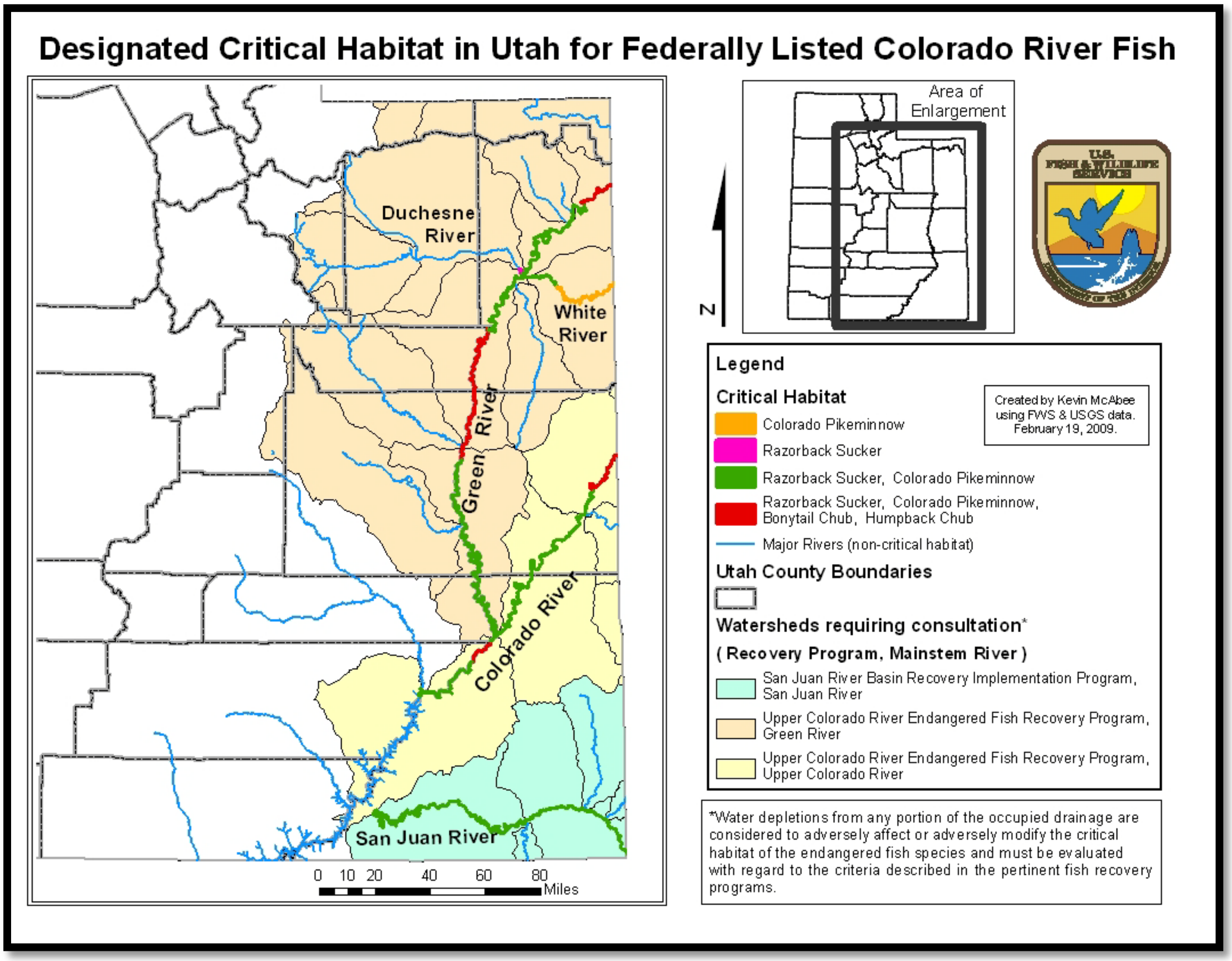


Figure 7. Designated Critical Habitat in the State of Utah



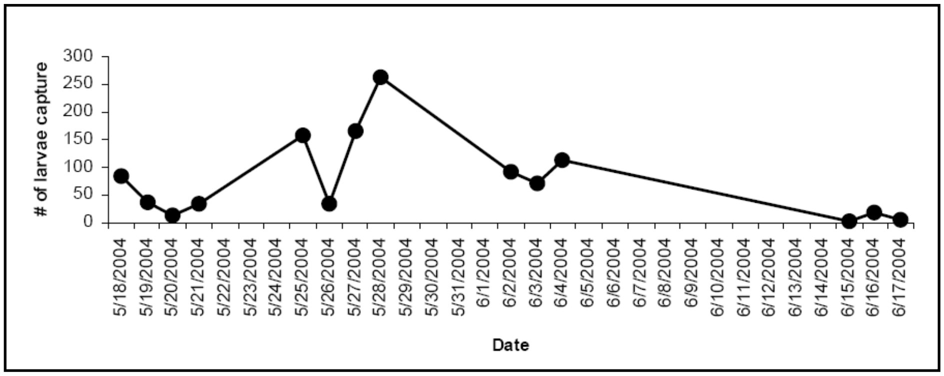
Full Project Operations Larval Entrainment Scenario
10,000 af/yr using Three Pumps in a 2% exceedance year

Baseline data:
1) Pumps operating based on Table 2.7 of the EA
2) 2% Flow data fond on pages 3 through 5 of the EA

Period	Average Daily flow in 2% exceedance year
May 16 to 31	4310
June 1 to 15	3709
June 16 to 30	2053
July 1 to 15	1251
July 16 to 31	1004
August 1 to 15	1003

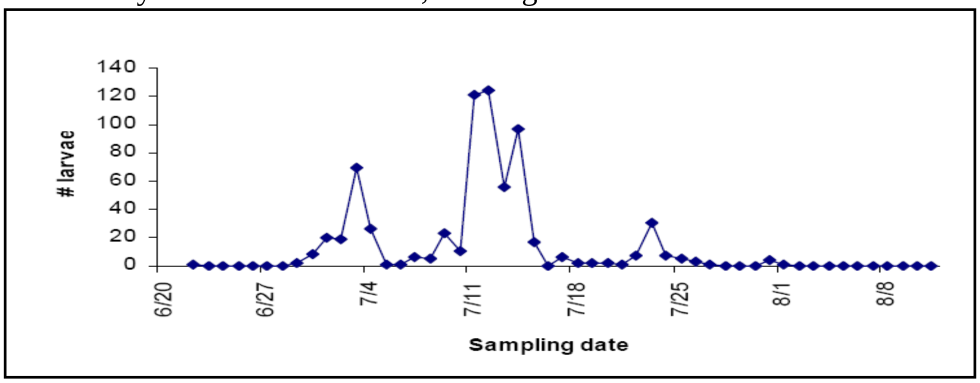
3) We assume a yearly razorback sucker larval drift distribution based on 2004 (Bestgen et al. 2008 Figure 2), indicating the following approximate percentages:

May 1 to 15 = 0% drift; May 16 to 31 = 47.5% drift
June 1 to 15 = 47.5% drift; June 16 to 31 = 5% drift



4) We assume a yearly Colorado pikeminnow larval drift distribution similar to 2006 (Bestgen et al. 2008 Figure 12), indicating the following approximate percentages:

June 15 to 30 = 1% drift; July 1 to 15 = 50% drift
July 16 to 31 = 48% drift; August 1 to 15= 1% drift



Razorback sucker

$$RZE = \left(\frac{Intake\ Rate}{Flow\ of\ Green\ River}\right) * (PD_{midnight} * RZ_{midnight} + PD_{day} * RZ_{day})$$

$$RZE_{May\ 16-31} = \left(\frac{37}{4310}\right) * \left(\frac{12}{12} * 0.2\right)$$

$$RZE_{May\ 16-31} = (0.008585) * (0.2)$$

$$RZE_{May\ 16-31} = 0.001717$$

$$RZE_{\text{June } 1-15} = \left(\frac{53}{3709}\right) * \left(\frac{2}{6} * 0.8 + \frac{2}{12} * 0.2\right) + \left(\frac{37}{3709}\right)\left(\frac{10}{12} * 0.2\right)$$

$$RZE_{\text{June } 1-15} = (0.01429)(0.3) * +(0.01)(0.16667)$$

$$RZE_{\text{June } 1-15} = 0.004287 + 0.001667$$

$$RZE_{\text{June } 1-15} = (0.005954)$$

$$RZE_{June\ 16-30} = \left(\frac{53}{2053}\right) * \left(\frac{1}{6} * 0.8 + \frac{12}{12} * 0.2\right)$$

$$RZE_{June\ 16-30} = (0.025816) * \left(\frac{2}{15} + \frac{1}{5}\right)$$

$$RZE_{June\ 16-30} = (0.025816) * \left(\frac{1}{3}\right)$$

$$RZE_{June\ 16-30} = (0.008605)$$

$$RZE = 0.475 * RZE_{May\ 16-31} + 0.475 * RZE_{June\ 1-15} + 0.05 * RZE_{June\ 16-31}$$

$$RZE = 0.475 * 0.001717 + 0.475 * 0.005954 + 0.05 * 0.008605$$

$$RZE = 0.004074 \text{ or } 0.4074\%$$

Colorado pikeminnow

$$CPM = \left(\frac{Intake\ Rate}{Flow\ of\ Green\ River}\right) * (PD_{midnight} * CP_{midnight} + \ PD_{day} * CP_{day}\ )$$

$$CPE_{June\ 16-30} = \left(\frac{53}{2053}\right) * \left(\frac{1}{6} * 0.8 + \ \frac{12}{12} * 0.2\right)$$

$$CPE_{June\ 16-30} = (0.025816) * \left(\frac{2}{15} + \ \frac{1}{5}\right)$$

$$CPE_{June\ 16-30} = (0.025816) * \left(\frac{1}{3}\right)$$

$$CPE_{June\ 16-30} = (0.008605)$$

$$CPE_{July\ 1-15} = \left(\frac{53}{1251}\right) * \left(\frac{2}{6} * 0.8 + \ \frac{10}{12} * 0.2\right) + \ \left(\frac{20}{1251}\right)\left(\frac{2}{12} * 0.2\right)$$

$$CPE_{July\ 1-15} = (0.042366) * \left(\frac{4}{15} + \frac{5}{30}\right) + \ (0.01599)\left(\frac{1}{30}\right)$$

$$CPE_{July\ 1-15} = (0.042366) * \left(\frac{13}{30}\right) + \ (0.01599)\left(\frac{1}{30}\right)$$

$$CPE_{July\ 1-15} = 0.018359 + \ 0.000533$$

$$CPE_{July\ 1-15} = 0.018891$$

$$CPE_{July\ 16-31} = \left(\frac{53}{1004}\right) * \left(\frac{2}{6} * 0.8 + \ \frac{10}{12} * 0.2\right) + \ \left(\frac{20}{1004}\right)\left(\frac{2}{12} * 0.2\right)$$

$$CPE_{July\ 16-31} = (0.052789) * \left(\frac{4}{15} + \frac{5}{30}\right) + \ (0.0199)\left(\frac{1}{30}\right)$$

$$CPE_{July\ 16-31} = (0.052789) * \left(\frac{13}{30}\right) + \ (0.0199)\left(\frac{1}{30}\right)$$

$$CPE_{July\ 16-31} = 0.02288 + \ 0.000664$$

$$CPE_{July\ 16-31} = 0.02354$$

$$CPE_{August\ 1-15} = \left(\frac{53}{1003}\right) * \left(\frac{2}{6} * 0.8 + \frac{10}{12} * 0.2\right) + \left(\frac{20}{1003}\right)\left(\frac{2}{12} * 0.2\right)$$

$$CPE_{August\ 1-15} = (0.05284) * \left(\frac{4}{15} + \frac{5}{30}\right) + (0.0199)\left(\frac{1}{30}\right)$$

$$CPE_{August\ 1-15} = (0.05284) * \left(\frac{13}{30}\right) + (0.0199)\left(\frac{1}{30}\right)$$

$$CPE_{August\ 1-15} = 0.02290 + 0.000664$$

$$CPE_{August\ 1-15} = 0.02356$$

$$CPE = 0.01 * CPE_{June\ 16-31} + 0.5 * CPE_{July\ 1-15} + 0.48 * CPE_{July\ 16-31} + 0.01 * CPE_{August\ 1-15}$$

$$CPE = 0.01 * 0.008605 + 0.5 * 0.018891 + 0.48 * 0.02354 \quad + 0.01 * 0.02356$$

$$CPE = 0.021066\ or\ 2.1\%$$