3.0 Affected Environment

This chapter provides a brief geographic description of the area in which the proposed action is to be undertaken. It then provides a description of the existing conditions for all resource areas that might be affected by the Action Alternative or the No Action Alternative. For a discussion of the potential consequences of each of the two alternatives, please see chapter 4.

3.1 Introduction

Flaming Gorge Dam is located in northeastern Utah, and Flaming Gorge Reservoir is located in northeastern Utah and southwestern Wyoming. The Wyoming portion of the reservoir is located in Sweetwater County and consists of high desert topography including low hills, shale badlands, and desert shrubbery. The Utah portion of the reservoir is located in Daggett County, in the Uinta Mountains, where the topography includes benches, canyons, and forest. Leaving the reservoir, the Green River flows east into Colorado, traversing the Uinta Mountains. In Colorado, the Green River turns south to its confluence with the Yampa River, turns west-southwest back into Utah, and then runs generally south to its confluence with the Colorado River. In Colorado and Utah, the Green River flows through the eastern part of the Uinta Basin, which extends south from the Uinta Mountains to the Tavaputs Plateau of the Book Cliffs. Please refer to the frontispiece map of the project area.

3.2 POTENTIALLY AFFECTED AREA

The geographic area that could be affected by the Proposed Action includes the Flaming Gorge Reservoir, which extends northward 91 miles from Flaming Gorge Dam, and the Green River downstream to the Colorado River confluence (see the frontispiece map). The Colorado River confluence is about 410 river miles south of Flaming Gorge Dam.

3.2.1 Description of Flaming Gorge Dam, Powerplant, and Reservoir

This section describes Flaming Gorge Dam, Powerplant, and Reservoir as they contribute to conditions in and along the Green River below the dam.

3.2.1.1 Flaming Gorge Dam and Reservoir

Flaming Gorge Dam is the principal feature of the Flaming Gorge Unit, one of four units of the Colorado River Storage Project (CRSP) that was authorized by an act of Congress on April 11, 1956. Completed in 1964, the dam and powerplant are operated and maintained by the Bureau of Reclamation. The reservoir began filling December 10, 1962, and filled for the first time August 1, 1974. Flaming Gorge Dam is a thin-arch concrete dam, which, from the streambed, stands 502 feet high and contains 987,000 cubic yards of concrete. The dam impounds waters of the Green River to form Flaming Gorge Reservoir, which has a total capacity of 3,788,900 acre-feet. At full elevation of 6040 feet, the L-shaped reservoir has a surface area of 42,020 acres and is 91 river miles long, with the first 32-mile-long portion roughly paralleling the Utah/Wyoming border and the remaining 59 miles extending northward into Wyoming. Flaming Gorge Dam has the capability of releasing 28,600 cubic feet per second (cfs) through the combined capacities of the powerplant, river outlet works, and spillway.

3.2.1.2 Flaming Gorge Dam River Outlet Works and Spillway

The river outlet works consist of two 72-inch-diameter steel pipes that extend through the dam and continue downstream to a valve structure located near the east abutment of the dam. The outlet works discharge directly into the Green River, bypassing the powerplant and turbines. The combined capacity of the two outlet pipes is 4,000 cfs. Normally, the outlet works are only used to release flows above the capacity of the powerplant, which is 4,600 cfs. However, on occasion, if the powerplant is out of service, water may be bypassed through the outlet works to maintain flows in the river. Since the intake for the outlet works is lower in the dam than either the penstocks (pipes that carry water from the reservoir to the turbines in the powerplant) or the spillway, outlet works water releases are typically colder than releases made through the other structures. Further information on water temperatures can be found in section 3.3.

The spillway is used to release water from Flaming Gorge Reservoir in amounts that exceed the combined release capacity of the river outlet works and the powerplant. The spillway is controlled manually by two 16¾- by 34-foot hydraulically operated fixed-wheel gates. The spillway can safely discharge up to 20,000 cfs. The reservoir level must be above 6006 feet before water can be released through the spillway. The spillway was used in 1983, 1984, and 1999 for flood control purposes. In 1997, the spillway was used instead of the outlet works when repair work was being done on the outlet works.

3.2.1.3 Flaming Gorge Powerplant

Flaming Gorge Powerplant, located at the base of Flaming Gorge Dam, first began producing hydroelectric power on

September 27, 1963. Water is conveyed to the powerplant by three 10-foot-diameter penstocks located near the center of the dam. The powerplant houses three generating units with a total capacity of about 152 megawatts (MW). On average, Flaming Gorge Powerplant generates 528,900 megawatt-hours of electrical energy per year, which is enough energy to serve about 150,000 homes. This is largely dependent on hydrologic conditions in the upper Green River Basin. The powerplant is capable of operating within the approximate range of 100 to 4,600 cfs. Under normal operating conditions, water is released through the penstocks and turbines where the energy from falling water is used to produce electricity. Water from the penstock cools the turbine bearings. When design temperatures are exceeded, turbine alarms trip, resulting in the affected generator going offline. This operating restriction has limited the ability to release warmer water downstream. Further detail is provided in section 3.3.4.1.

3.2.1.4 Flaming Gorge Dam Selective Withdrawal Structure

In 1978, Reclamation began releasing water through the selective withdrawal structure to provide warmer water for trout downstream. Prior to construction of the selective withdrawal structure, water releases were made through the penstocks. This mode of operation resulted in summertime water release temperatures ranging from 41-48 degrees Fahrenheit (°F) (5-9 degrees Celsius [°C]) which limited trout growth rates and the desired cold water sport fishery development. The selective withdrawal structure consists of a set of interlocking panels that can be manually raised to any height above the penstock intake to within 40 feet of the water surface. Around April 1 of each year, the upper gates are raised to an elevation about 40 feet below the surface of the reservoir. As inflows increase and debris approaches the intake structure, the gates are lowered to prevent the debris from entering the penstocks. As the debris dissipates, the gates are again raised to discharge warmer water into the river. Moving the gates up or down does not give an instantaneous change in the temperature. Temperature adjustment is an iterative process. Following gate movement, the discharge temperature is monitored; and if the temperature goal is not reached, another move is initiated.

3.3 WATER RESOURCES AND HYDROLOGY

This section describes the water resources in Flaming Gorge Reservoir and in the Green River downstream from Flaming Gorge Dam. It discusses basic hydrology and baseline conditions for water quality and water temperature.

3.3.1 Flaming Gorge Reservoir Hydrology

Reservoir elevations have fluctuated from a minimum of 5988 feet above sea level in January 1978 to a maximum elevation of 6044 feet above sea level in July 1983. Reservoir elevation fluctuations are the result of inflow volumes that are not matched by reservoir release volumes over a particular time period. Typically during the spring, inflow volumes exceed release volumes, resulting in increased reservoir elevations. The pattern is reversed during the fall and winter when release volumes exceed inflow volumes. Reservoirs are designed to operate this way so water can be stored when inflows are high and then released when water supplies are low and demand is high.

3.3.2 Flaming Gorge Reservoir Water Quality and Temperature

Water quality at Flaming Gorge Reservoir fluctuates with depth and location due to the interaction between underlying geologic formations, fluctuations in water volume, presence of organisms, and air. The shallow inflow area near Green River, Wyoming, receives sediments from erosion of the ancient Green River Lake deposits, as well as from the even older Mancos Sea deposits, which are also prevalent in the watershed. This sediment is laden with nutrients, particularly phosphorus, which drives large algal blooms in the northernmost 20 to 30 miles of the reservoir. However, where water depths increase, sediments, nutrients, and algae settle, forming new organic lake deposits. The water becomes nutrient depleted in the deeper portions of the reservoir closer to the dam. About 50 miles upstream of Flaming Gorge Dam, the water depth is greater than 200 feet and most of the sediment or algae have settled out. Nearly two-thirds of Flaming Gorge Reservoir has only minimal phytoplankton to support the food chain. Most of the reservoir is classified as nutrient and plankton deficient.

During the 1970s and 1980s, salinity and limnological studies of Flaming Gorge Reservoir revealed two important items (Bolke and Waddell, 1975; Miller, 1984). First, drawdown of the reservoir results in re-suspension of sediments deposited during filling. This sediment scouring releases high concentrations of phosphorus that drive large blooms of noxious and potentially toxin-producing blue-green algae into the northernmost 10 to 30 miles of the reservoir (Miller, 1984). These algal blooms decrease recreation activity and reduce dissolved oxygen, which affect the fishery resources during the August to October period. Second, reservoir drawdown results in salt leaching and increased salinity.

In 1978, the reservoir was drawn down to 5988 feet above mean sea level. The resulting algal blooms extended 20 to 30 miles further down the reservoir from their normal location near the Buckboard Marina and severely impacted fisheries and recreation in the Wyoming portion of the reservoir. The heaviest blue-green algal blooms occurred in October 1978, associated with the drawdown of about 50 feet.

Figures 3-1 and 3-2 are satellite images of Flaming Gorge Reservoir showing algae concentrations. The upper end of Flaming Gorge Reservoir, where the algal blooms are illustrated in red, would be classified as eutrophic (high nutrient) to hyper-eutrophic in the summer and fall. The area shown in red has chlorophyll a concentrations greater than 27 micrograms per Liter (µg/L) and can reach several hundred µg/L or hyper-eutrophic status at times in the red zones (greater than 10 being an indication of poor water quality and eutrophic conditions). The areas depicted in yellow would be classified as mesotrophic, which is generally considered a healthy environment for cold water fishery. Most of the reservoir shown in blue is oligotrophic (low nutrient) and often lacks sufficient algae to support a healthy food base.

In October 2002, the reservoir was drawn down to an elevation of 6011 feet, the lowest since 1982. This drought-induced drawdown produced a large algal bloom in the upper end of the reservoir (Miller, 2002).

The magnitude of algal blooms varies with reservoir elevation. The smaller the reservoir drawdown, the less sediment is re-suspended, and the less phosphorus is released from the sediment into the water. The combination of wet hydrology from 1983 to 1987, the test flows from 1987 to 1992, and the flow constraints implemented by the 1992 Biological Opinion resulted in decreased summer and fall reservoir drawdown. This resulted in improved water quality and decreased algal blooms.

Salinity in the reservoir can also be affected by reservoir elevations. During drawdown periods, bank storage (groundwater around the reservoir) flows back into the reservoir. Groundwater can potentially contain high levels of salt, depending on the sediment and rock formations surrounding the reservoir. It is estimated that the salt loading in Flaming Gorge Reservoir has decreased by a few

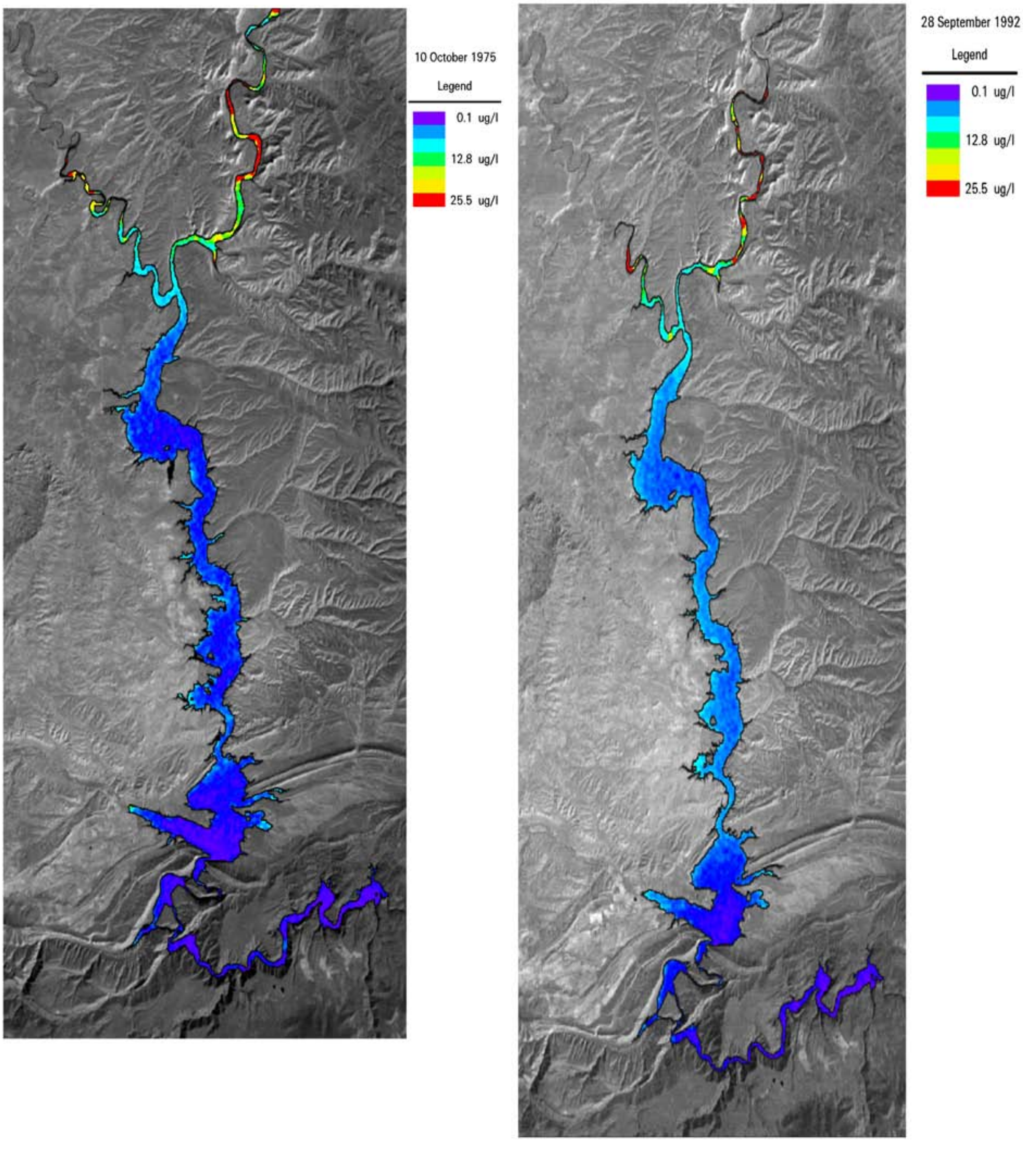

Figure 3-1 and 3-2.—Figures 3-1 and 3-2 (figure 3-2 is on the following page) depict the magnitude of algal blooms at Flaming Gorge in 1975 and in 1992 during years with minimal summer drawdown. However, in 1978 with extensive drawdown approaching nearly 60 feet, the algal blooms extended another 30 miles farther down reservoir. In 2002 with reservoir drawdown only 30 feet at elevation 6011, the algal blooms were very similar to those shown for 1978.

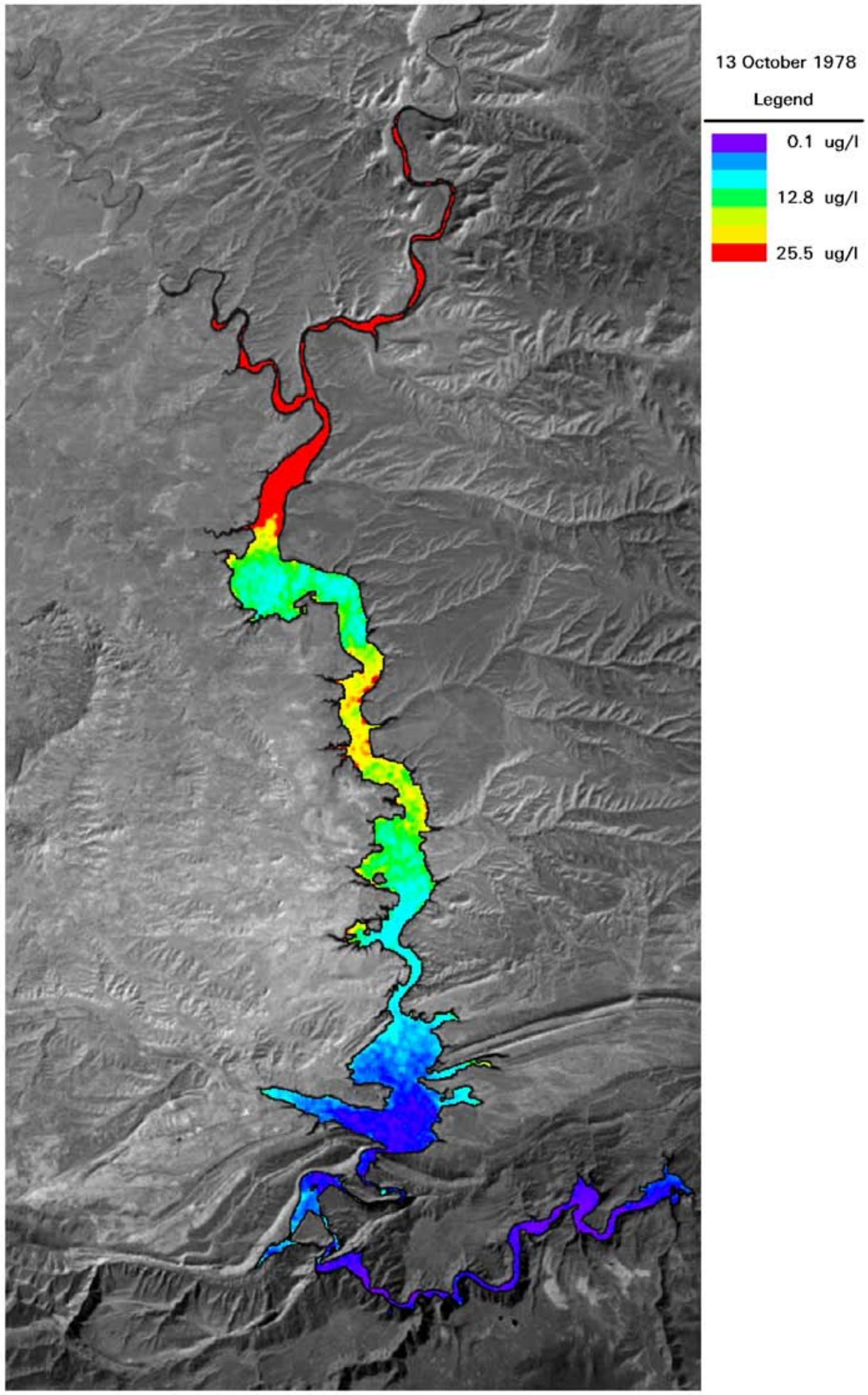

Figure 3-2.—The red and yellow depict areas with large enough blue-green algal blooms to impact both recreation and cold water fisheries. When the reservoir is drawn down, the algal blooms are much more extensive than when it is fuller. Figure 3-2 shows that the algal blooms extend nearly 20 miles farther down reservoir than they are in figure 3-1.

hundred thousand tons per year by reduced drawdown since 1983 (Miller, 2004).

3.3.3 Green River Hydrology

Most of the total annual streamflow in the Green River Basin is provided by the runoff of melting snow in the high mountains of the Uinta Range in northeastern Utah and the Wyoming and Wind River Ranges of west-central Wyoming. Prior to the construction of Flaming Gorge Dam, the hydrograph was dominated by spring peak flows from snowmelt runoff and low fall and winter base flows (Grams and Schmidt, 1999). The pre-dam spring flow typically peaked by early June and receded by mid-July. The pre-dam peak flows were typically 10,000 to 20,000 cfs, while base flows were typically 800 to 1,000 cfs (see figure 3-3).

The pattern of flows or hydrograph changed after the closure of Flaming Gorge Dam in 1962. Except for flood releases in 1983, 1984, 1986, 1997, and 1999, Green River spring peak flows were restricted to powerplant capacity at or below 4,600 cfs. Typical flows in the Green River below Flaming Gorge Dam between the mid-1960s and the early 1990s during the base flow period were 2,000 to 3,000 cfs.

From 1992 to present, Reclamation has operated Flaming Gorge Dam to meet the requirements of the Reasonable and Prudent Alternative (RPA), which included a powerplant capacity release of 1 to 6 weeks each spring followed by a period of low summer flows. The intent of these requirements was to establish flow and temperature regimes of the Green River that more closely resembled pre-dam conditions. While this change did not return the Green

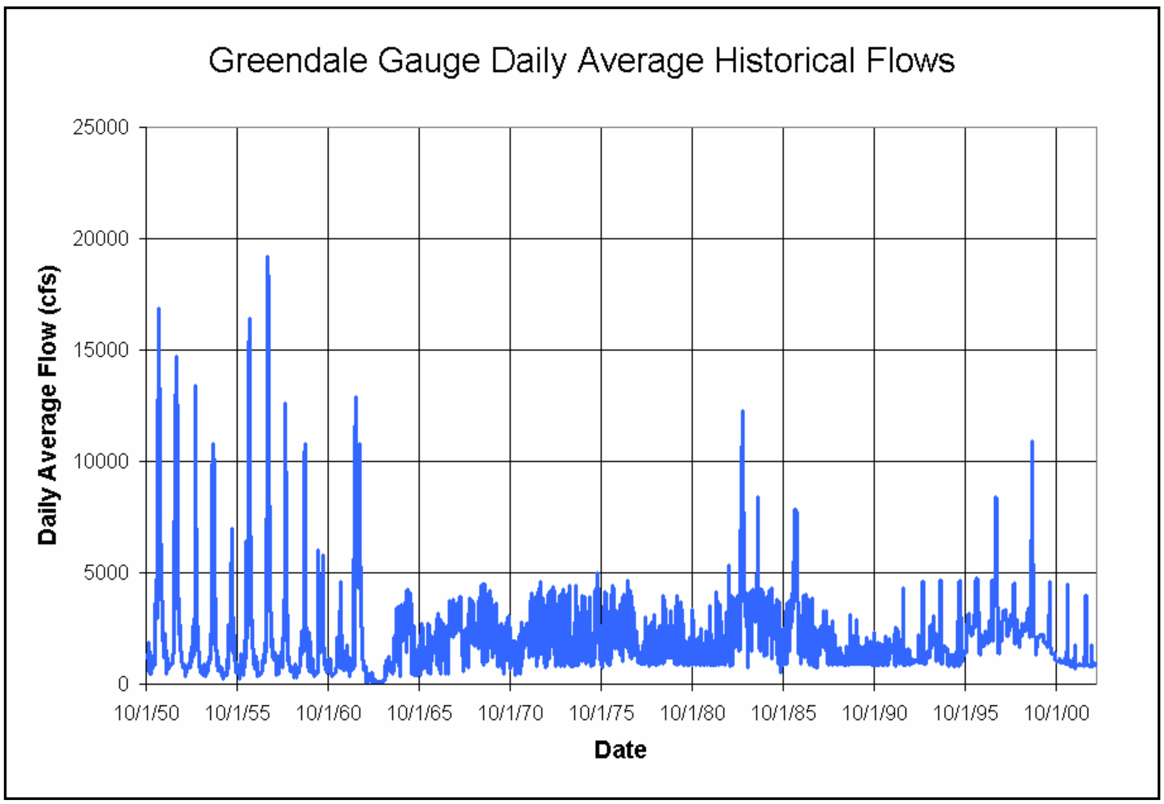

Figure 3-3.—Green River Historic Flows at Greendale, Utah, Located 0.25 Mile Downstream From Flaming Gorge Dam.

River to the flow pattern that occurred prior to closure of the dam, these changes in operation resulted in a more natural flow pattern. Peak flows, although smaller in magnitude than pre-dam peak flows, were released during the spring, and flows during the base flow period were reduced.

3.3.3.1 Reach 1

Flows in this reach are measured at the United States Geological Survey (USGS) gauge near Greendale, Utah, approximately 0.25 mile below the dam (figure 3-3). Except for usually minor flow contributions from tributary streams, flows in Reach 1 are completely regulated by Flaming Gorge Dam. While the average annual discharge (about 2,170 cfs[1]) has not been affected by Flaming Gorge Dam operations, the pattern of flows has changed. Powerplant operations prior to 1992 resulted in relatively uniform monthly release volumes with significant within-day fluctuations as compared to pre-dam conditions. Since 1992, monthly release volumes have shifted to a more natural pattern with high volumes during the spring and low volumes during the summer, fall, and winter. Within-day fluctuations have continued since 1992 but have been moderated somewhat by the requirements of the RPA of the 1992 Biological Opinion.

3.3.3.2 Reach 2

Flows in this reach are recorded at the USGS gauge near Jensen, Utah, about 29 miles downstream from the Yampa River confluence. The average annual flow of the Green River at the gauge near Jensen, Utah, is 4,370 cfs. Reach 2 exhibits a more seasonally variable flow, temperature, and sediment regime than Reach 1 because of inflow from the Yampa River. The average annual discharge of the Yampa River is about 2,150 cfs. During the spring, flows on the Green River in Reach 2 are usually dominated by the flows of the Yampa River, which can peak as high as 20,000 to 30,000 cfs in wet years or as high as 7,000 to 10,000 cfs in drier years. On average, the Yampa River peaks with a mean daily flow of 14,280 cfs. During the late summer, fall, and winter months, flows of the Yampa River do not contribute significant flows in Reach 2. In dry years, the flows of the Yampa River during these months can be as low as 100 to 200 cfs. In wet years, flows on the Yampa River during these months can reach 500 to 800 cfs. On average during the period from August through February, the flows of the Yampa River are 410 cfs. This is only 10 to 20 percent (%) of the average flow of the Green River in Reach 2 during these same months, due to releases from Flaming Gorge Dam.

3.3.3.3 Reach 3

Flows in Reach 3 of the Green River are measured at the USGS gauge located near Green River, Utah. This gauge is located about 196 river miles downstream from the USGS gauge on the Green River near Jensen, Utah, and 120 river miles upstream of the confluence of the Green River with the Colorado River. The average annual discharge of the Green River at Green River, Utah, is about 6,230 cfs. Flows in this reach are affected by tributary flows from the San Rafael, Price, White, and Duchesne Rivers. The flows on the Duchesne River have been depleted significantly through the development of the Central Utah Project (CUP) which diverts water out of the Duchesne River and transfers it to the Wasatch Front in the Great Basin. For this reason, the actual flows of the Duchesne River at the confluence with the Green River are substantially diminished from the flows that would naturally occur at this location.

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[1] Average annual discharge values for gauges described in this portion of the environmental impact statement (EIS) are gauge data summary as reported by the USGS for the entire gauge history up to, and including, water year 2000 streamflow data.

Peak flows on the Price River occur in May and have averaged about 300 cfs historically. During the winter months, flows on the Price River have averaged about 60 cfs. Peak flows on the San Rafael River typically occur at the end of May and average about 600 cfs during the peak. San Rafael River flows during the winter months have averaged about 50 cfs historically. Peak flows on the Duchesne River have averaged about 2,000 cfs during the peak which usually occurs during the month of June; however, because of the CUP, future peak flows will likely be less than those that have occurred historically. During the winter months, the flows on the Duchesne River have averaged about 400 cfs. Peak flows of the White River have historically averaged about 2,000 cfs during the peak which most often occurs in late May. Winter flows on the White River have averaged about 400 cfs historically.

3.3.4 Green River Water Quality and Water Temperature

Prior to the construction of Flaming Gorge Dam, water quality in the Green River was characterized by sediment laden spring flows, but the snowmelt water was low in dissolved solids and salts. The later summer, fall, and winter flows were somewhat turbid with higher salinity. Water quality concerns that may be affected by the proposed action are limited to water temperature.

3.3.4.1 Reach 1

Daily water temperatures measured at the Greendale, Utah, USGS gauging station just below the present site of Flaming Gorge Dam during 1956-61 (table 3-1; see also Vanicek and Kramer, 1969) allow for estimating the summer and fall thermal regime in the Green River in Flaming Gorge Canyon prior to the emplacement of the dam. This is the period of the year for which temperatures are prescribed in the 1992 Biological Opinion and also the time during which the reservoir is stratified and temperatures can be most affected by the selective withdrawal structure. The pre-dam Green River in this reach experienced freezing temperatures from November through February. By April 1, average temperatures reached approximately 41 °F (5 °C) and, by June 1, typically exceeded 52 °F (11 °C). High temperatures of approximately 86 °F (30 °C) were reached during August. Cooling was rapid during September; and by the end of October, freezing temperatures could occur.

Table 3-1.—Pre-Dam Daily Water Temperature[1] Statistics in Degrees Celsius for the USGS Gauging Station at Greendale, Utah, Below Flaming Gorge Dam, During 1956-61

	Jun	Jul	Aug	Sept	Oct
Mean	16.7	20.3	20.2	14.8	8.0
Median	16.7	20.6	20.6	15.0	7.5
Minimum	11.1	13.3	14.4	6.7	0.0
Maximum	21.7	25.6	30.0	20.0	17.2
10th Percentile	13.3	17.8	17.2	10.1	3.9
90th Percentile	20.0	22.2	23.0	18.9	13.3

[1] Temperatures are in °C. Conversion from °C to °F = 9/5 x C + 32. 10% of all recorded temperatures lie below the 10th Percentile value; 90% of all recorded temperatures lie below the 90th Percentile value

Water temperatures in Reach 1 are controlled by the selective withdrawal structure on Flaming Gorge Dam, which typically is operated during May through September.

The potential of Flaming Gorge Dam to approximate the pre-dam water temperature regime using the selective withdrawal structure has been estimated using the CEQUAL-W2 two-dimensional reservoir model. Modeling was conducted for water years 1981-83, assuming 40 feet submergence for the selective withdrawal but using flow routing as it would occur under the Action Alternative. The years 1981-83 were chosen because they represent a wide range of inflow and reservoir elevations and, therefore, encompass a diverse set of reservoir and dam operations.

Potential release temperatures from Flaming Gorge Dam using the selective withdrawal structure are lower in early summer through

August than pre-dam water temperatures in the Green River, but they are higher during September and October (table 3-2). This lag, which is a reflection of the time necessary to stratify the reservoir and accrue heat in this large body of water, has the effect of adjusting dates at which critical temperatures are reached for warm water native fish. An average daily temperature of 61 °F (16 °C) in the pre-dam river was reached during June; but in the post-dam river with selective withdrawal releases, this average is not reached until July. Declining temperatures during fall months show the opposite relationship, with warmer temperatures persisting longer in selective withdrawal releases. Distinct differences in water temperatures are noticeable when comparing values during September and October under pre-dam (table 3-1) and post-dam selective withdrawal (table 3-2) operations. Thus, the potential exists to extend the growing season for native fish in early fall using the selective withdrawal, thereby compensating for the summer lag in warming.

Table 3-2.—Daily Statistics for Predicted Flaming Gorge Release Temperatures[1] in Degrees Celsius Based on Modeling Using CEQUAL-W2

	Jun	Jul	Aug	Sept	Oct
Mean	12.1	16.0	18.9	18.4	13.9
Median	11.7	16.9	19.9	18.4	14.1
Minimum	7.1	11.8	13.1	15.6	10.3
Maximum	16.4	19.7	20.9	20.4	15.6
10th Percentile	7.9	12.6	15.8	16.5	12.1
90th Percentile	15.8	18.8	20.6	20.1	15.4

[1] Temperatures are in °C. Conversion from °C to °F = 9/5 x C + 32.

The CEQUAL-W2 model considered only the maximum temperatures that could be released and did not take into account constraints that occur when releasing through hydroelectric turbines. Release waters are used to maintain bearing temperatures on turbines below critical values, and there are upper limits imposed on release temperatures by this dependency.

Design operating criteria for the turbine bearings at Flaming Gorge Dam have specifications for bearing oil temperatures not to exceed 140 °F (60 °C). Alarms are programmed to go off when turbine bearings exceed that temperature (*Designer's Operating Criteria*, *Flaming Gorge Dam, Powerplant and Switchyard*, Flaming Gorge Unit, Green Division, Colorado River Storage Project, November 1963). The relationship between release water temperatures and turbine bearing temperatures is affected by the volume of water released as well as the efficiency of exchange between bearing oil and release water. The uncertainty in this relationship has resulted in operation of the selective withdrawal to avoid tripping turbine alarms and subsequent downtime for generators. For these reasons, the target maximum release water temperature since the 1992 Biological Opinion has been 55 °F (13 °C) (Blanchard, 1999).

Actual Flaming Gorge release water temperatures for the months of June-October during the period 1993-2001 are best estimated by measurements at the Greendale USGS gauging station, approximately 0.25 mile below the dam (table 3-3). These data show that dam releases have reached 59 °F (15 °C) on only a few occasions during September in the period 1993-2001 and that the average values for the months of July-September have been very near the 55 °F (13 °C) limit imposed by the uncertainty in release temperatures that could cause alarms to be tripped and downtime for hydroelectric generators. It is also consistent with assumptions concerning release temperatures made by the *Flow and Temperature Recommendations for Endangered Fishes in the Green River Downstream of Flaming Gorge Dam* (2000 Flow and Temperature Recommendations) in making temperature recommendations.

The 2000 Flow and Temperature Recommendations introduce a new target for Lodore Canyon of 64-68 °F (18-20 °C) or greater for 2 to 5 weeks in summer and fall, which has

Table 3-3.—Daily Statistics for Water Temperatures[1] in Degrees Celsius at the Greendale, Utah, USGS Gauging Station Below Flaming Gorge Dam During the Period 1993-2001

	Jun[2]	Jul	Aug	Sept	Oct
Mean	10.5	12.4	12.3	12.8	10.5
Median	10.4	12.6	12.4	12.7	10.8
Minimum	7.6	9.6	9.4	9.4	0.0
Maximum	14.5	14.0	14.3	17.0	14.4
10th Percentile	8.8	11.3	11.0	11.8	8.3
90th Percentile	12.8	13.3	13.4	14.2	12.3

[1] Temperatures are in °C. Conversion from °C to °F = 9/5 x C + 32.
[2] For a total of 31 days in 1997 and 1999, flows exceeded powerplant capacity with releases through the bypass tubes, which resulted in cooler downstream temperatures than were released through the selective withdrawal.

been incorporated into the Action Alternative for this EIS. Water temperatures measured at the Browns Park gauge located 38 miles below the dam provide the best retrospective data set for determining the extent to which the recommended temperatures were met during the period since the 1992 Biological Opinion. Neither daily mean or daily median temperatures in the months of June through October met this recommended target (table 3-4). Maximum recorded daily mean temperatures exceeded 64 °F (18 °C) in June, July, and August; but only in July was this temperature met or exceeded on more than 10% of the days.

Table 3-4.—Daily Statistics for Water Temperatures[1] in Degrees Celsius at the Browns Park, U.S. Fish and Wildlife Service Measuring Station During the Period 1993-2001. The Station Is Approximately 38 Miles Downriver From Flaming Gorge Dam.

	Jun	Jul	Aug	Sept	Oct
Mean	13.5	16.5	16.2	13.9	10.4
Median	13.4	16.8	16.2	14.0	10.7
Minimum	8.9	12.8	9.5	7.7	4.6
Maximum	19.8	20.4	19.5	16.7	14.6
10th Percentile	10.4	14.4	15.1	12.0	8.2
90th Percentile	17.6	18.2	17.2	15.7	12.3

[1] Temperatures are in °C. Conversion from °C to °F = 9/5 x C + 32.

3.3.4.2 Reach 2

The 1992 Biological Opinion targets water temperatures at the beginning of Reach 2 (confluence of the Green and Yampa Rivers) and recommends that summer temperatures in these two streams should not deviate by more than 9 °F (5 °C). The water temperature gauge established by the U.S. Fish and Wildlife Service in Echo Park on the Green River, above its confluence with the Yampa River, has only been operational since 1998; so the ability to measure attainment of this recommendation is limited to after 1998.

Maximum differences between the Green and Yampa Rivers exceeded 9 °F (5 °C) in each of the months of June through October during the period of record (table 3-5). The differences exceeded 9 °F (5 °C) by less than 2 °F (1 °C) in all months but July; however, in that month, the maximum difference was 13.3 °F (7.4 °C). July was the only month in which more than 10% of the recorded daily average temperatures exceeded the 9 °F (5 °C) targeted difference.

Table 3-5.—Differences in Daily Mean Temperatures[1] in Degrees Celsius Between the Green and Yampa Rivers as Measured at the Echo Park Gauging Stations Located in Both Rivers Above the Confluence. Negative Numbers Indicate Water Temperatures That Were Colder in the Green River Than in the Yampa River

	Jun	Jul	Aug	Sept	Oct
Mean	-2.2	-3.2	-3.7	-1.5	0.5
Median	-2.4	-2.9	-4.0	-1.9	0.5
Minimum[2]	1.1	0.2	-1.1	2.9	3.2
Maximum[3]	-5.2	-7.4	-5.5	-5.1	-5.8
10th Percentile	-0.4	-1.5	-2.1	-1.2	2.7
90th Percentile	-3.3	-6.4	-4.9	-3.6	-0.8

[1] Temperatures are in °C. Conversion from °C to °F = 9/5 x C + 32.
[2] Minimum differences represent the highest positive or least negative differences in water temperature between the Green and Yampa Rivers during the respective month.
[3] Maximum differences represent the highest negative differences in water temperature between the Green and Yampa Rivers during the respective month.

Release water from the reservoir will reach the ambient water temperature as it travels downstream (figure 3-4). The rate at which the water warms depends on the flow rate, the release water temperature, meteorological conditions, and the flow temperature of the tributaries. The relationship between release temperature and downstream temperature for a given location does not form a direct correlation. During late spring through summer, increasing reservoir release temperatures will result in warmer downstream temperatures.

Summer water temperatures in both the Yampa and the Green Rivers at their confluence are highly dependent upon streamflow and air temperature. The higher the flows, the lower the temperature, and vice versa. Temperatures in the Green and Yampa Rivers are similar until flows in the Yampa River begin to recede. The temperature at the confluence of the two rivers differs by less than 9 °F (5 °C) until the Yampa River flows decline to near those of the Green River. The Yampa River quickly reaches summer base flow conditions, while flows on the Green River are elevated due to the dam releases. While the Yampa River flow approaches historic conditions during snowmelt runoff, during summer base flow periods, much of its flow is diverted for irrigation. As a result, there are lower base flows and warmer temperatures in the Yampa River than occurred historically.

The temperature goal of less than 5 °C difference between the Green and Yampa Rivers will be met most of the time. The exception would be a high summer flow in the Green River coupled with a relatively low flow in the Yampa River. In June-July 1998, the maximum temperature difference between the Green and Yampa Rivers occurred when Green River summer base flows were greater than 2,000 cfs, while the Yampa River was contributing much less than that. During the extreme drought conditions of 2002, the Yampa River flow dropped to less than 10 cfs, while the Green River flowed at 800 cfs. Both rivers were very warm (70-82 °F [21-28 °C]); however, the temperature difference still did not exceed the 9 °F (5 °C) goal even on an hourly basis.

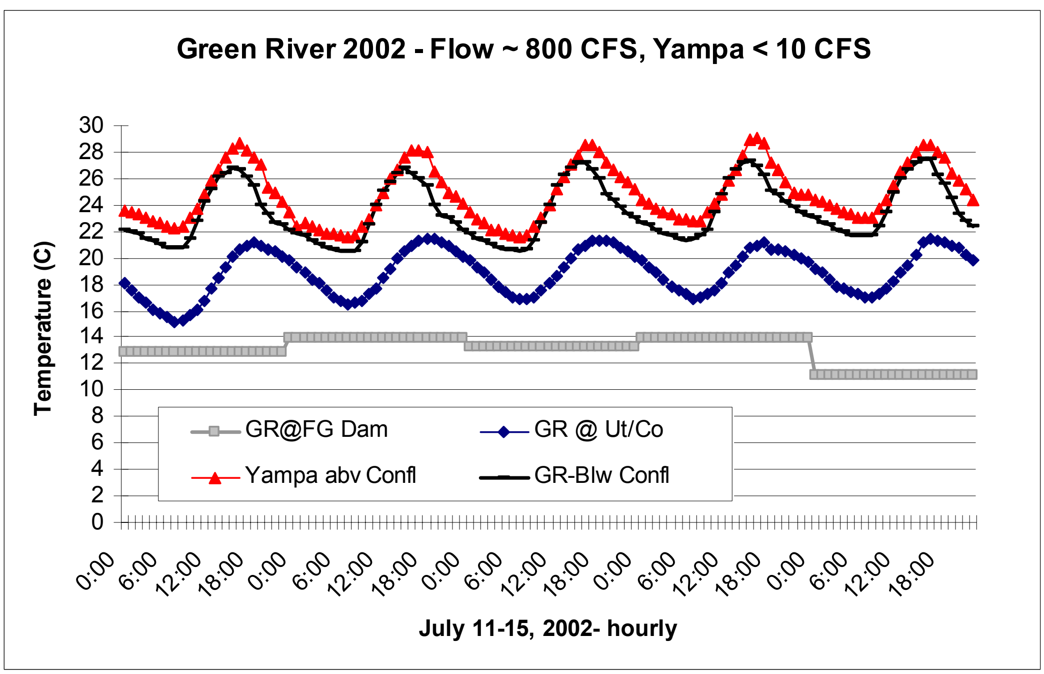

Figure 3-4.—2002 Hourly Temperature Variations From Flaming Gorge Dam to the Yampa River Confluence. Green River Flows at Approximately 800 cfs; Yampa Flows Near 10 cfs.

3.3.4.3 Reach 3

The 1992 Biological Opinion temperature requirement for the Green River at Gray Canyon calls for an average near 72-77 °F (22-25 °C) from July 1 to August 15. The extent to which this target was met is best estimated by measurements taken at the USGS gauging station at Green River, Utah, which is approximately 280 miles downriver from Flaming Gorge Dam. Records for June through October during 1993-2001 (table 3-6) show that fewer than 10% of the measurements during July and August were below 73 °F (23 °C). Inspection of these water temperatures and output of river modeling completed since the biological opinion was written (Carron, 2003) shows, however, that release temperatures from Flaming Gorge Dam have little influence on water temperatures in Reach 3 during summer months.

Table 3-6.—Daily Statistics for Water Temperatures[1] at Green River, Utah, USGS Gauging Station During the Period 1993-2001

	Jun	Jul	Aug	Sept	Oct
Mean	20.8	25.2	25.4	21.0	13.5
Median	20.5	25.0	25.0	21.0	13.3
Minimum	14.5	19.0	22.0	14.0	5.0
Maximum	28.0	30.0	30.0	26.0	20.0
10th Percentile	18.0	23.0	24.0	17.0	10.0
90th Percentile	25.0	28.0	27.0	24.0	18.0

[1] Temperatures are in °C. Conversion from °C to °F = 9/5 x C + 32.

3.3.5 Sediment Transport and Geomorphology

Prior to construction of Flaming Gorge Dam, the sediment transport regimes and characteristics of the Green River bed and bank varied greatly between canyon and fan-eddy-dominated reaches and meandering reaches (Grams and Schmidt, 2002). This variability still remains, although the decreased magnitude of peak flows due to construction of Flaming Gorge Dam has affected the quantity of sediment transported by a given flow due to alteration of the channel morphology and the availability of sediment within the channel.

Climate also influences sediment transport. Climate conditions can reduce a stream's ability to transport its supplied sediment load. Reduced upland vegetation cover due to drought reduces soil stability and increases erosion and subsequent siltation of streams. Drought followed by very wet years can also lead to increased upland erosion and stream siltation.

Recent research on the Green River has focused on the relationships between sediment transport and channel morphology over a range of flows in different geomorphic settings (Grams and Schmidt, 2002; Merritt and Cooper, 2000; Orchard and Schmidt, 2000; Allred and Schmidt, 1999; Grams and Schmidt, 1999; Martin et al., 1998; FLO Engineering, Inc., 1996). These studies include:

- Cobble and gravel deposits that are preferred spawning habitat of the endangered fishes have become less abundant and less frequently mobilized as they have aggraded with fine-grained sediment. Grams and Schmidt (2002) observed mid-channel sand deposits aggrading on deposits that, in the pre-dam era, were active gravel bars. These observations were limited to debris fan-eddy-dominated areas within Reach 1.
- Flow regulation reduced the dynamics of sediment deposition and erosion patterns. Each year, sediment deposits exposed during base flows are colonized by vegetation; and if subsequent floods do not scour these areas, a process of channel narrowing and increasing bank elevation can occur. At some point, this process becomes difficult to reverse because older, deeper-rooted vegetation is difficult to remove by all but the most extreme flood events. In Reach 1, Martin, et al. (1998) described the

re-distribution of sand in Lodore Canyon during 1995-97 when releases from Flaming Gorge Dam exceeded powerplant capacity. During a 6-day release when the flow of the Green River reached 8,600 cfs in this reach, significant erosion of eddy sandbars within this canyon reach was measured by these researchers. Merritt and Cooper (2000) described channel narrowing (11%) in Browns Park in Reach 1 during the decade immediately after closure of Flaming Gorge Dam followed by bank erosion and channel widening in Browns Park since 1977.

- Flood plains serve as important nursery habitat for growth and conditioning of endangered fish species in the Green River, particularly the razorback sucker. The frequency and extent of flood plain inundation varies considerably along the Green River and is largely a function of site-specific channel morphology (including the presence or absence of natural or human-made levees). In Reach 2, the greatest area of flood plain habitat suitable for satisfying the life-history requirements of endangered fishes is located in the Ouray National Wildlife Refuge. Under existing conditions, flood plain inundation begins to increase rapidly as flows exceed 18,600 cfs in this reach (FLO Engineering, Inc., 1996).

3.4 HYDROPOWER GENERATION AND MARKETING

The three generating units have a total capacity of about 152 MW with a current generating capability of about 141 MW due to turbine limitations. The Flaming Gorge Powerplant has added more than 20,235 gigawatthours (GWh) of electricity into the power grid from November 1963 through the end of June 2002. While the Flaming Gorge Powerplant has generated an average of about 528.9 GWh of electricity annually, it has historically had a large amount of annual variability. Hydropower generation levels were as low as 251.6 GWh in 1990 and as high as 877.1 GWh in 1984. Generation is a result of water releases from the reservoir and is, among other things, dependent on the level of the water in the reservoir. A wet water year results in greater releases and greater power generation. Power generation is also affected by minimum streamflow levels, fluctuation restrictions, water delivery requirements, bypasses around the turbines, and water quality needs.

Power produced from the Flaming Gorge Powerplant is marketed by the Western Area Power Administration (Western) and is sold to municipalities, public utilities, and government agencies in Wyoming, Utah, Colorado, New Mexico, Arizona, and Nevada. Interconnecting transmission lines, both public and private, carry the power to major metropolitan areas and rural areas throughout the West. There are approximately 183 CRSP customers who purchase wholesale electricity from Western's CRSP-Management Center office in Salt Lake City, Utah. Electrical power from the CRSP generally serves the rural areas and small towns of the Rocky Mountain States, Colorado Plateau, and Great Basin regions of the West. The CRSP marketing area includes parts of the States of Wyoming, Utah, Nevada, Arizona, New Mexico, Colorado, and Nebraska.

CRSP power customers are: (1) small and medium-sized towns that operate publicly owned electrical systems, (2) irrigation cooperatives and water conservation districts, (3) rural electrical associations or generation and transmission co-operatives who are wholesalers to these associations,
(4) municipal joint action agencies who are wholesalers to municipal electric utilities,
(5) Federal facilities such as U.S. Air Force bases, (6) universities and other State agencies, and (7) Indian tribes. Rural electric associations that buy power from CRSP serve

the rural areas of States. In Colorado and New Mexico, for example, CRSP customers serve almost all of the geographic area of the State outside of the major metropolitan areas.

Two Native American tribes receive CRSP electrical power (the Navajo Nation in Arizona and the Ute Mountain Ute Reservation in Utah), and effective October 1, 2004, 54 tribes have the opportunity of becoming CRSP firm electric service contractors.

Generally, the price these customers pay for their CRSP electrical power is less than the wholesale market price. However, these customers serve retail load in rural areas, where the cost to provide electrical service is high. Homes, farms, and other electrical connections are spread out, so that a significant transmission line and electrical generation investment has to be repaid by fewer retail customers. Generally, this is why private electrical suppliers chose not to extend their service to these areas and why the rural electric associations were set up to "electrify" the rural areas of the Nation. The retail prices charged by CRSP customers to end users are usually higher than adjacent urban areas. For example, the retail price for electricity charged by the CRSP customers who serve rural New Mexico is above $0.11 per kilowatthour (kWh) compared to about $0.07 per kWh in Albuquerque. Moreover, these rural areas and the tribal reservations are usually characterized by lower than average incomes and higher incidences of poverty. For example, the unemployment rate among the labor force on the Uintah and Ouray Ute Reservation in Utah was 28% in 1996. The per capita income on this same reservation in 1996 was $4,280, approximately one-fourth of the national average. The people that live in these areas are then less able to pay high electrical prices. Furthermore, higher electrical prices are one of the reasons that economic development is slower in rural areas of the American West.

These conditions do not accurately depict the situation for residences of the service territories of all CRSP customers. The CRSP municipal customers that are part of larger cities charge their end users less than that of surrounding towns. Usually, the retail price for towns like Bountiful and Murray, Utah, are lower than the price charged by the private electrical supplier in Salt Lake City.

Revenues earned from the sale of the power from Flaming Gorge Dam and other CRSP facilities are used to pay for construction, operation, and maintenance of the CRSP water storage units, among other repayment responsibilities associated with the CRSP and the participating projects. Western allocates long-term firm capacity and energy from the various Federal powerplants, including the Flaming Gorge facility, collectively referred to as the Salt Lake City Area Integrated Projects (SLCA/IP).

Western's power marketing responsibility, in most cases, begins at the switchyard of Federal hydroelectric power facilities and includes Federal transmission systems, while the hydroelectric plants are operated by Reclamation. Reclamation and Western work together on a daily basis in scheduling water releases. Western dispatches power generation at each facility to ensure compliance with minimum and maximum flow requirements and other constraints set by Reclamation in consultation with other Federal, State, and local entities.

Electric capacity and energy from SLCA/IP hydropower plants, along with power purchased by Western, is provided to Western's customers under contracts. Most power agreements are long-term firm contracts that specify the amounts of capacity and energy that Western agrees to offer for sale to its customers. These amounts constitute Western's commitment levels. Firm capacity and energy levels are guaranteed to the customer. If Western is unable to supply contracted amounts of firm capacity or energy from Reclamation hydroelectric resources, it must purchase the deficit from outside resources for delivery. Depending on the type of service offered, expense for this purchased power is either shared by all contractors and leads to a general increase in the overall rate or it is passed through to individual customers.

3.4.1 Hydropower Operations

Hydropower generation rises and falls instantaneously with the load (or demand)—a pattern called load following. The amount of load on the system is determined by how many electrical devices are using power. By comparison, coal- and nuclear-based resources are less efficient and have a relatively slow response time; consequently, they generally are not used for load following. At a hydropower facility, minimum and maximum water release levels determine the minimum and maximum power generation capability.

Ramping is the change in the water release from the reservoir to meet the electrical load. Both scheduled and unscheduled ramping are crucial in load following, ancillary services, emergency situations, and variations in real-time (what actually happens compared to what was scheduled) operations. North American Electric Reliability Council (NERC) and Western Electricity Coordinating Council operating criteria require Western and Reclamation to meet scheduled load changes by ramping the generators up or down beginning at 10 minutes before the hour and ending at 10 minutes after the hour.

As a control area operator, Western regulates the transmission system within a prescribed geographic area. Western is required to react to moment-by-moment changes in electrical demand within this area. Regulation means that "automatic generation control" will be used to adjust the power output of hydroelectric generators within a prescribed area in response to changes in the generation and transmission system to maintain the scheduled level of generation in accordance with prescribed NERC criteria.

Regulation depends on being able to ramp releases up or down quickly in response to system conditions. In addition, each utility is required to have sufficient generating capacity—in varying forms of readiness—to continue serving its customer load, even if the utility loses all or part of its own largest generating unit or largest capacity transmission line. This reserve capacity ensures electrical service reliability and an uninterrupted power supply. The Western Electricity Coordinating Council requires hydropower facilities to maintain 5-percent generation capacity in reserve; at Flaming Gorge, this would amount to about 7 MW (generated by a flow of about 260 cfs).

Generating capacity available that is in excess of the load on the system is called spinning reserve. "Spinning reserves" are used to quickly replace lost electrical generation resulting from a forced outage, such as the sudden loss of a major transmission line or generating unit. Additional generating units off line are also used to replace generation shortages, but they cannot replace lost generation capacity as quickly as spinning reserves.

3.5 AGRICULTURE

The highest agricultural use lands in the study area occur in Uintah County, south of Ouray and north of Green River. Uintah County, in the northeastern corner of Utah, covers about 4,477 square miles and has a total population of 25,926 people. Uintah County accounts for almost 5.5% of the total land area for the State of Utah (82,168 square miles) but only 1.1% of the total population (2000 Census of Population).

According to the 2000 Census of Population, urban dwellers (primarily in Vernal and Roosevelt) made up 45.9% of the county's population, with the remaining 54.1% of the total population being rural. The 1990 Census of Population showed that approximately 4% of the county's total population lived on farms within the county boundaries.

The number of farms in Utah has remained relatively stable from 1990 to 2000, at around 15,000 farms. Uintah County accounts for a little more than 5% of the total number of farms in the State.

3.5.1 Census of Agriculture Data

Census of Agriculture data for Uintah County, Utah, was available for 1997 and 1992. In 1997, there were 795 farms encompassing 2,268,090 acres of land, for an average farm size of 2,853 acres. The 1992 Census of Agriculture showed Uintah County as having 716 farms with an average farm size of 1,808 acres. The estimated, average market value of land and buildings for farmers in Uintah County rose from $206,510 in 1992 to $551,978 in 1997, a 167-percent gain in value.

In 1997, only about 39% of the farm residents in Uintah County listed farming as their principal occupation. The most common farm size in the county was between 10 and 49 acres. Total cropland in the county was 90,524 acres, of which 50% were in production. Idle croplands made up 5.5% of total cropland, and pastureland of all types totaled 2.1 million acres. Cropland in the county generally had a dual use, with about 76% of the total cropland acres being used for both grazing and the harvesting of a crop.

The 1997 agricultural census showed that 686 farms in Uintah County contained irrigated acreage. Total land for these 686 farms came to 2,225,467 acres of which 83,939 acres (3.8%) were irrigated. Irrigated cropland made up nearly 93% of the total harvested cropland in the county.

The primary crops produced in Uintah County included alfalfa and grass hay, barley, wheat, oats, corn grain, and corn silage. Wheat is primarily a dryland crop, with only 8% of wheat acres being irrigated. In contrast, acreage for hay and oat crops is about 95% under irrigation. Most of the barley acreage (74%) is irrigated with a small amount being dryland farmed.

3.5.2 Utah Agricultural Statistics

Information about the number of harvested acres of irrigated crops in Uintah County was obtained from the annual Utah Agricultural Statistics publication. This information source was also used for information about crop yields and price received. A 5-year average of the data was used to determine baseline crop acreage, yield, and price received.

Table 3-7 shows the irrigated crops produced in Uintah County from 1996 to 2000 and the number of acres of each harvested.

Hay is the most commonly produced crop in Uintah County, accounting for almost 87% of all the crops grown. More than 90% of all crop acres are accounted for if the corn silage acres are added to the hay acres. Alfalfa hay is clearly the dominant crop in the county with 71% of the total acreage for all the listed crops.

The next most commonly produced crop behind the hay crops (alfalfa and other hay) is corn silage, with an average of 2,100 acres. Barley more than doubled in acreage from 1996 to 1997 and has remained at that level. Corn grain showed a similar, smaller percentage increase in acreage over the same time. The number of acres planted in oats remained relatively constant over the 5-year timeframe.

Table 3-7.—Primary Crop Acreages for Uintah County, Utah, for 1996-2000

Crop	Acres Harvested					5-Year Average
	1996	1997	1998	1999	2000	
All Wheat	800	200	300	1,000	1,000	660
Corn Grain	700	1,000	1,400	1,000	1,100	1,040
Corn Silage	1,000	2,400	2,100	2,200	2,800	2,100
Oats	600	800	800	800	500	700
Barley	500	1,200	1,100	1,400	1,200	1,080
Other Hay	5,300	7,800	6,800	6,800	7,000	6,740
Alfalfa Hay	27,500	30,400	29,300	29,500	31,000	29,540
Total Number of Acres						41,860

Crop yields were also obtained for each of the above crops (table 3-8).

After obtaining the number of acres and yields for the crops grown in Uintah County, the price received for the crops was used to derive the total gross value of production. Prices received for the crops came from the Utah Agricultural Statistics and the U.S. Department of Agriculture (USDA) National Agricultural Statistics Service (table 3-9).

To derive the per acre gross income generated by the sale of a crop, the yield is multiplied by the price received. This product is then multiplied by the number of acres of that crop to calculate the total value of that crop to the county. Table 3-10 shows the per acre and total gross incomes for each of the crops listed in table 3-9.

3.6 Land Status and Use

Land within Flaming Gorge Reservoir is federally owned and consists primarily of Reclamation project lands acquired for the Flaming Gorge Unit of the CRSP. It is principally used for water storage. Land around Flaming Gorge Reservoir is federally owned public land, under the jurisdiction of the U.S. Department of Agriculture Forest Service (USDA Forest Service) and principally used for recreation.

Land ownership along the Green River downstream from Flaming Gorge Dam is a mixture of Federal, Indian trust, State, county, and private lands.

3.6.1 Flaming Gorge Dam and Reservoir

The reservoir lands and lands within the Flaming Gorge National Recreation Area (FGNRA) are under the jurisdiction of Reclamation and/or the USDA Forest Service. These federally owned lands have been withdrawn or acquired by fee or easement for the Flaming Gorge Unit of the CRSP. Their use is water storage, public outdoor recreation, and other purposes of the CRSP.

3.6.2 Green River Downstream From Flaming Gorge Dam

The lands along the Green River downstream from the dam have a variety of ownership and uses as outlined below. The river is divided into three reaches, as described in the following paragraphs.

Reach 1 begins just below the dam in the FGNRA, runs through Browns Park National Wildlife Refuge, and ends in the Dinosaur National Monument after traveling a distance of approximately 70 miles. The first 14 miles

Table 3-8.—Crop Yields for Uintah County, Utah, 1996-2000

Crop	Yield Unit	Crop Yield 1996	1997	1998	1999	2000	5-Year Average
All Wheat	Bushel	46	50	70	39	53	51.6
Corn Grain	Bushel	111	152	139	140	140	136.4
Corn Silage	Ton	23	21	19	20	17	20
Oats	Bushel	57	68	75	70	69	67.8
Barley	Bushel	98	92	88	74	64	83.2
Other Hay	Ton	3.6	4.1	4.2	4.1	3.4	3.9
Alfalfa Hay	Ton	3.8	4.5	4.5	4.5	3.7	4.2

Table 3-9.—Prices Received by Crop (1996-2000)
($)

Crop	Price Received 1996	1997	1998	1999	2000	5-Year Average
All Wheat	4.45	3.29	2.95	2.60	3.00	3.26
Corn Grain	3.80	3.05	2.45	2.36	2.50	2.83
Corn Silage	28.00	28.00	26.00	25.00	27.00	26.80
Oats	2.10	1.97	1.45	1.50	1.60	1.72
Barley	2.93	2.29	1.86	1.89	1.85	2.16
Other Hay	72.00	84.00	76.00	71.50	77.50	76.20
Alfalfa Hay	72.50	85.00	77.00	73.00	78.50	77.20

Table 3-10.—Average Annual Gross Income
for the Crops Grown in Uintah County
(1996-2000)

Crop	Acres	Yield	Price ($)	Gross Income Per Acre ($)	Total Value ($)
All Wheat	660	51.6	3.26	168.11	110,954.45
Corn Grain	1,040	136.4	2.83	386.28	401,736.19
Corn Silage	2,100	20	26.80	536.00	1,125,600.00
Oats	700	67.8	1.72	116.89	81,821.04
Barley	1,080	83.2	2.16	180.04	194,448.38
Alfalfa Hay	29,540	4.2	77.20	324.24	9,578,049.60
Other Hay	6,740	3.9	76.20	297.18	2,002,993.20
				Total Value	13,495,602.86

of this reach, located in the FGNRA, contains steep, wooded terrain and, therefore, is used mainly for limited recreational pursuits. Next, the river runs through Browns Park for approximately 16 miles. This land is more open with gentle slopes to the river and contains sage and scrub brush vegetation. The use here is mainly recreation consisting of camping, boating, and rafting. There are many unpaved access roads leading to camping spots and river access points for raft launching.

The river then enters Browns Park National Wildlife Refuge and meanders through many low wetland areas in the refuge for approximately 20 miles. Browns Park National Wildlife Refuge is managed by the U.S. Fish and Wildlife Service, and the land is used for wildlife mitigation. At this point, the river enters the Dinosaur National Monument managed by the National Park Service. This last 20 miles of Reach 1 consists mainly of a steep, rugged rock canyon called Lodore Canyon. Because of the rugged terrain, the area is a popular recreation site used for river rafting and camping.

Reach 2 begins at the confluence of the Green River and the Yampa River, in the middle of Dinosaur National Monument. After leaving the monument, the Green River flows through private lands, State of Utah lands, Federal lands managed by the Bureau of Land Management (BLM), Ouray National Wildlife Refuge, and Ute Indian tribal lands.

Within Dinosaur National Monument, the river flows through two steep, rock canyons (Whirlpool Canyon and Split Mountain Canyon) and one area with a wider river bottom and low lying meadows (Island Park and Rainbow Park). After leaving Dinosaur National Monument, the river runs through privately owned lands containing some areas of rolling hills and some low lying areas. Farms border the river corridor, mainly with pasture lands and range lands. Some development is beginning to appear in the historic flood plain areas, since the construction of Flaming Gorge Dam provides some flood control to these areas. Most of this development consists of agricultural sprinkler systems and basic farm and storage structures, although some development includes residential houses.

Next, the river flows past Stewart Lake Wildlife Refuge, managed by the State of Utah Division of Wildlife Resources, and private lands. In this area, some residential homes have been constructed in the historic flood plain or near the banks of the Green River. The river then runs through a stretch of Federal lands (managed by BLM), State of Utah lands, and private lands. These lands, in the vicinity of Horseshoe Bend, are used for public lands, agricultural development, and oil and gas development.

The last portion of Reach 2 brings the river through the following land ownerships: Ouray National Wildlife Refuge (managed by the U.S. Fish and Wildlife Service), Federal lands in trust for the Ute Indian Tribe, private lands, and BLM lands. These lands are used for wildlife mitigation, oil and gas exploration, and development and residential purposes.

There are four highway bridges crossing the Green River in Reach 2. The first bridge is on State Highway 149 and crosses the river approximately 6 miles southeast of the Dinosaur National Monument. The second bridge crosses the river on U.S. Highway 40 at Jensen, Utah. The third bridge is on State Highway 45 and crosses the Green River approximately 7 miles south of Naples, Utah. The fourth bridge crosses the river on State Highway 88 just south of Ouray, Utah.

Reach 3 begins at the confluence of the Green River and the White River. Land ownership includes some Ute Indian tribal lands; Federal, State, and county lands; and private lands. Land uses include agriculture, recreation, and oil and gas mining. Contained within this reach are the Canyonlands National Park and the Hill Creek Extension of the Uintah and Ouray Indian Reservation.

The land within Reach 3 is classified as "high desert," with elevations ranging from 3700 feet to 7200 feet above sea level. Much of the land immediately adjacent to the Green River is composed of vast sedimentary rock deposits which, over the years, have been deeply incised, creating deep canyons (particularly Desolation Canyon and Labyrinth Canyon). These rock deposits and deep canyons limit the use of the lands adjacent to the river and also limit the points of access to the river, therefore limiting the use of the river.

The areas immediately south of Ouray and north of Green River have the highest agricultural use within Reach 3. Predominant crops include corn, alfalfa, watermelon, and grain. Land use along the Green River is primarily determined by topography. Agricultural areas have a minimal slope and often abut dense riparian habitat along the river. A vast amount of Indian trust land, which is generally higher in elevation, is also used for oil and gas exploration. In these areas, there appears to be a general lack of vegetation and an abundance of collection/ distribution pipeline infrastructures running on the land surface, along with many dirt access roads.

3.7 ECOLOGICAL RESOURCES

This section describes the affected environment for plants and animals in and around the reservoir and the river. It includes information on threatened and endangered species and other special status species.

3.7.1 Flaming Gorge Dam and Reservoir

3.7.1.1 Aquatic Animals

The Flaming Gorge Reservoir fish community consists of the following nonnative species: lake trout (*Salvelinus namaycush),* brown trout (*Salmo trutta),* rainbow trout (*Oncorhynchus mykiss)*, cutthroat trout (*Oncorhynchus clarki),* kokanee salmon (*Oncorhynchus nerka),* white sucker (*Catostomus commersoni),* smallmouth bass (*Micropterus dolomieui),* channel catfish (*Ictalurus punctatus),* common carp (*Cyprinus carpio),*Utah chub (*Gila atraria*), redside shiner (*Richardsonius balteatus),* and the Bear Lake sculpin (*Cottus extensus).* It is also home to small numbers of the following native species: flannelmouth sucker (*Catostomus latipinnis),* mountain whitefish (*Prosopium williamsoni),* and the mottled sculpin (*Cottus bairdi).*

Since the reservoir was filled, rainbow trout have been annually stocked in Flaming Gorge Reservoir and provide the bulk of the harvest, as well as being the most sought-after species by anglers. Kokanee salmon and smallmouth bass were stocked during the mid 1960s and have since developed naturally reproducing fisheries. After rainbow trout, kokanee are typically second in harvest and popularity with anglers. Other sport fish occasionally stocked in the reservoir include brown trout and channel catfish.

Lake trout, which drifted into Flaming Gorge from the upper Green River drainage, have also become established as a wild population. Lake trout are managed as a trophy fishery in Flaming Gorge. Regulations are designed to keep lake trout numbers in balance with populations of kokanee salmon and Utah chubs, their primary prey.

Kokanee salmon concentrate in different locations in the reservoir every year, but consistent concentration areas include Cedar Springs, Jarvies Canyon, Hideout, Red Cliffs, Horseshoe Canyon, Pipeline, Wildhorse, Squaw Hollow, Lowe Canyon, and Big Bend. Flaming Gorge Reservoir provides important shoreline spawning habitat for kokanee salmon, and most recruitment of these fish comes from shoreline spawning; however, Kokanee can spawn at water depths up to 60 feet (Gipson and Hubert, 1993). Shoreline spawning habitat areas are located on the east shore of the reservoir, which has steep slopes (greater than 20 degrees), and abundant substrate of small (less than 4 inches) shale particles extending from the water's edge to depths of more than 60 feet (University of Wyoming, 1991). Kokanee are an important sport fish in the reservoir. As the fall spawning season approaches, mature kokanee concentrate or "stage" adjacent to these spawning areas.

Smallmouth bass are found in rocky shoreline habitat throughout Flaming Gorge Reservoir. A dense population dominated by smaller fish exists from the dam north to Linwood Bay. From the Antelope Flats area north, fewer but larger bass are found. Smallmouths in Flaming Gorge Reservoir feed almost exclusively on crayfish. They spawn from late May through early July and during this period mature fish move into shallow water 2 to 20 feet in depth (Sigler and Sigler, 1996). Smallmouth bass were introduced into Flaming Gorge Reservoir to promote growth of rainbow trout by reducing the Utah chub population (Tuescher and Luecke, 1996).

3.7.1.2 Aquatic Food Base

Prior to construction of the dam, the aquatic food base was comprised mostly of coarse organic material carried into the river from the drainage basin. That material is now deposited in Flaming Gorge Reservoir. Presently, benthic algae, phytoplankton, and zooplankton are at the base of the reservoir's food web. The reservoir traps nutrients like phosphorus and nitrogen as it traps incoming suspended sediments.

3.7.1.3 Vegetation

Shoreline vegetation along Flaming Gorge Reservoir consists mainly of pinion and juniper woodlands and sagebrush communities. Fluctuating water levels, steep gradient slopes, and loss of soil through erosion combine to severely limit vegetation establishment along the shoreline. Riparian and wetland vegetation associated with the reservoir is limited to mouths of tributaries and infrequent locations along the shoreline where lower gradient slope and fine soils that retain subsurface water connections are present. Most wetland vegetation is in the rush and sedge families, with occasional presence of native and nonnative grasses, willows (*Salix* sp.), cottonwoods (*Populus* sp.), and tamarisk (*Tamarix ramosissima*).

3.7.1.4 Terrestrial and Avian Animals

Several species of game mammals, including mule deer, elk, moose, pronghorn, and bighorn sheep, occur along the Green River corridor above and below Flaming Gorge Dam. All of these species use riparian habitats as foraging and watering areas but are not restricted to riparian areas at any time of the year. Mule deer, elk, and pronghorn range widely throughout this portion of Utah and Colorado but move toward the river in the fall and use the river valley, especially Browns Park, as wintering range. Mule deer occur along the river throughout the year and are the most abundant game mammal in the area. Moose numbers are low in the region but appear to be increasing (BLM, 1990). Within the area, moose habitat occurs in Browns Park (Schnurr, 1992).

3.7.2 Green River Downstream From Flaming Gorge Dam

3.7.2.1 Aquatic Animals Overview

Historically, the Green River in the area of Flaming Gorge was an unregulated, turbid, temperate stream that exhibited wide fluctuations in flow (2000 Flow and Temperature Recommendations). Water temperature ranged from near freezing to greater than 70 °F (21 °C) annually. The river supported 12 native fish species, including 4 that are now endangered: Colorado pikeminnow, humpback chub, bonytail, and razorback sucker. Several native species, including mountain whitefish

(*Prosopium williamsoni)*, mountain sucker (*Catostomus platyrhynchus),* mottled sculpin (*Cottus bairdi)*, and Colorado River cutthroat trout (*Oncorhynchus clarki pleuritcus)*, were likely only part-time residents in the Flaming Gorge area, preferring cooler water temperatures that were found farther upstream. The river warming that occurred naturally would have completely precluded their presence by the time the Green River reached its confluence with the Yampa River. From that confluence downstream, the remaining eight warm water species (the four endangered species plus the flannelmouth sucker (*Catostomus latipinnis)*, bluehead sucker (*Catostomus discobolus)*, roundtail chub (*Gila robusta)*, and speckled dace (*Rhinichthys osculus)* comprised the entire fish community. These species were historically found throughout the Green River and the lower reaches of its tributaries: the Yampa, White, Duchesne, Price, and San Rafael Rivers.

Earliest impacts to the Green River system came in two forms: alterations of the physical environment (channelization, diking, and pollution) and the introduction of nonnative species. The first major diversion structure placed in the main channel of the Green River was at Tusher Wash, near the town of Green River, Utah, in 1906 (Cavalli, 2000). Even considering similar diversion structures and larger storage projects on Green River tributaries, Tusher Wash Dam remained the only significant barrier to warm water fish movement and the most significant form of river regulation on the Green River until the construction of Flaming Gorge Dam.

By the early 1900s, nonnative fish populations—in particular, channel catfish (*Ictalurus punctatus*)—had become established in the main stem Colorado River. Since that time, either intentionally or otherwise, a total of 25 nonnative species representing 9 families has been introduced into the Green River and its tributaries. Nonnative fish now dominate the fish community of the entire Colorado River system and are believed to contribute to reductions in the distribution and abundance of native species through competition and predation (Carlson and Muth, 1989).

Completion of Flaming Gorge Dam in 1962 had profound effects on downstream conditions. Historic operations greatly altered the seasonal and daily flow and temperature patterns. These changes rendered sections of the Green River immediately downstream from the dam largely unsuitable for native fish. It also shifted the aquatic invertebrate community from one dominated by a diverse assemblage of warm water species (Holden and Crist, 1981) to species tolerant of cold, clear water (Vinson, 1998).

In 1962, a project to eradicate "coarse" fishes from the Flaming Gorge Reservoir basin and its tributaries was conducted to clear the way for the proposed trout sport fishery. The coarse fish referred to were the native Colorado River species. Effects of the project went beyond the intended scope (Miller, 1963; Dexter, 1965; Pearson et al., 1968) when detoxification of the fish toxicant (rotenone) failed and native fish were inadvertently killed downstream through Dinosaur National Monument (Holden, 1991). Followup reports conducted by the Wyoming Game and Fish Commission (Binns et al., 1964) indicated that razorback sucker and native chubs were collected near the dam site, but native fish populations were affected as much as 80 miles downstream.

Rainbow trout were first introduced to the Green River tailwater in 1963, and brown trout were introduced in 1965. The stocked fish survived, but growth rates were low due to cold dam releases (39 to 47 ºF [4 to 8 ºC]). Penstocks were modified in 1978 to raise release temperatures by withdrawal of water from higher reservoir depths (Holden and Crist, 1981), and growth rates of trout improved (Modde et al., 1991). Native fish also benefited from the warmer river. Within 6 months of the penstock modifications, Holden and Crist (1981) documented re-colonization and reproduction of both warm water native and nonnative fish in the Green River upstream of its confluence with the Yampa River. Adult Colorado pikeminnow and razorback sucker were observed, but no signs of successful reproduction were found.

The Upper Colorado River Endangered Fish Recovery Program (Recovery Program), established in 1987, promoted the early research that led to the flow and temperature recommendations identified in the 1992 Biological Opinion. In addition to identifying the flow needs of the endangered fish, the Recovery Program has directed effort at developing habitat, reducing nonnative species, reducing the impacts of sport fish and sport fishing, raising and stocking endangered species, and gaining public support for all these activities through an information and education program.

The Green River provides excellent habitat for the river otter. The State of Utah considers river otter a species of special concern due to declining populations and limited distribution. Reintroduction of river otter to the Green River drainage began in 1989 and 1990 with the release of 23 otters at sites below the dam (Utah Division of Wildlife Resources, 1992). Seventeen otters were released in Island and Rainbow Parks in Dinosaur National Monument in 1991 (Cranney and Day, 1993). Since then, otters have moved into the Flaming Gorge Reservoir and reaches of the river near Ouray, Utah. Fish (especially carp) make up most of this species' diet. Abandoned beaver dens, clusters of boulders, or rock crevices near the water's edge are used as shelters.

Beaver den mainly in the banks of the Green River and in wetlands created for waterfowl. These areas exist below the dam. Beaver are abundant in these areas and can affect woody plant species composition and coverage by their feeding habits. They can also negatively affect the operation of waterfowl management areas by their damming activities. Muskrat exist in abundance within the Green River below the dam.

Many species of waterbirds use the Green River below Flaming Gorge Dam. The Green River and waterfowl management areas adjacent to the river in Browns Park provide habitat for migration, breeding, nesting, and foraging activities of these birds.

3.7.2.2 Native Fish Species Overview

3.7.2.2.1 Colorado Pikeminnow – The Colorado pikeminnow was first included in the List of Endangered Species issued by the Office of Endangered Species on March 11, 1967, and subsequently received protection under the Endangered Species Act of 1973. Critical habitat was designated on March 21, 1994, and includes the entire Green River downstream from Reach 1. Threats to the species include streamflow regulation, habitat modification, competition with and predation by nonnative fish species, and pesticides and pollutants (U.S. Fish and Wildlife Service, 2002b).

This large, predatory fish is widely distributed throughout the Upper Colorado River Basin, and recent estimates of abundance indicate the population in the Green River subbasin is on the rise (McAda, 2002). Adult habitat includes deep, low velocity runs, pools, eddies, and seasonally flooded lowland habitats. Pikeminnow display fidelity to natal spawning areas, of which there are few in the Green River subbasin; one is located on the lower Yampa River, and one is located on the Green River in Gray Canyon. Pikeminnow migrate to those spawning areas during the spring, coinciding with the descending limb of the hydrograph as river temperatures warm in excess of 62 ºF (18 ºC). Spawning occurs after spring runoff at water temperatures typically between 64 and 73 ºF (18 and 23 ºC); however, there are accounts of spawning at cooler temperatures (61 ºF [16 ºC]) (Bestgen et al., 1998).

Although never visually observed due to high turbidity, researchers using radiotelemetry have determined that pikeminnow spawn over cobble-bottomed riffles (Tyus, 1990). These cobble bars are formed and maintained by various aspects of the spring peak and post-peak flows (Harvey et al., 1993). Eggs are adhesive and require a clean cobble surface for attachment (Hamman, 1981). Embryos incubate for 4-7 days, depending on river temperature; and larvae hatch and remain in the spawning substrates for an additional 6-7 days (Bestgen et al., 1998). Larvae then emerge from the substrate and are carried downstream to low velocity nursery habitats. Larvae produced in the lower Yampa River spawning bar are thought to mostly colonize backwaters between Jensen, Utah, and the Ouray National Wildlife Refuge. Larvae produced in Gray Canyon drift into habitats in Reach 3.

3.7.2.2.2 Humpback Chub – The humpback chub was first included in the List of Endangered Species issued by the Office of Endangered Species on March 11, 1967, and received protection as endangered under the Endangered Species Act of 1973. Critical habitat was designated on March 21, 1994, and included stretches of the Yampa, Colorado, and Green Rivers in the Upper Colorado River Basin. The canyon-bound reaches of the Green River between its confluence with the Yampa and Colorado Rivers (Reaches 2 and 3) were designated. Threats to the species include streamflow regulation, habitat modification, predation by nonnative fish species, parasitism, hybridization with other native chubs, and pesticides and pollutants (U.S. Fish and Wildlife Service, 2002c). This species is highly adapted to life in canyon environments. Adult habitat includes deep pools and shoreline eddies in the warmer portions of the main channel. Specific physical spawning requirements are less understood for this species than other native Colorado River fishes. Humpback chub do not display spawning migrations and appear to complete their life cycle within the confines of relatively short stretches of canyon bound river. Drift of humpback chub larvae is less extensive than for Colorado pikeminnow. Spawning coincides with the spring runoff and typically occurs very soon after the peak when main channel temperatures warm in excess of 62 ºF (17 ºC) (Chart and Lentsch, 1999; Tyus and Karp, 1989; Valdez and Clemmer, 1982). The majority of spawning occurs when temperatures range from 61 to 72 ºF (16 to 22 ºC) (U.S. Fish and Wildlife Service, 2002c). Young occupy warm, low velocity shoreline habitats but appear less specific in their nursery habitat selection than pikeminnow (Chart and Lentsch, 1999).

3.7.2.2.3 Razorback Sucker – The razorback sucker was federally listed as endangered on October 23, 1991, with critical habitat designated March 21, 1994. The entire Green River from its confluence with the Yampa River downstream to its confluence with the Colorado River (Reaches 2 and 3) was included in this designation. There is no critical habitat in Reach 1. Threats to the species include streamflow regulation, habitat modification, predation by nonnative fish species, and pesticides and pollutants (U.S. Fish and Wildlife Service, 2002d). It is found in warm water reaches of the Green River and the lower portions of its major tributaries. It occurs primarily in the low gradient reaches between the confluences of the Yampa and Duchesne Rivers in Reach 2. Adult habitat includes runs, pools, eddies, and seasonally flooded lowlands. Spawning occurs in April through June, as the river rises to its spring peak (McAda and Wydoski, 1980; Tyus, 1987; Modde and Wick, 1997; Muth et al., 1998). In recent years, spawning has occurred when average daily flows ranged between 2,754 and 22,000 cfs and temperatures ranged between 46 ºF (8 ºC) and 67 ºF (19 ºC). Razorback suckers spawn over coarse cobbles, and their eggs hatch in 6.5-12.5 days, dependent on water temperatures. Larval razorbacks are then transported downstream into off-channel nursery environments (tributary mouths, backwaters, and inundated flood plains) where quiet, warm water is found (Mueller, 1995; Paulin et al., 1989).

Declines in the abundance and distribution of razorback suckers in the Upper Colorado River Basin have been noted for decades (Wiltzius, 1978). Although there continues to be evidence of successful reproduction, the Green River population of wild razorback suckers continues to decline due to lack of sufficient recruitment and may soon be extirpated (Bestgen et al., 2002). Stocking efforts, which have been experimental in nature to date (Burdick, 2002), are scheduled to increase in the near future in an attempt to increase abundance.

3.7.2.2.4 Bonytail – The bonytail was listed as endangered under a final rule published on April 23, 1980. Critical habitat was designated on March 21, 1994, and includes Reaches 2 and 3 of the Green River. Threats to the species include streamflow regulation, habitat modification, predation by nonnative fish species, hybridization, and pesticides and pollutants (U.S. Fish and Wildlife Service, 2002a).

The bonytail was historically common to abundant in warm water reaches of larger rivers from Mexico to Wyoming, but it is now the rarest of the Colorado River endangered fishes. Life history requirements of the bonytail are poorly understood; it is considered adapted to main stem rivers where it has been observed in pools and eddies. As do other closely related fish species, bonytail probably spawn in the spring in rivers over rocky substrates. It has also been hypothesized that flooded bottomlands may provide important areas for growth and conditioning, particularly for the early life stages (U.S. Fish and Wildlife Service, 2002a).

3.7.2.2.5 Other Native Fish Species of Concern – Flannelmouth suckers are widespread in warm water reaches of larger river channels. Adults typically occupy pools and deeper runs, eddies, and shorelines and spawn in the spring prior to peak flows. Young flannelmouth suckers occupy low velocity shorelines or other seasonally flooded low velocity habitats.

Bluehead suckers are also widespread. They occur in a wider range of water temperatures, including cooler habitats than those occupied by flannelmouth sucker. The bluehead sucker is more of a fast water fish, occupying riffles or shallow runs over rocky substrates. It spawns in the spring at slightly warmer temperatures than flannelmouth suckers. Young bluehead suckers also occupy low velocity shorelines or seasonally flooded areas.

Roundtail chubs are less abundant in the Green River main stem than the native suckers but are more abundant in the smaller tributaries and in the upper reaches of the Green, White, and Colorado Rivers. Roundtail chubs are also commonly collected in the Yampa River, including its lower, canyon-bound portions (Haines and Modde, 2002). Adult habitat includes riffles, runs, pools, eddies, backwaters, and areas that provide a diversity of flows. Roundtail chubs spawn during the spring peak, typically on the descending limb as temperatures range between 62 and 70 °F (21 °C) (Chart and Lentsch, 1999). Young roundtail chubs occupy low velocity shoreline habitats.

McAda and Ryel (1999) report that in the Colorado River, larvae and young-of-the-year (YOY) of these native fishes were more abundant in years with high peak runoff than in years with low peak runoff. These three main channel dwelling species and their young likely provided the bulk of the Colorado pikeminnow diet prior to the establishment of nonnative species (Osmundson, 1999).

3.7.2.3 Reach 1

3.7.2.3.1 Aquatic Food Base – The main aquatic food base in the Green River downstream from Flaming Gorge Dam is the filamentous green alga *(Cladophora* sp*.)* and attached periphyton communities (Johnson et al., 1987) and a freshwater amphipod (*Hyallela* sp*.)* (U.S. Department of Energy, 1996). *Cladophora* serves as an indicator of productivity in the upper portion of the Green River. Algae and periphytic diatoms provide food for chironomids and amphipods, dominant invertebrates in the trout diet (Johnson et al., 1987; Modde et al., 1991). Macroinvertebrates are most abundant above the Yampa River confluence (Holden and Crist, 1981). In the tailwater and in canyons between the dam and Browns Park, large, stable substrates and clear, cold water support abundant growths of *Cladophora* and other attached algae (Holden and Crist, 1981; Gosse, 1982; Modde et al., 1991).

Low-gradient reaches within Browns Park lack *Cladophora* except where occasional rapids and riffles provide suitable hard substrates. Macroinvertebrates in these low-gradient reaches include chironomids, oligochaetes, mayfly larvae and biting midges, and sandflies (Annear, 1980; Holden and Crist, 1981; Grabowski and Hiebert, 1989). Productivity generally declines further downstream from the dam. This is likely due to increased turbidity and declining availability of nutrients like phosphorus and nitrogen.

In general, daily fluctuating flows in the river are detrimental to the food base of both native and nonnative fish and have a negative effect on algal production and abundance of aquatic invertebrates due to repeated drying and wetting of the shoreline zone. Production of *Cladophora* is lower within the fluctuating zone, and areas dewatered for greater than 12 hours do not sustain a *Cladophora*-based community.

Greater drift of macroinvertebrates occurs during fluctuating flows rather than during steady flows. Large floods can wash a great quantity of macroinvertebrates downstream. This could temporarily reduce the food base in the reaches of the river directly below the dam following a flood (Vinson, 1998).

The New Zealand mud snail (*Potamopyrgus antipodarum*) is a nonnative species that is rapidly spreading throughout the Western United States. This small snail has become extremely abundant in some ecosystems, reaching densities of 100,000 per square meter and comprising 95% of the invertebrate biomass. Trout eat the snails but may derive very limited nutritional value from them. The New Zealand mud snail has been recently detected in several river systems in Utah and was first found in the Green River below Flaming Gorge Dam in September 2001. Since that time, their distribution and abundances have increased, and this snail is currently found from the dam downstream to the State line. Their preferred habitat appears to be beds of rooted aquatic vegetation, particularly sego pondweed (*Potamogeton pectinatus*) (Vinson, 2004). Ultimate distributions, densities, and this invasive species' effect on the existing aquatic community remains uncertain.

3.7.2.3.2 Threatened and Endangered Fish –

3.7.2.3.2.1 Colorado Pikeminnow – Colorado pikeminnow historically occurred throughout Reach 1 and likely reproduced in or near Flaming Gorge Canyon (2000 Flow and Temperature Recommendations). Low velocity habitats found in Browns Park may have provided nursery habitat for larvae and other life stages. Juvenile and adult pikeminnow (greater than 400 millimeters total length) are currently found in Lodore Canyon during spring, summer, and fall. Ongoing telemetry efforts indicate that adult pikeminnow may also be spending the winter in Reach 1 (Kitcheyan, 2003). Pikeminnow abundance has increased since 1980 (Bestgen and Crist, 2000), and they are distributed as far upstream as Browns Park. Growth rates of pikeminnow in Lodore Canyon are high, presumably due to the abundance of forage (Bestgen and Crist, 2000). Although many of the native species currently found in Reach 1 successfully reproduce there (a positive response to penstock modifications and associated river warming), Colorado pikeminnow do not. Provided that suitable spawning habitat exists in Reach 1, further warming of the river would likely be necessary for pikeminnow to successfully reproduce.

3.7.2.3.2.2 Humpback Chub – The best available information suggests that prior to the construction of Flaming Gorge Dam, the upstream distribution of humpback chub in the Green River reached Flaming Gorge Canyon (Vanicek, 1967; Holden, 1991). Due to the fish eradication program of the 1960s, this species was eliminated from Reach 1. Primarily due to a combination of sub-optimal thermal regimes and this species' sedentary nature, humpback chub have not re-colonized Reach 1.

3.7.2.3.2.3 Razorback Sucker – Prior to construction of Flaming Gorge Dam, razorback suckers were found as far upstream as Green River, Wyoming (Jordan, 1891; Evermann and Rutter, 1895; Simon, 1946). This species was more common in the lower Green River and apparently rare upstream of the Yampa River confluence even before construction of Flaming Gorge Dam (Simon, 1946). Razorback suckers disappeared from the Green River upstream of the Yampa River confluence for a period following dam construction (Vanicek et al., 1970). Since penstock modification, razorback sucker adults have been collected in Reach 1 on several occasions, however always in very low numbers. Those collections have been confined in recent years to the lower portion of Lodore Canyon.

3.7.2.3.2.4 Bonytail – The last evidence of natural bonytail reproduction in the Upper Colorado River Basin was documented in the Green River of Dinosaur National Monument near Echo Park (the transition between Reaches 1 and 2 (Vanicek and Kramer, 1969). Since that time, collections of bonytail have been very rare throughout the Upper Colorado River Basin. Bonytail have not been collected during the three most recent fishery surveys conducted in the lower portions of Reach 1 (as summarized by Bestgen and Crist, 2000). Hatchery-produced bonytail have been stocked on an experimental basis (Chart and Cranney, 1993; Bedame and Hudson, 2003); and the Recovery Program intends to increase efforts in the near future. Since 2000, the State of Colorado has released 18,000 bonytail (approximately 4 inches in length) at Browns Park and 5,000 bonytail near the downstream terminus of Reach 1. Additional stocking is planned for the future. Future sampling efforts will be directed at determining the success of those releases.

3.7.2.3.3 Native Fish Species, Nonlisted – There are three common native species found in Reach 1 main channel habitats: the flannelmouth sucker, bluehead sucker, and roundtail chub. All three species were present in pre-dam and in all post-dam fisheries collections. Examination of two comparable data sets from the mid-1970s (Holden and Crist, 1981) and the mid-1990s (Bestgen and Crist, 2000) indicates that the distribution and relative abundance of flannelmouth and bluehead suckers in Lodore Canyon has changed very little, with the greatest abundances of both species found in the upper canyon. Although roundtail chub were not abundant in either study, Bestgen and Crist hypothesized that the population is declining. Possible explanations for such a decline included poor recruitment due to cooler than optimal water temperatures and a high abundance of brown trout and other predatory fish.

Although successful reproduction of these species seemed to be reduced in Reach 1 during that period of time between closure of the dam and penstock modification, Bestgen and Crist (2000) report that all three species currently reproduce there.

Perhaps of greatest concern regarding the native flannelmouth suckers in Reach 1 is the increasing incidence of their hybridization with nonnative white suckers. The white sucker is more suited to cool water temperatures, and its distribution declines in a downstream direction from the dam through Lodore Canyon. Hybridization is a chronic threat to the continued existence of the native sucker populations and appears to be increasing in several Upper Colorado River Basin locations (Bezzerides and Bestgen, 2002).

3.7.2.3.4 Nonnative Fish –

3.7.2.3.4.1 Cold Water Nonnatives (Trout) – The first known nonnative trout introduced to the Green River tailwater were 18,900 catchable-sized rainbow trout stocked in 1963, and brown trout were first stocked in 1965. Initial plants of Yellowstone and Snake River cutthroat trout occurred in 1967 and 1971, respectively, and brook trout were first stocked in the tailwater in 1970.

The Utah Division of Wildlife Resources currently manages the tailwater below the Flaming Gorge Dam with a combination of stocking and special regulations. Rainbow and cutthroat trout are stocked annually in the river between the dam and Little Hole, and some natural reproduction of these species occurs in this reach (Modde et al., 1991). Brown trout have not been stocked into the Green River for several years, and current populations are sustained through natural reproduction. Trout below the dam are in good physical condition.

The current management practice is to stock hatchery-reared rainbow trout about 7 inches long with the goal of having those fish reach 12 inches by end of year. Trout less than 12 inches at the end of a growing season are more likely to die during the winter than larger trout (Modde et al., 1991). Increased growth rate during the warmer period of the year increases the proportion of the trout population that survives the winter. Excessive activity during the winter can result in mortality if it causes energy reserves of individual trout to fall below critical levels. Since flow fluctuations force increased movements of trout, the potential for winter mortality increases with increasing fluctuations in flow.

Rainbow and brown trout are the co-dominant fish species from the dam to the State line. The trout fishery has been divided into three sections: the *A* section extends from the dam to Little Hole (7 miles), the *B* section from Little Hole to Taylor Flat (9.5 miles), and the *C* section from Taylor Flat to the Colorado/Utah State line (12.5 miles). The overwhelming majority of fishing occurs in the *A* section. Brown trout are present throughout Reach 1 and accounted for as much as 27% of the fish collected with electrofishing in portions of Lodore Canyon (Bestgen and Crist, 2000).

The portion of Reach 1 between Flaming Gorge Dam and Taylor Flat (16 river miles) provides the best habitat for trout in the Green River, and spawning occurs there for all species. The greatest density of redds (nests) occurs immediately below the dam and between Little Hole and Red Creek (Modde et al., 1991). Brown trout redds have been identified only downstream from Little Hole. Eddies are preferred by adult rainbow and cutthroat trout, although a variety of other habitats are used, and use changes seasonally and with changing flows. YOY trout typically inhabit shallow (less than 16 inches deep), near shore (within 2 meters of the shoreline) areas with low water velocity (less than 1 foot per second). The amount of habitat available for adult rainbow trout is strongly influenced by flow and, on the basis of field measurements, is maximized in the tailwaters at flows between 800 and 1,200 cfs (Modde et al., 1991). Research has demonstrated that the Green River tailwater contains limited juvenile habitat, particularly during high discharges (Johnson et al., 1987).

Whirling disease is the common name of the disorder caused by the parasite *Myxobolus cerebralis* that has been implicated in severe declines of some wild populations of rainbow trout in the Western United States during the 1990s. This disease has its most devastating effects on early life stages of trout. Whirling disease has not been detected in the Green River tailrace trout fishery but has recently been reported from the New Fork River, a tributary to the Green River downstream from Flaming Gorge Dam (State of Utah, Division of Wildlife Resources, letter, dated January 27, 2004). Whirling disease will likely show up in the tailrace fishery at some point in the future; but based on the State of Utah's management strategy (stocking 7-inch trout), its impact may not be as significant as in a wild trout fishery.

Fluctuating flows can result in low trout recruitment by several mechanisms. Potential spawning substrates can be reduced, eggs can be desiccated, fry can be stranded, and YOY trout can be forced from the narrow band of suitable shoreline habitat. This causes either direct mortality or increased energy expenditures and vulnerability to predation. Internal Utah Division of Wildlife Resources (UDWR) memos from November 1969 first documented the stranding and associated fish mortality due to rapid down-ramps at the dam (Brayton and Armstead, 1997). Incidents of stranding have typically occurred during emergency situations and not exclusively during spawning events. A September 1974 Interim Operating Criteria formalized the minimum flow ". . . for the foreseeable future and under normal conditions, a continuous flow of 800 cfs will be maintained as a minimum."

Trout fry are dependent on zooplankton as food. Adults feed on macroinvertebrates, decaying organic material, and fish. Brown trout tend to be more piscivorous than rainbow trout and can be significant predators on native species where they co-occur (Valdez and Hugentobler, 1993). A large portion of the diet of trout below the dam is composed of *Cladophora*, amphipods, and the other invertebrates supported by *Cladophora*. Within Reach 1, algae production is supported at all depths, because the high degree of water clarity allows sunlight to penetrate to the bottom in all areas.

Optimum temperature for growth of both rainbow and brown trout ranges from 50-61 °F (10-16 °C) (Hokanson et al., 1977; Stevenson, 1987; Brannon, 1999). When temperatures reach 68-72 ºF (20-22 °C), growth can become limited; at 77-79 ºF (25-26 °C), temperature can become lethal (Molony, 2001).

3.7.2.3.4.2 Warm Water Nonnatives (Large-Bodied: Common Carp, Channel Catfish, and Smallmouth Bass) – Common carp prefer sheltered areas with an abundance of aquatic vegetation in warm water lakes, reservoirs, and rivers. The adults are opportunistic feeders that are able to utilize any available food source (Sigler, 1958). Carp typically spawn in flooded vegetation during the months of May and June in temperate climates. Carp are tolerant of a wide range of temperatures, but production is highly correlated with the number of days greater than 68 ºF (20 °C) (Backiel and Stegman, 1968).

Adult carp are common throughout Reach 1. Although found in very low numbers near the dam, their numbers increase in a downstream direction. They comprised approximately 12% of the entire electrofishing catch in both the upper and lower portions of Lodore Canyon during 1994-1996 (Bestgen and Crist, 2000). A summary of fish collections in Reach 1 prior to closure of the dam (Gaufin et al., 1960) and during three post-dam surveys (Banks, 1964; Smith, 1966; Vanicek et al., 1970; Holden and Crist, 1981) indicates carp consistently reproduce in Reach 1.

Channel catfish prefer warmer water with a diversity of water velocities, depths, and structural features that provide cover and feeding areas. Channel catfish spawn in late spring and early summer (generally late May through mid-July) when temperatures reach about 70 ºF (21 °C) (Pflieger, 1975). The optimal temperature range for adult channel catfish growth is 79-84 ºF (26-29 °C) (Chen, 1976), and growth is poor at temperatures less than 70 ºF (21 °C) (Andrews and Stickney, 1972).

Distribution of channel catfish in rivers has generally been shown to depend on both size of fish and the season. Smaller-sized catfish in the San Juan River tend to prefer lower velocities and sand or silt substrates, which are found in the lower portions of that river (Gido and Propst, 1999). Channel catfish are predacious and have been implicated in the decline of native fishes throughout the Upper Colorado River Basin. Colorado pikeminnow are known to prey on channel catfish; however, this interaction can turn negative if the prey (catfish) becomes lodged in the throat of the predator (pikeminnow) (McAda, 1983). Researchers at a 1995 nonnative fish control workshop in Boulder, Colorado, identified channel catfish as the greatest nonnative fish threat to the endangered fish community.

In Reach 1, catfish have been found sporadically in electrofishing samples from throughout much of Lodore Canyon, with the greatest abundances reported in the lower portions of the canyon. Bestgen and Crist (2000) surmised that river warming associated with the lower and more stable base flows called for in the 1992 Biological Opinion could have resulted in their increased abundance in recent years. Channel catfish are not known to successfully reproduce in Reach 1. Therefore, this relatively recent increase in abundance in lower Lodore Canyon is likely because of immigration from Reach 2 or the Yampa River.

Smallmouth bass occur in Lodore Canyon and become more abundant further downstream. These fish are not native to the Green River and pose a threat to endangered fish species. They prey on native species, especially young. They also compete with native fish for food and cover. Smallmouth bass inhabit streams and rivers with gradients ranging from 4-25 feet per mile (Funk and Pflieger, 1975). The gradient through Lodore Canyon averages 15.3 feet per mile.

3.7.2.3.4.3 Warm Water Nonnatives (Small-Bodied Minnows: Red Shiner, Fathead Minnow, Sand Shiner, and Redside Shiner) – This group of minnows can attain an adult size of 1 inch in their first year and attain maximum sizes of only 2 to 3 inches throughout the course of their 2- to 3-year life span. They are all capable of spawning numerous times in a single spawning season, and each species has the potential to become extremely abundant. The redside shiner (*Richardsonius balteatus)* prefers cool water and is found in a variety of habitats. Red shiner (*Cyprinella lutrensis)*, fathead minnow (*Pimephales promelas)*, and sand shiner (*Notropis stramineus)* all prefer warmer water and low velocity habitats and are tolerant of high turbidities. They are commonly found in those habitats used by the young of native fish species.

Researchers studying the interactions of these nonnative minnows and young Colorado pikeminnow in controlled environments found negative impacts to pikeminnow from competition (Byers et al., 1994) and predation (Bestgen et al., 1997). Nesler (2002) hypothesized that, from a potential impact perspective, the relative abundance of these three species could pose more of a threat to native fish than nonnative game fish (largemouth bass [*Micropterus salmoides]*, green sunfish [*Lepomis cyanellus*], and catfishes) in the Colorado River in Colorado.

Analyzing 15 years of fall YOY fish sampling on the Colorado River, McAda and Ryel (1999) showed that catch rates of native species were negatively correlated with catch rates of red shiner, fathead minnow, and sand shiner and positively correlated with the catch of young Colorado pikeminnow. They also found that the relative abundance of these nonnative minnows was lower in years with high spring peak flows than it was in years with low spring peak flows (McAda and Ryel, 1999).

In the upper, canyon-bound stretches of Reach 1, which provide the premier trout habitat, this entire group of fish is poorly represented. Redside shiners and fathead minnows are very abundant in the Browns Park area, where shifting sandbars provide sheltered low velocity habitats during the low flow periods (Bestgen and Crist, 2000). Redside shiners become less abundant through upper and middle reaches of Lodore Canyon where suitable low velocity habitats are scarce and river temperatures are warm. Further downstream in Reach 2, summer water temperatures greatly reduce redside shiner abundance.

Displaying a greater preference for warmer water, red shiner and sand shiner were virtually absent from seine collection in the Browns Park area and in the upper and middle stretches of Lodore Canyon (Bestgen and Crist, 2000). However, in the lower reaches of Lodore Canyon (the lower boundary of Reach 1), the combination of warmer water and suitable habitats accounts for their increased abundance. Fathead minnow, red shiner, and sand shiner abundances increase downstream and dominate the fish community in low velocity habitats in Reaches 2 and 3.

Successful reproduction has been documented for all four species of nonnative minnows in Reach 1. However, based on the distribution of adults, red shiner and sand shiner reproduction is highest in the very lowest portions of the reach.

3.7.2.4 Reach 2

3.7.2.4.1 Aquatic Food Base – Gourley and Crowl (2002) described Green River productivity (food base) in Reach 2 over a 3-year period. Riverine productivity, as it directly relates to fish, was dominated by macroinvertebrates with the primary groups being Diptera (true flies, primarily midges) and Odonata (dragonflies). In addition to the dipterans, Ephemeroptera (mayflies), Trichoptera (caddisflies) and Plecoptera (stoneflies) became more abundant during the high flow periods. Zooplankton densities were always low in the main channel with the greatest densities found in backwaters (Grabowski and Hiebert, 1989).

On the flood plain, macroinvertebrates also became abundant seasonally (at times more abundant than in the main channel), and densities of zooplankton were much higher than those found in the main channel. Crowl et al. (2002) stressed the importance of maintaining the connection between the river and its flood plain in terms of overall food web structure and complexity. They stated that increased availability of both macroinvertebrates and zooplankton has repeatedly been shown to benefit fish growth by offering fish (particularly young fish) a variety of food types as their feeding preferences change.

3.7.2.4.2 Threatened and Endangered Fish – In Reach 2, except for Whirlpool and Split Mountain Canyons (the upper portion of the reach), fish sampling has been quite intensive in the more accessible low gradient, alluvial areas that account for approximately 82% of the 98.7 river miles in this reach. The Interagency Standardized Monitoring Program, which was initiated in 1986, was responsible for collections of juvenile and adult Colorado pikeminnow throughout this reach each spring and sampled all species in backwaters each fall from the mouth of Split Mountain Canyon (river mile 220) downstream through the remainder of Reach 2. The Flaming Gorge studies, which served as the basis for the 2000 Flow and Temperature Recommendations, sampled various aspects of the fish community throughout the Green River and are summarized in the 2000 Flow and Temperature Recommendations.

In more recent years, an intensive effort has been conducted to characterize the fish communities in both the inundated flood plain and the main channel. Birchell et al. (2002) focused their efforts in the Uinta Basin portion of Reach 2, sampling 12 flood plain sites and 42 contiguous river miles. The results of these long-term and intensive sampling efforts provide the basis for the following description of the affected environment.

3.7.2.4.2.1 Colorado Pikeminnow – Late juvenile and adult Colorado pikeminnow are more abundant in Reach 2 than the other two reaches of the Green River. Pikeminnow spawning has not been documented in Reach 2. Resident adults migrate either to the Yampa River spawning area about 16 miles above the Green River confluence or downstream into Reach 3 to the spawning area in Gray Canyon. Prior to spawning migrations, Colorado pikeminnow adults stage in the flooded habitats available in Reach 2.

The low gradient stretches of Reaches 2 and 3 provide nursery area for larval pikeminnow drifting downstream off the Yampa River spawning bars. As Green River flows decline from their spring peak, sandbars become exposed in the main channel. Low velocity pools or backwaters form around these sandbars and can persist throughout the base flow period if flows remain stable. These backwaters, abundant in the lower half of Reach 2, provide habitats for the young pikeminnow through their first year of life (Tyus and Haines, 1991). The summer densities of young pikeminnow have varied greatly from year to year (e.g., 0.25 fish per 100 cubic meters [m^3] sampled habitat in 1996 to as many as 177 fish per 100 m^3 in 1992). Trammell et al., (1999) intensively sampled these habitats in Reach 2 as part of the Recovery Program's Flaming Gorge Studies to better describe pikeminnow habitat and how flows create and maintain them (2000 Flow and Temperature Recommendations). This information factored heavily into both the peak and base flow components of the 2000 Flow and Temperature Recommendations.

3.7.2.4.2.2 Humpback Chub – Due to its affinity for the more isolated canyon bound reaches of river, it is not surprising that records of humpback chub in Reach 2 are sparse. A few humpback chubs have been reported from Whirlpool Canyon (Holden and Stalnaker, 1975; Karp and Tyus, 1990) and Split Mountain Canyons (Vanicek, 1967). However, other than some very occasional and opportunistic sampling, those canyons have not been sampled since the 1980s. The populations are not expected to be large, but their status remains relatively unknown.

3.7.2.4.2.3 Razorback Sucker – The population of razorbacks in Reach 2 has persisted longer than any other in the Upper Colorado River Basin. Unfortunately, this population is also in decline, and recent abundance estimates suggest the number of wild adults may have dwindled from 524 individuals reported 6 years earlier (Modde et al., 1996) to 100 (Bestgen et al., 2002). Concentrations of razorback sucker in spawning condition were located at two sites within or very near Reach 2: the mouth of the Yampa River (just upstream of the Green River confluence) and in the Green River adjacent to Escalante Ranch (river mile 302-313) (Tyus and Karp, 1990). Fish in spawning condition captured at those areas were found in runs of cobble, gravel, and sand substrates in water averaging 0.63 meter deep. More than 99% of the razorback sucker larvae collected in the middle Green River during spring and summer 1992-1996 (Muth et al., 1998) were from areas within or downstream from the Escalante Ranch. Bestgen et al. (2002) and Muth et al. (1998) provide a thorough description of flows and temperatures that coincide with razorback sucker spawning.

The occurrence of razorback sucker in the middle Green River coincides with the greatest expanse of flood plain habitat in the Upper Colorado River Basin. Historically, inundated flood plain habitats provided nursery areas for recently hatched larval razorback suckers. Tyus and Karp (1990) associated low recruitment with reductions in the availability of this habitat type since 1962 (dam construction), and Modde et al. (1996) linked increases of razorback sucker recruitment back to the high water years of 1983, 1984, and 1986. Flood plain habitats were shown to support much higher densities of zooplankton (larval razorback sucker food) than main channel habitats (Birchell et al., 2002). Modde and Irving (1998) demonstrated that most razorback sucker adults in the middle Green River moved into the flooded bottomlands soon after spawning. In Reach 2, the amount of flood plain inundation increases rapidly as flows exceed

18,600 cfs (2000 Flow and Temperature Recommendations). The timing of flood plain inundation may be of equal or greater importance than the amount and duration of the inundation and should be a factor of dam operations (Bestgen et al., 2002). Captures of larvae in Reach 2, 1997-1999, coincided only with the latter part of spring peak flows when flows were declining.

Flood plain habitats support large numbers of nonnative fish. In a recent study of these habitats in Reach 2, nonnatives comprised 99% of the total catch, which was attributed to the productivity found there (Birchell et al., 2002). Black bullhead, fathead minnow, and green sunfish dominated the flood plain nonnative fish community, which was attributed to their ability to use these habitats for reproduction. Negative interactions were expected between the nonnatives and native species (young razorback sucker in this case) in flood plain habitats, but researchers did not detect increases in riverine populations of nonnatives when the flood plain habitats drained naturally. It should be noted that populations of nonnatives in the main channel were very high prior to flood plain draining (Birchell et al., 2002). Efforts to increase the availability of flood plain habitats to benefit razorback sucker will have to account for the potential benefit to nonnatives as well.

3.7.2.4.2.4 Bonytail – In addition to the recent releases of hatchery-reared bonytail by the State of Colorado in Reach 1, there have been two experimental stockings in Reach 2. In a study to determine survival and habitat selection of hatchery reared adult bonytail, the State of Utah Division of Wildlife Resources radio-tagged and released 86 individuals in Island and Rainbow Parks in Dinosaur National Monument during 1988-1989 (Chart and Cranney, 1993). During the summer of 2002, the U.S. Fish and Wildlife Service and Utah Division of Wildlife Resources experimentally stocked several hundred thousand larval bonytail in an artificially flooded wetland along the Green River to determine survival rates in the face of nonnative competition and predation. Preliminary results indicate that some bonytail grew to 60 millimeters total length by July (Modde and Christopherson, 2003).

The Recovery Program intends to stock 5,330 hatchery-produced bonytail (greater than or equal to 200 millimeters total length) for 6 consecutive years to establish a target adult population of 4,400 adult bonytail in the middle Green River (Nesler et al., 2003). These targets are the first step in meeting criteria identified in the Bonytail Recovery Goals (U.S. Fish and Wildlife Service, 2002a).

3.7.2.4.3 Native Fish, Nonlisted – In addition to the four endangered species present in Reach 2, three other large-bodied native species are found there: the flannelmouth sucker, bluehead sucker, and roundtail chub. Flannelmouth sucker was the most abundant native fish collected in the main channel and in flood plain habitats during 1996-1999 (Birchell et al., 2002). Bluehead sucker was numerically the next most abundant species but was significantly less abundant than flannelmouth sucker and not significantly more abundant than the endangered Colorado pikeminnow. Roundtail chubs were very scarce in electrofishing samples.

Flannelmouth suckers were found to use the inundated flood plain; however, they vacated all flood plain habitats as the river dropped and the connection was lost. Although some native fish larvae were collected in flood plain habitats, the main channel appears to provide most of the nursery area for young native fish. On the Colorado River, McAda and Ryel (1999) looked at similar collection information and determined that larvae and YOY of native fishes were more abundant in years with high peak runoff than in years of low peaks. A greater understanding of the relationship between native species' reproductive success and flow and habitat in the Green River is needed.

3.7.2.4.4 Nonnative Fish –

3.7.2.4.4.1 Coldwater Nonnatives – Trout are virtually nonexistent in the main channel fish collections in Reach 2 and Reach 3. There is a very localized population of brown, rainbow, and cutthroat trout at the mouth of Jones Hole Creek, a 4-mile-long spring-fed tributary stream. Trout are abundant throughout Jones Hole Creek from Jones Hole National Fish Hatchery, located near the stream source, downstream from the Green River. The trout found in the Green River proper are an extension of the stream population taking advantage of the cool, clear tributary flows at the confluence.

Northern pike (*Esox lucius)* is classified as a coolwater species and has been collected primarily in the alluvial reaches of Reach 2 for many years. This species is similar in size and body shape to the Colorado pikeminnow and, like the pikeminnow, switches to an almost exclusive fish diet early in life. Northern pike in the Green River system apparently come from dispersal of a breeding population in the Yampa River in Colorado. Juvenile and adult pike have been found in increasing numbers throughout Reach 2 for many years. This predacious nonnative species prefers low flow areas in the spring (inundated flood plain or the mouths of tributaries/dry washes) and is known to spawn in these areas in the upper Yampa River. The Recovery Program has funded, and plans to continue to fund, specific efforts to control this species in the Yampa River in Colorado and in the Green River through the Uintah Basin of Utah.

3.7.2.4.4.2 Warm Water Nonnatives (Large-Bodied: Common Carp, Channel Catfish, and Smallmouth Bass) – In a 4-year study of the main channel and flood plain habitats throughout a 40-mile stretch of Reach 2, researchers used a variety of techniques to characterize the fish community (Birchell et al., 2002). Of 172,007 fish collected from main channel habitats, 169,473 (98.5%) were nonnative. Carp was typically the most abundant large-bodied fish collected in the main channel. Channel catfish were less abundant than large-bodied native fish (predominately native suckers), but they were collected in all areas every year.

In the flood plain habitats, in excess of a million fish were collected, with nonnative species accounting for over 99% of the total catch in most areas. Carp were collected in the flood plain but were often outnumbered by black bullhead and green sunfish. After 3 weeks of flood plain inundation, carp were found to reproduce in many of the habitats. Channel catfish did not appear to use the flood plain habitats to any great extent.

The relationship between these two abundant nonnative species and flows is not well understood. Carp will utilize flooded areas and will spawn there if the habitats persist for 3 weeks or longer. Channel catfish reproduction in canyon bound reaches may be negatively affected by high flow years, but the majority of the channel type through Reach 2 is broad and meandering.

Smallmouth bass occur throughout Reach 2. They are considered detrimental to native fish species.

3.7.2.4.4.3 Warm Water Nonnatives (Small-Bodied Minnows: Red Shiner, Fathead Minnow, Sand Shiner, and Redside Shiner) – In a 6-year study to characterize the use of low velocity habitats by young Colorado pikeminnow, Day et al. (1999) found the nonnative red shiner to be the most commonly collected species (occurring in 91% of the 945 samples). Red shiner was by far the most abundant species occupying these areas, which are the same habitats that young Colorado pikeminnow prefer during their first year of life. The second most abundant species was fathead minnow, occurring in 70% of the sites sampled, followed by sand shiner, which increased in abundance during the last 3 years of study. The nonnative species greatly outnumbered native fish in these important habitats every year. These data are consistent with less intensive, but more long-term, sampling conducted under the Interagency Standardized Monitoring Program since 1986.

During spring runoff, these small nonnative species proliferate in inundated flood plain habitats. Of the three, fathead minnow took the greatest advantage of flooded areas, often comprising greater than 50% of the total catch (often ranging from tens to hundreds of thousands) in a given habitat throughout the year. Within 3 weeks of connection to the main channel (i.e., nonnative invasion) nonnative minnows would begin to reproduce. As the riverflows receded, many of their larvae were flushed out to the main channel.

Although negative correlations between nonnative minnow densities and magnitude and duration of the spring runoff have been documented in some areas throughout the upper basin (McAda and Ryel, 1999), the relationship is confused in Reach 2, due primarily to the abundance of the flood plain habitat. Nevertheless, researchers in all areas observed that these nonnative minnows recovered quickly from any setback, whether from adverse environmental conditions or nonnative control efforts.

3.7.2.5 Reach 3

3.7.2.5.1 Aquatic Food Base – Specific investigations to describe primary (algae) and secondary productivity (aquatic insects) are lacking in Reach 3. The energy pathways described for the flood plain habitats in Reach 2 apply to similar habitats found in the very upper portions of Reach 3. The large, out-of-bank habitats that flood at flows above 18,600 cfs near Ouray, Utah, are generally lacking in the middle and lower portions of Reach 3. In Reach 3, as the river rises during the spring, it floods the mouths of tributaries and otherwise dry washes, which offer similar habitat and production as the flood plain on a much smaller scale. During the base flow period, main channel backwater habitats are presumed to be where most of the primary and secondary productivity occurs through the low gradient stretches of Reach 3—similar to the situation in Reach 2. Productivity increases in main channel areas where gradient and substrate size increase, which, in part, explains increased densities of fish in these areas. Cobble runs and riffles are found throughout the Desolation and Gray Canyon sections of Reach 3. In the lower 100 miles of the Green River, cobble bars are relatively scarce, found only at the mouths of side canyons.

3.7.2.5.2 Endangered Fish –

3.7.2.5.2.1 Colorado Pikeminnow – All life stages of Colorado pikeminnow are found in Reach 3. One of two Colorado pikeminnow spawning bars in the Green River subbasin is found in Gray Canyon in Reach 3. The other spawning location is on the Yampa River. Spawning was first documented on the Green River in the late 1980s (Tyus, 1990) near Three Fords Rapid in Gray Canyon. Since then, groups of fish in spawning condition have been collected as far as 5 miles upstream and downstream from that specific location (Chart and Lentsch, 2000), but spawning still seems centered on the Three Fords site. Harvey and Mussetter (1994) report that the spawning bars in Reach 3 are constructed at high flows, but the actual spawning habitat is created and cleansed following the peak flow when discharge ranges between 2,800 and 8,020 cfs. Adult pikeminnow have migrated as far as 180 miles, from both upstream and downstream in the Green River, and from the White River to spawn at this site in Reach 3 (summarized in Irving and Modde, 2000).

The lowermost 120 miles of the Green River typically support the greatest abundances of YOY pikeminnow found in the Green or Colorado subbasins (McAda and Rydel, 1999). Catch rates of YOY pikeminnow were greater than other reaches in 12 of the 14 years sampled, 1986-1999. Catch rates were greatest in 1988, when 5.6 YOY pikeminnow were collected per 10 square meters of sampled backwater habitat and lowest in 1997 when the catch rate dropped to 0.097. Reach 3 provides nursery habitat (backwaters) for larvae produced at the Gray Canyon spawning bar as well as those produced upstream at the Yampa River spawning bar. Backwater habitats in Reach 3 are formed by similar geomorphic processes, as described in Reach 2 (Rakowski and Schmidt, 1999) but are generally less abundant than in Reach 2. YOY pikeminnow also occupy low velocity habitats in Desolation and Gray Canyons. Three separate research efforts studying YOY pikeminnow backwater use in Reaches 2 and 3 found selection for larger, deeper, scour channel backwater habitats when they were available (Day et al., 1999; Day et al., 2000; Trammell et al., 1999). This information factored heavily in the development of the 2000 Flow and Temperature Recommendations.

Juvenile pikeminnow (ages 2-5; 100-350 millimeters) are also found in greater abundances in the lower portions of Reach 3 than farther upstream. Standardized monitoring (shoreline electrofishing) from 1986-2000 revealed that roughly 60% of the pikeminnow collected in Reach 3 were less than 400 millimeters in length, whereas only 10% collected in Reach 2 were that small (interpreted from graphs in McAda, 2002). Researchers have speculated that pikeminnow disperse upstream of the lower reaches of the Green and Colorado River (Osmundson et al., 1997) as they mature, which would account for this skewed size distribution (Tyus, 1991; McAda, 2002). Juvenile pikeminnow are collected in backwaters but are also found along quiet shoreline areas and other main channel habitats.

3.7.2.5.2.2 Humpback Chub – Reach 3 supports the greatest concentration of humpback chub in the Green River subbasin. The Desolation/Gray population was discovered by researchers in the late 1960s (Holden and Stalnaker, 1975). Monitoring to determine the distribution and relative abundance of this population of humpback chub, which also includes roundtail chubs and apparent hybrids of the two species, began in the 1980s. More recently, the Recovery Program has initiated a mark/recapture study to determine population size and how that relates to criteria outlined in the Humpback Chub Recovery Goals (U.S. Fish and Wildlife Service, 2002c). Those efforts have been hampered by low flows, and these data are preliminary at this time.

The humpback chub population in Desolation and Gray Canyons occupies 55 miles of river located roughly 210 river miles below Flaming Gorge Dam. Catch rates, which describe the number of fish collected in a net positioned in a quiet portion of the river for 1 hour, vary greatly from site to site within the canyon and have varied from year to year. Juvenile and adult chubs are most readily collected from main channel eddy and pool habitats. The Utah Division of Wildlife Resources reports an average humpback chub catch rate of 0.13 from 1993-2000 (i.e., it takes between 7 and 8 hours of netting to catch one humpback chub [derived from data provided in Utah Division of Wildlife Resources Recovery Program Project 22-C, *2000 Annual Report*]). For comparison, average catch rates in Westwater Canyon on the Colorado River for the same period of time averaged 0.33 (i.e., one might assume that humpback chub in Westwater Canyon are roughly 2.5 times as abundant as in Desolation and Gray Canyons). Conversely, catch rates in the lower Yampa River Canyon and in Cataract Canyon on the Colorado River are much lower than those reported for Desolation Canyon.

YOY chubs (both humpback and roundtail) were collected during two separate studies designed to better understand chub reproduction and recruitment in Desolation and Gray Canyons (Day et al. (2000) sampled backwaters during 1994-1996; Chart and Lentsch (2000) sampled a variety of habitats during 1992-1996). Day et al., (2000) found chubs in large and deep backwaters in Desolation Canyon. They also reported that increased turbidity was a characteristic of backwaters used by chubs. Although YOY were collected each year, survival through their first winter was not always documented. Competition and predation by abundant nonnative fishes (channel catfish in the main channel and nonnative minnows in the backwaters) may negatively impact survival of young chubs in Desolation and Gray Canyons (Chart and Lentsch, 2000). During the period of 1992-1996, YOY produced in 1993 (a high water year) were best represented in sampling as age 1+ fish the following year. During the same timeframe, survival of young channel catfish was low.

3.7.2.5.2.3 Razorback Sucker – As was mentioned in section 3.7.2.4.2.3, the abundance of wild razorback suckers throughout the Green River system is in decline. A total of 118 wild adult razorback suckers were collected during an intensive sampling effort throughout the Green River, 1996-1999. The overwhelming majority of those were collected in Reach 2 between the confluence of the White River and Split Mountain Canyon (Bestgen et al., 2002). Razorback sucker adults have been collected from Reach 3, but in very low numbers. Since 1980, only 19 wild adult razorbacks have been collected from Reach 3, including Desolation Canyon downstream to the confluence with the Colorado River (Chart et al., 1999). The last wild razorback collected in this area was captured in 1997 near the mouth of the San Rafael River, 97 miles upstream of the confluence with the Colorado River and 313 miles below Flaming Gorge Dam.

Although adult razorback suckers have been extremely rare in the lower river, larvae were present in samples every year from 1994-1999. The majority of those captures came from an area near the mouth of the San Rafael River. The presence of larvae at this location in multiple years and the relatively large size of larvae found there suggest that the San Rafael River may be an important rearing area for razorback suckers (Bestgen et al., 2002). During many years, larvae were present in Reach 3 prior to their appearance in Reach 2; this left researchers reasonably certain that those larvae captured in Reach 3 were produced there (Muth et al., 1998).

As mentioned in the Reach 2 discussion, based on the timing of razorback sucker spawning, inundated flood plain habitats likely provided important warm, food-rich areas for larvae. Equally important as the magnitude and duration of the flows is the timing of the flows. In Reach 3, larval razorback collections (spawning time) coincide with peak or pre-peak spring flows that allow the larvae to fully utilize the inundated habitats. However, low velocity habitats at any time of the year are also havens for nonnative fish. In Reach 3, the predominant nonnative predators/competitors are channel catfish and nonnative minnows. The Recovery Program has experimented with mechanical control of these species in Reach 3 with limited or no apparent success to date (Bedame, 2002; Meismer and Trammell, 2002).

3.7.2.5.2.4 Bonytail – The only wild bonytail collected in Reach 3 was reported by Tyus et al. (1987) from U.S. Fish and Wildlife Service collections in Gray Canyon, 1982-1985. The Recovery Program and the State of Utah began stocking bonytail in the lower Green River near the town of Green River, Utah, in 1999 (Bedame and Hudson, 2003). The Recovery Program's Integrated Stocking Plan (Nesler et al., 2003) calls for stocking levels to achieve Recovery Goal criteria. As stipulated in the Bonytail Recovery Goal (U.S. Fish and Wildlife Service, 2002a), populations of 4,400 adult bonytail are required in the middle Green and Colorado Rivers. A redundant population (a third population of 4,400 adults) is required in Reach 3 as insurance against a catastrophic event in one of the other recovery areas. To achieve the target and maintain it for several years, the Recovery Program intends to stock 5,330 bonytails (greater than or equal to 200 millimeters total length) for 6 years.

3.7.2.5.3 Native Fish, Nonlisted – Flannelmouth sucker, bluehead sucker, roundtail chub, and speckled dace are found throughout Reach 3. The greatest amount of native fish community data is from Desolation and Gray Canyons; data were collected while monitoring the population of humpback chub (summarized in Chart and Lentsch, 2000). Fish community information from main channel habitats downstream from Desolation and Gray Canyons is more spotty, collected by various researchers (Cavalli, 2000; Chart et al., 1999; Valdez, 1990). These studies serve as the basis for the description of the main channel fish community (native and nonnative) in Reach 3.

In Desolation and Gray Canyons (1989-1996), flannelmouth and bluehead sucker comprised approximately 20-30% of the large-bodied fishes collected in main channel habitats. Flannelmouth sucker were typically more abundant than blueheads. Bluehead sucker prefer swift flowing habitats with large substrates, which are abundant in these canyons, but they also prefer cooler temperatures and are typically more abundant in the upper reaches of the river. Collections of juvenile sized suckers (ages 1-3) varied greatly from year to year and were either low or lacking throughout the study period. However, a group of age 1 native suckers (spawned the previous year) were relatively abundant in 1994; 1993 was one of the higher flow years studied (peak flow of 25,400 cfs, recorded on May 31).

Roundtail chub were collected throughout Desolation and Gray Canyons. The relationships discussed between flow and humpback chub reproductive success apply to this species as well.

Downstream from Desolation and Gray Canyons, the river gradient drops, cobble bars become less abundant, and substrate shifts to sand as the river flows to the confluence with the Colorado River. Through this stretch, numbers of large-bodied fish in the main channel generally decline, presumably due to the reduction in productivity associated with sand substrates and high turbidity. Flannelmouth sucker is still the most commonly collected native fish in the main channel and is similar in abundance to nonnative carp and catfish. Bluehead sucker become rare in this portion of Reach 3, and roundtail chub are virtually nonexistent.

Native species comprise as much as 70% of the catch in deeper habitats of the San Rafael and Price Rivers, tributaries to the Green River in Reach 3 (Tyus and Saunders, 2001). Based on the species composition and habitat availability found in these smaller river systems, it is assumed that a significant amount of native fish reproduction occurs there. That production may, in turn, contribute to populations in the Green River main channel; however, specific data on reproductive success in these tributaries are not available to substantiate this link. In their status review of flannelmouth sucker, bluehead sucker, and roundtail chub, Bezzerides and Bestgen (2002) report that these species currently occupy only 45%, 50%, and 45% of their historical range in the Colorado River Basin, respectively. Much of that loss of range has occurred in tributaries to the Green, San Juan, and Colorado Rivers.

3.7.2.5.4 Nonnative Fish –

3.7.2.5.4.1 Cold Water Nonnatives – Trout are not found in any portion of the Green River in Reach 3 because summer temperatures are too warm. Northern pike and walleye have been collected in relatively low numbers compared to other locations in the subbasin. However, preliminary data collected in the past few years suggests that walleye are increasing in Reach 3 (Hudson, 2003). Northern pike and walleye are more commonly found in northern climes, native to rivers and lakes in Canada, though they are also found as far south as the northern portions of Alabama and Georgia. Both species spawn earlier in the spring than any of the native Colorado River species. Main channel summer maximum temperatures in Reach 2 and 3 likely become stressful for these species, but not likely lethal. The Recovery Program is currently funding efforts to control these species in upstream reaches (in Reach 2, the Duchesne River, and in the Yampa River), the likely sources of these predacious nonnative species.

3.7.2.5.4.2 Warm Water Nonnatives (Large-Bodied: Carp, Channel Catfish, and Smallmouth Bass) – Carp, channel catfish, and smallmouth bass are found throughout Reach 3. In Desolation and Gray Canyons, channel catfish were the most commonly collected species while netting and electrofishing main channel habitats, 1989-1996 (Chart and Lentsch, 2000). Channel catfish were nearly twice as abundant as native chubs. Whereas data suggests that native fish reproduction in Desolation and Gray Canyons was positively correlated with spring flow, there was some indication that channel catfish reproduction was negatively impacted during the higher flow years. Carp were also abundant during that study, with similar catch rates as native chubs. YOY and juvenile carp were not collected in large enough numbers to determine relationships with flow. Channel catfish have experienced summer die-offs in Desolation and Gray Canyons during extremely low flow years. The most recent such event occurred when Green River flows dropped below 1,000 cfs during the summer of 2002 (Hudson, message posted to Recovery Program listserver, 2002). Catfish die offs appear to be linked with the occurrence of summer storms, which result in a large pulse of sediment into an extremely warm river.

In the lower 50 miles of Reach 3, Valdez (1990) found carp and catfish the dominant species in main channel habitat sampled with electrofishing (1987 and 1988) and with nets in 1988.

The Recovery Program is currently funding efforts to remove channel catfish and smallmouth bass in Desolation and Gray Canyons. The purpose of those efforts is to reduce the perceived negative impacts this predacious nonnative species is having on humpback chubs.

3.7.2.5.4.3 Warm Water Nonnatives (Small-Bodied: Red Shiners, Sand Shiners, and Fathead Minnows) – Three nonnative species–red shiner, sand shiner, and fathead minnow–dominate the fish community in low velocity habitats throughout Reach 3. Day et al. (2000) reported negative correlations between red shiner and fathead minnow catch per unit effort in Desolation and Gray Canyons. In other words, although these species remained relatively abundant from year to year, their numbers were reduced in the higher flow years. Similarly, Trammel and Chart (1999) reported that backwater habitat availability and nonnative shiner and minnow densities in Reach 3 were lower in years with moderate to high spring peaks.

In portions of Reach 3 (Desolation and Gray Canyons, for example) densities of native fish, including chubs and pikeminnow, were also negatively correlated with the same aspects of the spring hydrograph that reduced nonnative species (Day et al., 2000). Flow manipulation alone may not be sufficient to control these nonnative species (McAda and Kaeding, 1989).

The Recovery Program has funded studies to determine the feasibility of mechanically controlling nonnative minnows in the lower Green and Colorado Rivers. Unfortunately, results of those studies did not show a measurable, lasting reduction in the densities of those species. At a recent workshop of the Recovery Program, participants were unable to identify alternative approaches to potentially improve the success of reducing these species through mechanical control (Upper Colorado River Endangered Fish Recovery Program, 2002).

3.7.2.6 Vegetation

Vegetation found along the Green River and affected by riverflows is classified as riparian and wetland vegetation. Wetlands are areas that are saturated or inundated by surface or subsurface water for at least a few weeks of the year and that support vegetation adapted to this saturated condition. Riverine wetlands occur along rivers or moving bodies of water and generally receive seasonal pulses of floodwaters that contribute to the saturated condition. The riparian zone is a transition zone between water and upland and is composed of plant species that are usually more robust than their upland counterparts and/or are composed of different species than those of adjacent areas.

Because much of the Western United States is arid, riparian zones provide the moisture and nutrients to support a greater variety of vegetation than upland areas that, in turn, support a greater diversity of wildlife. In addition to providing habitat for 75-80% of Utah's wildlife, riparian zones are important for their role in water quality improvement, flood control, recreation, and ground water recharge and discharge.

The riparian zone of the Green River changes character as the river alternately meanders through bedrock confined canyons and broad valleys. Narrow canyon reaches such as Red Canyon, Lodore, Whirlpool, and lower Labyrinth Canyon provide only limited opportunities for plant growth; yet plant communities are complex due to the diverse environmental gradients between surface types (pools, eddies, gravel bars). The wider alluvial, unconfined reaches of Browns Park, Island Park, and Ouray historically were composed of expansive and highly productive riparian plant communities. Intermediate to the above reach types are the confined alluvial reaches such as Echo Park, Grays, Desolation, and Stillwater Canyons. These areas, while still confined within a limited width of valley floor, historically also allowed for development of complex riparian zones.

The floodflows of the pre-dam period played a major role in defining species composition and location. These historic floods scoured away existing vegetation and deposited fine sediment. These actions provided the proper conditions for seedling establishment of woody riparian vegetation, namely Fremont cottonwood (*Populus deltoides* subsp. *wislizenii)* and coyote willow (*Salix exigua*). A range of vegetation responses has occurred since closure of Flaming Gorge Dam. These responses vary depending on river reach, sediment, and flow contributions from tributaries, moisture content of substrate, elevation above river, and responses during extreme drought and wet years.

Fremont cottonwood is the dominant tree species along the wide alluvial sections of the Green River, while box elder (*Acer negundo*) is the dominant tree of the canyon reaches. Both species are flood dependent. Successful establishment of cottonwood communities depends on spring peak flows and associated overbank flooding timed to correspond with seed dispersal. Under current flow regimes, the floodflows necessary to scour away existing vegetation and deposit fine loamy sediment needed for new seedbeds rarely occur.

Under post-dam conditions, stage change is small, and many newly established cottonwood seedlings, restricted to the river margin, have little prospect of long-term survival. Their location makes them susceptible to both prolonged inundation and scour from high flows and ice. If seedlings do establish at the few protected sites, they face competition from both woody and herbaceous nonnative plants that have now invaded the Green River corridor. Invasive plants, such as tamarisk (*Tamarix ramosissima, T. chinenis,* or hybrid of the two), giant whitetop, or perennial pepperweed (*Cardaria draba*), and sweet clover (*Melilotus* sp.) colonize the same opens sites necessary for cottonwood seed germination and seedling survival. Competition for water appears to be a key factor related to cottonwood survival. When water is scarce, cottonwood seedlings suffer greater stress than neighboring tamarisk and other invasive species (Cooper et al., 1999).

The presence of tamarisk is important to note due to its contributions to channel narrowing and stabilization, soil salinity, and displacement of native riparian vegetation with accompanying reduction in biodiversity. This invasive shrub flowers and produces seeds throughout summer and into fall. Tamarisk can rapidly colonize bare, moist soils and, once established, can tolerate a range of environmental conditions.

Tamarisk invasion along the lower Green River was underway by the 1920s. Prior to dam closure, tamarisk establishment occurred in a relatively wide range of locations and elevations within the flood plain. River regulation has reduced the range of elevations suitable for establishment but has increased the availability of suitable habitat (Larson, 2004). River regulation has provided optimum establishment opportunities, especially when peak flows occur later in the summer, benefiting tamarisk over cottonwood seed germination. In canyon reaches, post-dam tamarisk establishment is prevalent on gravel bars and debris fans (Larson, 2004; Birken, 2004; Cooper et al., 2003). Under river regulation, large floods generally occur too infrequently to prevent tamarisk seedlings from reaching the age where they become highly resistant to removal by floodflows.

Russian olive (*Elaeagnus angustifolia*) is another invasive plant of concern along alluvial reaches of the Green River. Relative to willow and cottonwood, it is drought and shade tolerant at both the seedling and adult stages. Russian olive does not depend on spring flooding and disturbed soils for establishment. Due to these characteristics, it can become the dominant climax community and prevent establishment of native vegetation, especially cottonwoods (Shafroth et al., 1995).

A description of the riparian communities of the three reaches and related environments follows.

3.7.2.6.1 Reach 1 – Reach 1 is most dependent on flows from Flaming Gorge for its riparian and wetland vegetation makeup. Many species found in Reach 1 were not present pre-Flaming Gorge Dam and are not present today on similar reaches of the nearby Yampa River (Cooper, 1999). After dam closure, the riparian zone was no longer subject to high spring floodflows and low summer/fall base flows. The new, more stable flow regime led to a shift in plant community composition and location.

The zone closest to the river's edge is now composed of marsh type plants—those that can tolerate long periods of root saturation. This post-dam flood plain (Grams and Schmidt, 2002) is inundated on an almost annual basis, sometimes in 8-week stretches, by the powerplant releases of 4,600 cfs. Canyon reaches and the upper portion of Browns Park have an almost continuous narrow band of wetland plants that have established along the river's edge. Plants in the sedge and rush families dominate this zone, particularly spike rush (*Eleocharis palustris*), with coyote willow (*Salix exigua*), cattail (*Typha latifloia* and *T. angustifolia*), bulrush (*Scirpus* sp.), common reed (*Phragmites australis*), and tamarisk also present.

In the wide alluvial valley of lower Browns Park, low elevation islands are vegetated by coyote willow, spike rush, bulrush, and other marsh species. Islands are one of the few areas in this reach where expansion of wetland and riparian vegetation is occurring (Merritt and Cooper, 2000). Most of this expansion is in a downstream direction; there has been little vertical accretion of sediment. Thus, island soils are saturated by shallow ground water for most of the year, providing favorable conditions for marsh plants but precluding riparian forest species such as cottonwood.

At elevations just above this post-dam flood plain is a zone that is only rarely flooded under post-dam conditions. Inundation of this intermediate bench surface (Grams and Schmidt, 2002) generally begins above flows of 4,600 cfs. Several surface types are associated with this zone, and each surface type tends to have a distinct plant community. Tamarisk, coyote willow, and the giant whitetop are found on debris fans, islands, and cobble bars. The nonnative grass, redtop (*Agrostis stolonifera*), characterizes eddy and pool bars.

In Lodore Canyon, tamarisk invasion is especially prevalent on many debris fans. Under river regulation, decreased flood magnitudes and the formation of inset flood plains has limited tamarisk's establishment to a narrow elevation zone. This zone tends to be densely covered with tamarisk. Larson (2004) found that the majority of tamarisk in both Lodore Canyon and Yampa Canyon are located on deposits inundated less frequently than the 2-year flood (the intermediate bench surface in Lodore). Larson also found that tamarisk do not appear to establish at most base flow elevations due to the ability of even small floodflows to remove them.

Without the power of large spring flows to remove or prevent establishment of most vegetation in the active flood zone, island and mainland cobble bars are filling in with vegetation, and side channels are connecting islands to mainland. The threatened Ute ladies'-tresses orchid falls within the intermediate bench zone and the lower post-dam flood plain and is found on vegetated cobble bars in Red and Lodore Canyons and Browns Park (see section 4.7.8.2 for a full discussion of effects).

Lower Browns Park is composed of high, straight riverbanks with the post-dam flood plain inserted below these banks. Appropriate elevations and locations for cottonwood establishment are now occupied by the nonnative plants whitetop, tamarisk, sweet clover, and Canada thistle (*Cirsium arvense*), and the native scouring rush (*Equisetum* sp.) and occasional coyote willow. These areas do not receive the scouring effect of large floodflows; thus, there is little opportunity for cottonwood establishment.

The old high water terrace, a pre-dam feature found at higher elevations, is an area that, in Reach 1, does not receive floodflows in the current post-dam setting. Conifers and box elder are common in the canyon reaches with Fremont cottonwood common on the meandering wider valley reaches. Common understory species of both canyon and wider valley reaches are mostly composed of upland and desert shrub type plants: sagebrush, rabbitbrush (*Chrysothamnus nauseosa),* greasewood (*Sarcobatus vermiculatus*), desert grasses, and aster. This desert plant community is atypical of unregulated rivers of the arid and semiarid West.

In lower Browns Park, the old high water zone sits high above nearly vertical banks that line both sides of the river and prevent overbank flooding even during the infrequent post-dam high flood years. Older stands of Fremont cottonwood forests are prevalent, having become established during floodflows of the pre-dam era. Comparative studies along the Yampa River indicate that these Browns Park cottonwood forests are in various stages of premature decay. With the loss of the historical floodflows, the cottonwoods have lost their fine root system, leaving main taproots as the only means of supplying water (Williams, 2000).

There is very little successful cottonwood regeneration occurring in lower Browns Park due to a lack of unvegetated sites that provide the proper moisture, yet protection from ice and scouring high flows. The existing cottonwood community is not replacing itself and, instead, is being replaced by the nonnative tamarisk or native desert species. There has been little cottonwood establishment in Reach 1 since 1962.

3.7.2.6.2 Reach 2 – The Yampa River tempers the effects of river regulation on the riparian zone of Reach 2. As in Reach 1, there is the presence of a distinct post-dam flood plain with corresponding wetland plants. The addition of unregulated flows from the Yampa River creates greater stage changes, thereby limiting true wet meadow communities that proliferate under more stable flows.

In Whirlpool and Split Mountain Canyons, plant communities with more similarities to the Yampa River Canyon than Lodore Canyon of Reach 1 dominate the herbaceous riparian vegetation. Herbaceous communities characterized by prairie cordgrass (*Spartina pectinata)* and the sedge *(Carex emory)* are typical of the Yampa Canyon and Green River canyons of Reach 2 but are absent in Reach 1. In Lodore Canyon, the most characteristic community is dominated by redtop grass, yet this community is absent in the canyons of Reach 2. Inundation of the post-dam flood plain surfaces of Reach 2 begins at about 16,000 cfs, which is the post-dam 2-year flood.

The intermediate bench, which is only occasionally flooded in the post-dam era, is generally inundated by flows greater than 21,000 cfs. In the alluvial valley of Island Park, soil deposition is occurring in abandoned channels and oxbows, providing opportunities for cottonwood establishment. During the wetter years of 1984-1986, successful cottonwood establishment was prevalent. Old (100-year plus) cottonwoods are sparse and are located on a high terrace that sits 13-15.5 feet above base flow stage. Like Browns Park, the understory vegetation of this terrace is composed of desert shrub species (i.e., big sagebrush (*A. tridentata*) greasewood, rabbitbrush, and desert grasses). Islands range from unvegetated to densely vegetated with coyote willow and young tamarisk.

Further downriver in the wide alluvial valley of the Ouray area, the intermediate bench is heavily vegetated with tamarisk, Russian olive, and three-leaf sumac (*Rhus aromatica*) with an understory of herbaceous vegetation dominated by grasses and poverty weed (*Iva axillaris*). Side channels with silt-clay substrates that occasionally receive floodflows are currently providing seedling beds for tamarisk and Russian olive.

In the Ouray area of Reach 2, there are occasional bands of young cottonwoods that likely established with the 1983-86 floods. Other than populations within Dinosaur National Monument, this is the only age group of cottonwoods that appears to have established in Reach 2 since closure of Flaming Gorge Dam. Tamarisk established throughout the upper Green River well before river regulation (Allred and Schmidt, 1999; Birken, 2004). Following dam closure, this invasive species took quick advantage of the additional establishment opportunities that came about with the lack of scouring floodflows. This change allowed vegetation to expand further down the riverbanks, contributing to accretion and channel narrowing.

3.7.2.6.3 Reach 3 – The upper portion of Reach 3 is a continuation of the wide alluvial flood plain forests as described for Reach 2.

Throughout Reach 3, at least two distinct topographic surfaces now exist in the area of bank accretion. An intermediate elevation surface is densely vegetated with tamarisk and Russian olive, and one low elevation surface that includes one to two natural levees is densely covered with willows (Allred and Schmidt, 1999; Cooper, 1999).

In Gray Canyon, large-scale cottonwood establishment currently occurs on gravel bars. This establishment surface is a different landform than that historically occupied by cottonwood (Cooper, 1999). Cooper found that, since dam closure, cottonwoods established only in 1983 on higher Gray Canyon flood plain surfaces. The high flow years of 1984-1986 likely provided the needed moisture to insure seedling survival at these higher surfaces.

Throughout Labyrinth and Stillwater Canyons, there are ancient lakes behind the levees in all bottoms. These lakes have laminated clay soils and are surrounded by tamarisk and cottonwood but used to function as reservoirs and perhaps marshes in the years of big flows, likely prior to the 1930s (Cooper, 2002). The active flood plain is dominated by a dense thicket of sandbar willow and young tamarisk on the banks.

Thick bands of 40+ year-old tamarisk proliferate just above the active flood plain; and, in the old high water zone, stands of greasewood, three-leaf sumac, desert olive (*Forestiera* sp.), and herbaceous vegetation dominate. High terraces with 100- to 300-year-old cottonwoods are present throughout**.**

3.7.2.7 Terrestrial and Avian Animals

3.7.2.7.1 Reach 1 – Thick growth and the variety of plant species in the riparian zone provide a structural diversity that makes the Green River corridor some of the most important wildlife habitat in the region. Wider and more extensive riparian zones provide habitat for a larger and more diverse wildlife and avian community. Wetland and riparian habitats along the river serve as an oasis in a desert region where rainfall averages only about 7 inches a year. Drier habitat around the wetlands adds to the diversity of species living in the area.

Riparian vegetation supplies food and cover for insects emerging from the river, as well as its own resident invertebrate populations and their terrestrial predators (e.g., predacious insects, amphibians, reptiles, birds, and mammals). These resources, in turn, provide food for numerous fish, mammals, birds, reptiles, amphibians, and invertebrates. Terrestrial and aquatic invertebrate assemblages play a major role in both aquatic and terrestrial food webs in the system.

Many species use riparian woody plants directly as nest sites or cover. Other wildlife species (e.g., beaver [*Castor canadenis*]) use these plants as food. Waterfowl nest in emergent marsh plants and other suitable sites.

Increase in riparian habitat since construction of the dam has led to increases in both population size and species diversity within the river corridor. This new zone of vegetation provides important habitat for many native terrestrial wildlife species, including numerous species of mammals (including bats), birds, amphibians, reptiles, and terrestrial invertebrates.

Ant populations have increased after dam closure due to the reduced frequency of high bank scouring flows that removed colonies of ants from the scour zone. Willow communities support more species of insects compared to tamarisk communities.

Many passerine and/or migratory birds are dependent on this riparian vegetation for general and nesting cover and foraging areas. For insectivorous birds, riparian vegetation provides cover and food. Some species that do not nest in the riparian zone use the zone as feeding areas. At high flows during nesting season, some ground nesting birds may lose their young to inundation.

Riparian patch size is important to several bird species (e.g., southwestern willow flycatcher), and they will not use a patch that is too small. Actions that decrease riparian patch size would, therefore, affect use of these areas by these birds.

Numerous species of nongame vertebrate wildlife use riparian habitats along the Green River below Flaming Gorge Dam (Bogan et al., 1983). The greatest species diversity occurs in the riparian habitats of broad valleys such as Browns, Echo, Island, and Rainbow Parks. Wildlife is less diverse in canyon areas (e.g., Lodore, Split Mountain) because of limited riparian habitat.

Several bat species exist within the area. They are attracted to the river corridor by the insects associated with the river and riparian vegetation. Bats and birds are also important prey for raptors. The formerly endangered peregrine falcon (*Falco peregrinus*) feeds on bats, swallows and other passerine birds, and ducks within the canyons. Prey is plentiful due to the abundance of insects along the river that attract prey species for the falcon. The peregrine falcon occurs along the Green River below Flaming Gorge Dam and is most common in major canyons where potential nest and perch sites exist on cliff faces. The species nests within Dinosaur National Monument (Eason, 1992) along both the Green and Yampa Rivers. Numbers of nests have increased within the past two decades. Only 2 active nest sites were known within the monument in 1976, but 8 nesting pairs fledged a total of 13 young in 1992. There are currently 12 active eyries within Dinosaur National Monument. Each eyrie has fledged an average of one and two young per year. Although peregrines usually occur in the area only during the breeding season (March-October), some birds could occur during the winter (U.S. Fish and Wildlife Service, 1977).

Ringtail (*Bassariscus astutus*) are found in the river corridor. Human activity may increase their numbers due to the ringtail's scavenging habits in human refuse.

Several species of game mammals, including mule deer (*Odocoileus hemionus*), elk (*Cervus elaphus*), moose (*Alces alces*), pronghorn (*Antilocapra Americana*), and bighorn sheep (*Ovis Canadensis*), occur along the Green River corridor above and below Flaming Gorge Dam (BLM, 1990; Schnurr, 1992). All of these species use riparian habitats as foraging and watering areas but are not restricted to riparian areas at any time of the year. Mule deer, elk, and pronghorn range widely throughout this portion of Utah and Colorado but move toward the river in the fall and use the river valley, especially Browns Park, as wintering range. Mule deer occur along the river throughout the year and are the most abundant game mammal in the area. Moose numbers are low in the region but appear to be increasing (BLM, 1990). Within the area, moose habitat occurs in Browns Park.

The Green River and associated wetlands provide important breeding, migration, and wintering habitat for numerous waterfowl species (Aldrich, 1992). Before the river was confined by dikes and the dam, annual spring floods inundated bottomland areas in Browns Park and other broad flood plain areas along the river. These flooded bottomlands provided important foraging and breeding areas for migrating and resident water birds. Browns Park National Wildlife Refuge and Browns Park Wildlife Management Area, situated along the river corridor in Browns Park, are managed to mitigate the effects of dam-induced reductions in spring flooding on these important waterfowl habitats. Within these management areas, bottomlands are artificially flooded each year by pumping river water into diked marshlands to create suitable waterfowl habitat. Other slack water areas are attractive to waterbirds and provide habitat for them.

Waterfowl species that commonly breed along the Green River corridor include Canada goose (*Branta Canadensis*), mallard (*Anas platyrhynchos*), common merganser (*Mergus merganser*), gadwall (*Anus strepera*), green-winged teal (*Anus crecca*), and redhead (*Anthya Americana*). In addition to these species, American widgeon (*Anus Americana*), common goldeneye (*Bucephala clangula*), and American coot (*Fulica americana*) are common during migration or winter. Waterfowl use large eddies and riparian communities associated with them as nesting and brood habitat. They use ice-free areas of the river during the winter.

Canada geese are particularly susceptible to changes in flow on the Green River (Holden, 1992; Aldrich, 1992). Islands and sandbars with low vegetation (e.g., grasses and forbs) are important nesting habitat for this species, and Browns Park is the most important nesting area for Canada geese in the area (Schnurr, 1992). Most nesting occurs from March 15 to May 15.

Great blue heron (*Ardea herodias*), spotted sandpiper (*Actitis macularia*), and killdeer (*Charadrius vociferous*) forage along shoreline and riparian habitats during the breeding season (Bogan et al., 1983). The great blue heron uses large trees (e.g., cottonwood) as nesting and roosting sites along the river. Killdeer and spotted sandpiper nest on the ground above the water line.

Many species of amphibians and reptiles inhabit the river corridor. Most of these animals use both upland and riparian sites. The river is a source of abundant invertebrate food for these species. Cliff faces above the river provide escape and resting habitat for reptiles. The zone of fluctuating water level is an important foraging area for reptiles and amphibians. Dense stands of tamarisk do not usually provide suitable habitat for these animals (Jakle and Gatz, 1985). The leopard frog (*Rana pipiens*) depends on backwater and flooded bottom land habitat.

3.7.2.7.2 Reach 2 – This reach is home to herds of pronghorn, mule deer, elk, bighorn sheep, and wild horses. Mule deer are relatively common and widespread within this reach.

Bighorn sheep are common in riparian areas along the Green River within Lodore, Whirlpool, and Split Mountain Canyons. These animals are the result of reintroductions that began in 1952 after a die-off of the natural population.

Numerous species of nongame vertebrate wildlife use riparian habitats along the Green River below the Yampa River confluence. The greatest species diversity occurs in the riparian habitats of broad valleys, such as Echo, Island, and Rainbow Parks and Ouray National Wildlife Refuge. Wildlife is less diverse in canyon areas (e.g., Split Mountain) because of the lack of habitat diversity.

The Green River corridor within this reach provides habitat for a vast number of migrating waterfowl, shorebirds, and wading birds from spring through fall. Over 200 species of birds can be found within this reach. Hawks, Canada geese, falcons, and many species of songbirds are commonly seen. Bald eagles (*Haliaeetus leucocephalus*) winter along the Green River.

Other birds commonly using this area include the pied-billed grebe (*Podilymbus podiceps*), eared grebe (*Podiceps nigricollis*), western grebe (*Aechmophorus occidentalis*), Clark's grebes *(Aechmorphorus clarkia*), double-crested cormorant (*Phalacrocorax auritus*), great blue heron, snowy egret (*Egretta thula*), black-crowned night-heron (*Nycticorax nycticorax*), white-faced ibis (*Plegadis chihi*), American bittern (*Botaurus lentiginosus*), mallard, gadwall, northern pintail (*Anus acuta*), redhead, common merganser, ruddy duck (*Oxyura jamaicensis*), American widgeon, Virginia rail (*Rallus limicola*), black-necked stilt (*Himantopus mexicanus*), American avocet (*Recurvirostra Americana*), Wilson's phalarope (*Phalaropus tricolor*), Forster's tern (*Sterna forsteri*), black tern (*Chlidonias niger*), greater yellowlegs (*Tringa melanoleuca*), lesser yellowlegs (*Tringa flavipes*), willet (*Catoptrophorus semipalmatus*), killdeer, and all three species of teal. During migration, these species of birds and many others visit the Ouray National Wildlife Refuge and other wetlands, along with occasional flocks of sandhill cranes (*Grus canadensis*).

Marshlands yield abundant food, water, and shelter for migrating waterfowl. Cattails and bulrush provide nesting habitat for redhead and ruddy ducks. Most ducks, however, do not locate nests in such wet places, preferring drier sites. These include the mallard, pintail, gadwall, and cinnamon teal (*Anus cyanoptera*). Waterfowl offspring prefer concentrated, nutritious food.

Macroinvertebrates fulfill this need, and marsh waters can provide these small food parcels.

Cottonwoods grow in stands along the Green River. Although of marginal value to waterfowl, cottonwoods provide cover, food, and nesting sites for a wide variety of animals. Mule deer, raccoons (*Procyon lotor*), porcupines (*Erethizon dorsatum*), Lewis's woodpeckers (*Melanerpes lewis*), red-tailed hawks (*Buteo jamaicenis*), great horned owls (*Bubo virginianus*), yellow-rumped warblers (*Dendroica coronata*), and other wildlife frequent the cottonwood groves. Great blue herons and double-crested cormorants nest in rookeries high up in cottonwoods along the river. A blue heron rookery exists near Old Charley Wash. Cottonwoods give the area a lot of its wildlife diversity.

Many areas have salty or alkali soils; only vegetation tolerant of saline soils will flourish in these areas. Greasewood (*Sacrobatus vermiculatus*), tamarisk (*Tamarix* sp.), and saltgrass (*Distichlis spicata*) dominate the plant life. Although this habitat is not ideal for waterfowl due to its poor nesting cover, ducks such as cinnamon teal commonly nest in saltgrass if it is near water. These areas are important to mule deer as winter cover.

3.7.2.7.3 Reach 3 – The majority of terrestrial and avian animals that exist within riparian zones of the upper reaches of the affected area also exist within riparian zones of Reach 3. However, riparian habitat is much more limited in this reach than upstream reaches. Most of Reach 3 has a limited area of flood plain.

Species occupying the shrublands, grasslands, and riparian habitats near the river include the northern harrier (*Circus cyaneus*), burrowing owl (*Athene cunicularia*), ring-necked pheasant (*Phasianus colchicus*), Say's phoebe (*Sayornis saya*), western kingbird *(Tyrannus verticalis*) eastern kingbirds (*Tyrannus tyrannus*), horned lark (*Eremophila alpestris*), loggerhead shrike (*Lanius ludovicianus*), sage thrasher (*Oreoscoptes montanus*) (uncommon), vesper sparrow (*Pooecetes gramineus*), lark sparrow (*Chondestes grammacus*), and sage sparrow *(Amphispiza belli*), lazuli bunting (*Passerina amoena*), mourning dove (*Zenaida macroura*), yellow-billed cuckoo (*Coccyzus americanus*), Lewis's woodpecker (*Melanerpes lewis*), downy woodpecker (*Picoides pubescens*), hairy woodpecker (*Picoides villosus*), northern flicker (*Colaptes auratus*), black-capped chickadee (*Poecile atricapillus*), house wren (*Troglodytes aedon*), warbling vireo (*Vireo gilvus*), yellow warbler (*Dendroica petechia*), yellow-breasted chat (*Iicteria virens*), spotted towhee (*Pipilo maculatus*), northern oriole (*Icterus galbula*), marsh wren (*Cistothorus palustris*). Yellow-headed blackbird (*Xanthocephalus xanthocephalis*) breed in and around wetlands; and a few Lewis's woodpeckers nest in riverside cottonwoods. From spring through fall, Lewis's woodpecker can be found in cottonwood forests.

The river is used by beaver, northern river otter (*Lutra Canadensis*), and muskrats (*Ondatra zibethicus*). Adjacent stands of cottonwoods, willows, squawbrush (*Rhus trilobata*), and tamarisk (*Tamarix sp.*) provide cover for cottontails (*Sylvilagus auduboni*), raccoons, mule deer, bobcats (*Felis rufus*), and porcupines. Raptors, including bald and golden eagles (*Aquila chrysaetos*), great-horned owls, and several species of hawks, also use this habitat. Peregrine falcons and osprey (*Pandion haliaetus*) find refuge along the river.

Greasewood, rabbitbrush (*Chrysothamnus sp.*), and cacti compete for the limited water of the higher, drier sites. Prairie dogs (*Cynomys sp.*), jackrabbits (*Lepus sp.*), and coyotes (*Canis latrans*) are typical upland residents. Other upland species include burrowing owl (*Athene cunicularia*), short-eared owl (*Asio flammeus*), American kestrel (*Falco sparverius*), loggerhead shrike, sage thrasher, Brewer's sparrow (*Spizella breweri*), sage sparrow, Ord's kangaroo rat (*Dipodomys ordii*), black and white-tailed jackrabbit, desert cottontail (*Sylvilagus audubonii*), white-tailed antelope squirrel (*Ammospermophilus leucurus*), mule deer, and pronghorn. Many species of reptiles live in these uplands.

The river and its associated habitats provide food and cover for nesting ducks including mallards, pintails, and teal, as well as Canada geese. The area provides food for migrating waterfowl like sandhill cranes (*Grus Canadensis*) and whooping cranes (*Grus Americana*). Deer, raccoon, ring-necked pheasant, garter snake (*Thamnophis sirtalis*), Woodhouse's toad (*Bufo woodhousei*), boreal chorus frog (*Pseudacris triseriata*), and northern leopard frog (*Rana pipiens*) also benefit from the food and cover provided by these riparian habitats.

Wildlife depends on riparian zones within Desolation Canyon for habitat and water. These species include bighorn sheep, mule deer, elk, mountain lion (*Felis concolor*), black bear (*Ursus americanus*), golden eagle, prairie falcon (*Falco mexicanus*), Cooper's hawk (*Accipiter cooperii*), goshawk (*Accipiter gentiles*), American kestrel, red-tail hawk, Canada geese, bald eagle, and peregrine falcon.

3.7.3 Other Threatened and Endangered Species

3.7.3.1 Southwestern Willow Flycatcher

The southwestern willow flycatcher (*Empidonax traillii extimus*) was federally listed as an endangered species in 1995 (U.S. Fish and Wildlife Service, 1995). A final recovery plan was published in March 2003 (U.S. Fish and Wildlife Service, 2003). The U.S. Fish and Wildlife Service has designated an "administrative boundary" between subspecies of willow flycatchers until genetic and/or vocal analysis can offer a clearer distinction between the subspecies. The current administrative designation considers all resident willow flycatchers within the Colorado Plateau physiographic region south of the Uintah Basin to be southwestern willow flycatchers. Therefore, for this EIS, only Reach 3 is considered to be southwestern willow flycatcher habitat. There is no critical habitat designation within the Green River Basin.

The southwestern willow flycatcher is a small neotropical migrant bird that depends on riparian vegetation for much of its life cycle. Once common along rivers of the Southwest, rough estimates are that there are now 1,200 to 1,300 pairs left in the United States. Population declines are attributed to loss and fragmentation of riparian habitat, encroachment of exotic plants, and parasitism by brown-headed cowbirds. In Utah and Colorado, the southwestern willow flycatcher historically nested in dense willow habitat that tended to have a scattered overstory of cottonwoods. Following widespread invasion of nonnative shrubs, the southwestern willow flycatcher now also nests in tamarisk and Russian olive. Preferred nesting habitat also seems to be associated with standing water, exposed sandbars, or nearby fluvial marshes.

Using the U.S. Fish and Wildlife Service approved protocol (Sogge et al., 1997a), surveys were conducted in Reach 3 in 1999 and 2000 (Johnson et al., 1999; Howe and Hanberg, 2000; Howe, 2000). A total of eight birds were identified as southwestern willow flycatchers. The majority of suitable habitat between Ouray and Green River, Utah, occurs on islands and sandbars (Howe and Hanberg, 2000). Mainland patches of large tamarisk, often mixed with willow, characterize southwestern willow flycatcher habitat along the lower Green River. The habitat component of standing water or fluvial marshes is limited.

There is little information about the history of southwestern willow flycatcher along the Green River. Explanations as to the absence of birds are speculative. Causes are most likely due to unsuitable habitat components (i.e., geographic, temperature, predators, food resources, adjacent land uses, and lack of standing water) and effects of historic extirpation and slow colonization (Johnson et al., 1999). In addition, 2 years of surveys do not necessarily mean that birds have been extirpated from the lower Green River. Sogge et al. (1997b) have documented several instances where flycatchers disappeared from former breeding locations along the Colorado River only to return 3 to 5 years later. Suitable habitat may currently be unoccupied because the flycatcher is now so rare that there are not enough individuals to disperse into all available habitats. If so, effective management of suitable but unoccupied riparian habitats is important as these birds recover under Endangered Species Act recovery activities.

Survey results indicate that the Green River is used as a migratory stopover for northern subspecies of willow flycatchers moving farther north to breed and for possible intergrades between the subspecies. Migration is a period of extreme energy demand, and most songbirds must stop periodically during migration to replenish depleted fat stores. Based on the numbers recorded during surveys, the Green River appears to provide important stopover habitat for the willow flycatcher subspecies as well as other neotropical migrants.

3.7.3.2 Ute Ladies'-Tresses

The Ute ladies'-tresses (*Spiranthes diluvialis*) was federally listed as a threatened species on January 17, 1992 (U.S. Fish and Wildlife Service, 1992a). Critical habitat has not been designated for this species. The current range of Ute ladies'-tresses includes Colorado, Idaho, Montana, Nebraska, Utah, Washington, and Wyoming, with a historical occurrence in Nevada. Along the Green River, Ute ladies'-tresses are currently found only in Reaches 1 and 2.

The Ute ladies'-tresses is a perennial orchid which typically occurs on sandy or loamy alluvial soils mixed with gravels. Typical habitat is in mesic to very wet meadows along streams and abandoned stream meanders, riparian edges, gravel bars, and near springs, seeps, and lakeshores at elevations ranging from 4265 to 6561 feet (U.S. Fish and Wildlife Service, 1992a; UDWR, 2002; Nevada Natural Heritage Program, 2001; NatureServe, 2001). Threats to populations of Ute ladies'-tresses include modification of riparian habitats by urbanization, stream channelization (for agriculture and development) and other hydrologic changes, conversion to agriculture and development, heavy summer livestock grazing, and hay mowing. Most populations are small and vulnerable to extirpation by habitat changes or local catastrophic events (U.S. Fish and Wildlife Service, 1992a). Several historic populations in Utah and Colorado appear to have been extirpated.

Populations of Ute ladies'-tresses often are located in riparian habitats on active flood plains in unconfined river reaches below confined reaches (Ward and Naumann, 1998). Along major rivers, these habitats may be somewhat transitory, subject to erosion and deposition. Ute ladies'-tresses are often found in early mid-succession stage habitats, and adverse changes to habitat in some areas may be the result of succession resulting in tall and dense vegetation. Periodic inundation may help maintain open habitat characteristics. Although tolerant of periodic inundation, frequent scouring or deposition can eliminate Ute ladies'-tresses or preclude their establishment (Ward and Naumann, 1998).

3.7.3.2.1 Reach 1 – A large number of Ute ladies'-tresses occurs within Reach 1. The occurrence of Ute ladies'-tresses along the Green River is influenced by river channel geometry, hydrology, and depositional and erosional patterns. Surveys conducted from 1998 to 2002 located 10 sites in Red Canyon, 25 sites in Browns Park, and 81 sites in Lodore Canyon (Grams et al., 2002; Ward and Naumann, 1998). The numbers of individuals found at these locations were generally low, ranging from 1 to 50; however, several sites in Lodore Canyon contained hundreds of flowering plants.

Within Reach 1, Ute ladies'-tresses predominantly occur on features that post-date Flaming Gorge Dam: post-dam flood plains and intermediate benches (Ward and Naumann, 1998; Grams et al., 2002). The post-dam flood plains are typically flat surfaces and are inundated annually by flows of 4,600 cfs; the intermediate benches are inundated by 10,900 cfs and average 6.2 feet above the 800-cfs base flow. In Lodore Canyon, many otherwise suitable areas are invaded with tamarisk and support few or no Ute ladies'-tresses.

3.7.3.2.2 Reach 2 – Within Reach 2, riverflows are strongly influenced by the Yampa River, and suitable habitat for Ute ladies'-tresses is less common (Ward and Naumann, 1998).

In Island Park and Rainbow Park, Ute ladies'-tresses typically occur on post-dam flood plains and intermediate benches, which are inundated more frequently than in Reach 1. In this reach, the post-dam flood plains are inundated at about 16,100 cfs (the post-dam 2-year flood). The intermediate benches are likely inundated by flows exceeding 20,000 cfs (and typically above the 17,100-cfs stage). Most occurrences of Ute ladies'-tresses are found on areas approximately 3 feet above the 3,300-cfs elevation. In this reach, nine populations of Ute ladies'-tresses have been found in Island Park-Rainbow Park, five below Split Mountain (Ward and Naumann, 1998). One population in Island Park occurs on a higher terrace, averaging 14 feet above base flow, which shows no evidence of inundation.

3.7.3.3 Bald Eagle

About 50 bald eagles (*Haliaectus leucocephalus*) winter along the Green River below Flaming Gorge Dam each year (Howe, 1992; Huffman, 1992). Eagles perch in large trees, especially cottonwoods, near open, ice-free water and forage for fish and occasionally waterfowl. Concentrations of eagles occur in broad, open areas of the valley with cottonwood groves, such as Browns Park and Island Park (Huffman, 1992).

Although nesting by the bald eagle has not been observed in the vicinity of Flaming Gorge Dam or the Green River, it is possible given documented nesting activity elsewhere in Utah and Colorado (Kjos, 1992) and the availability of suitable large cottonwood trees in Browns, Island, and Rainbow Parks.

The bald eagle winters along the Green River below the dam and also around the reservoir. They feed on the abundant trout population, especially during spawning activities of winter-spawning trout. Osprey also are found in the same areas and exploit the same prey base. Riparian areas with large cottonwood trees are used for roosting and perching. There are no known bald eagle nests in the area.

3.7.3.4 Black-Footed Ferret

Black-footed ferret (*Mustela migripes*) exist in release sites in eastern Utah near the Colorado border, located near prairie dog towns in the project area. These release sites are in Coyote Basin in Uintah County southeast of Jensen, Utah. This species is very rare.

3.7.3.5 Canada Lynx

Canada lynx (*Lynx canadensis*) may exist within the project area in coniferous forests. The Uinta Mountains likely form the species' southernmost range, though recent reports have given evidence of their existence in the Manti LaSal National Forest further south. The species is considered rare in Utah.

3.7.3.6 Mexican Spotted Owl

Mexican spotted owls (*Strix occidentalis Lucida*) are found within the Green River corridor. They were listed as a threatened species in 1993. This bird nests in caves in steep-walled, usually narrow, moist canyons. Most nesting sites occur in southern Utah, but sites have been found as far north as Dinosaur National Monument (Huffman, 1992). These owls prey on a variety of animals including mice, vole, bats, birds, and beetles, but their primary prey is woodrat. The primary threat to these birds has been habitat loss due to timber harvest practices. These owls prefer diverse, multiple layered forests. They will use uniform forests, grasslands, and shrublands also. The Mexican spotted owl is a potential year-round resident in wooded canyons along the Green River in all reaches below Flaming Gorge Dam. They are found as far north as Dinosaur National Monument.

3.7.4 Other Special Status Species

3.7.4.1 Yellow-Billed Cuckoo

In July 2001, the U.S. Fish and Wildlife Service announced the designation of the western population of the yellow-billed cuckoo (*Coccyzus americanus*) as a candidate species for listing as federally endangered. The yellow-billed cuckoo is currently listed on several State wildlife lists as sensitive or threatened, including Utah (as sensitive). Biologists have generally recognized western and eastern subspecies. The eastern and western populations are considered to be discrete based on physical (geographical area), morphological, behavioral, and genetic characteristics (U.S. Fish and Wildlife Service, 2001).

Yellow-billed cuckoo were historically uncommon to rare in Utah and likely uncommon in western Colorado (Bailey and Niedrach, 1965 in U.S. Fish and Wildlife Service, 2001; Kingery, 1998 in U.S. Fish and Wildlife Service, 2001). While still relatively common east of the Rockies, cuckoos of the West have faced significant population declines due to loss or degradation of 80-95% of their habitat, increased use of pesticides (thereby reducing food sources), and low colonization rates (U.S. Fish and Wildlife Service, 2001; Hughes, 1999). Habitat degradation and loss have been attributed to the result of conversion to agriculture, grazing, dams and riverflow management, bank protection, and competition from exotic plants. Additional impacts identified on the Green River include recreation and oil and gas drilling (Howe and Hanberg, 2000).

3.7.4.1.1 Reach 1 – Current conditions in Reach 1 provide little to no suitable habitat for yellow-billed cuckoo. Instead of the dense understory of riparian vegetation that characterize cuckoo habitat, the cottonwood gallery forests of Browns Park have an understory of low desert shrubs. There is little cottonwood regeneration occurring, and the cottonwood forests are being replaced by desert shrubs. There have been no recorded sightings of yellow-billed cuckoo in Reach 1.

3.7.4.1.2 Reach 2 – The Ouray area of Reach 2 contains large patches of suitable habitat—mature cottonwood forest with dense understory. Yellow-billed cuckoo breeding was confirmed in 1992. From 1999 through 2001, additional birds were detected at four sites in the Ouray area. Breeding was not confirmed but was probable due to the presence of birds and territories during late-season surveys. Ute Indian tribal lands along Reach 2 have not been surveyed.

3.7.4.1.3 Reach 3 – Suitable habitat in Reach 3 is characterized by large blocks of vegetation having an extensive overstory of cottonwood and old-growth tamarisk with a dense understory of tamarisk and willow. Eighteen sites with potential cuckoo habitat have been identified in sections of Reach 3 from the upper end of Desolation Canyon to the lower end of Gray Canyon (Howe and Hanberg, 2000). Additional suitable habitat has been identified along the lower Green River in Canyonlands National Park (Johnson et al., 1999). Recent surveys for Reach 3 have recorded a single sighting at Mineral Bottom.

3.7.4.2 Whooping Crane

Whooping cranes (*Grus americanus*) migrate through the region of Flaming Gorge Dam and the Green River Basin in the spring and fall. These cranes belong to a population established at Gray's Lake National Wildlife Refuge in southeastern Idaho. These birds are part of a recovery program for this species (Armbruster, 1990). Efforts to establish the Gray's Lake population began in 1975. The current population consists of cranes that have not yet nested but migrate annually with sandhill cranes to wintering grounds in and around the Bosque del Apache National Wildlife Refuge (Armbruster, 1990).

Habitats used by whooping cranes during migration include agricultural fields, wetlands, and small reservoirs (Rose, 1992). Whooping cranes have been observed in the vicinity of the Green River near Jensen, Utah. Wetlands along the river could be used occasionally by migrating individuals.

3.8 CULTURAL RESOURCES

Historic properties are the subset of cultural resources including sites, districts, buildings, structures, or objects that are at least 50 years of age and are included in, or eligible for inclusion in, the *National Register of Historic Places* (NRHP). Historic properties also include properties of traditional religious and cultural importance to tribes and other communities that meet one or more of the NRHP criteria for evaluation (see Code of Federal Regulations [CFR] 60). Cultural resources also include sacred sites as defined under Executive Order 13007.

3.8.1 Definition of Affected Environment

The affected environment for cultural resources corresponds to the area of potential effect (APE), defined in 36 CFR 800.16(d) as "the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties, if any such properties exist." For purposes of this EIS, the APE for cultural resources includes Flaming Gorge Reservoir and the Green River flood plain downstream from Flaming Gorge Dam to the town of Green River, Utah. Though Reach 3 extends to the confluence of the Green and Colorado Rivers, Reclamation believes that the best available data (see section 4.3.2.7) about implementing flow recommendations results in such negligible changes in hydrology below the town of Green River, Utah, that this is a reasonable termination point for the determination of APE for cultural resources.

Effects to cultural resources were defined following 36 CFR 800.16(i) as any alteration to the characteristics of a historic property qualifying it for inclusion in or eligibility for the NRHP. Direct, indirect, or cumulative effects were defined using a combination of the Council of Environmental Quality regulations at 40 CFR 1508.8 and the criteria of adverse effect at 36 CFR 800.5. Direct effects are reasonably foreseeable changes in the integrity of properties believed to be caused by the proposed action and that are likely to occur at the same time and place; indirect effects were defined as those reasonable foreseeable effects caused by the undertaking that may occur later in time, be further removed in distance or be cumulative.

Reclamation reviewed existing information on historic properties and other resources within the APE in compliance with 36 CFR 800.4(a). To identify cultural resources that might be present within the APE of the proposed action, Reclamation reviewed information on file at the State Historic Preservation Offices (SHPO) of Wyoming, Colorado, and Utah, as well as information synthesized by Spangler (1995). Information regarding the locations of individual cultural resource sites is restricted in order to preserve and protect these nonrenewable resources.

Consultation regarding cultural resources has been conducted with the Northern Ute Tribe; the Southern Ute Tribe; the Ute Mountain Ute Tribe; the Northwest Band of Shoshone; the Wind River Shoshone of Fort Washakie; the Hopi Tribe; the Paiute Indian Tribe of Utah; the Pueblo of Nambe; the Pueblo of Zia; the Kaibab Paiute Tribe; the Pueblo of Laguna; and the Pueblo of Zuni.

Information was also sought from Federal land managing agencies surrounding Flaming Gorge Reservoir and lands bordering the Green River downstream from Flaming Gorge Dam to the confluence of the Green and Colorado Rivers. This section describes the cultural resources located within the Flaming Gorge Reservoir APE and within the APE downstream along Reaches 1, 2, and 3 of the Green River.

3.8.1.1 Flaming Gorge Reservoir

Historic properties near Flaming Gorge Reservoir that could be affected by the proposed action are defined by location either below or above the 6040-foot-high water level elevation of the reservoir. Sites located below this level could be directly affected, and those located above could be indirectly and cumulatively affected. For a list of cultural resource sites located in and around the reservoir, see tables 3-11 and 3-12.

3.8.1.2 Green River

The downstream APE for cultural resources includes all of Reaches 1 and 2. The APE for the proposed action on Reach 3 extends from the confluence of the Green and White Rivers to the confluence of the Green and Colorado Rivers. However, since the hydrological model showed negligible differences in stage elevations between the No Action and the Action Alternatives, the APE for cultural resources was not extended further downstream than the town of Green River, Utah.

In all three reaches, the lateral extent of the APE considered for cultural resources is the flood plain of the Green River that could be inundated or wetted by the maximum proposed releases from Flaming Gorge Dam under the No Action and Action Alternatives. The indirect and cumulative effect on downstream resources is defined by the highest historic release from the dam of 12,300 cfs.

3.8.1.2.1 Reach 1 – Potentially affected cultural resources situated below Flaming Gorge Dam in Reach 1 on the Green River were determined based on a 10,000-cfs water flow in the river. See frontispiece map for the location of Reaches 1, 2, and 3. Historic properties that could be inundated at the 10,000-cfs water level were considered to be within the APE. Those located above the 10,000-cfs water level but below the highest historic release from the dam (12,300 cfs, March 16, 1983) (Elbrock, 2004) are also considered to be within the APE because they could be indirectly and perhaps cumulatively affected. Table 3-13 lists all previously documented cultural resource sites in Reaches 1 and 2 that could be affected by the proposed action. There are 33 located in Utah, and 16 are in Colorado. Thirty-two of the sites are prehistoric, eleven are historic, five are unknown, and one is multicomponent (both prehistoric and historic). Of the 49 sites, 24 are either listed on or eligible for the NRHP.

3.8.1.2.2 Reach 2 – The APE for cultural resources in Reach 2 was also determined using hydrologic modeling information and historic flood flow information. At the beginning of Reach 2, the Yampa River adds a large volume of water to the Green River. Thus, cultural resource sites located in the flood plain, in areas that would be inundated by a flow of 25,000 cfs, could be directly affected by the proposed action. Sites at an elevation that could be inundated by flows greater than 25,000 cfs could be indirectly affected (see table 3-13).

3.8.1.2.3 Reach 3 – Reach 3 begins at river mile 165 downstream from Flaming Gorge Dam at the confluence of the Green and White Rivers and ends at river mile 411 with the confluence of the Green and Colorado Rivers.

Table 3-14 lists cultural resource sites in the Reach 3 APE. There are 24 sites—18 are prehistoric, 4 are historic, 1 is multicomponent, and 1 is unknown. Of the 24 cultural resource sites, 12 are either listed in or eligible for the NRHP. All of Reach 3 is located in Utah.

Table 3-11.—Cultural Resources Inundated by Flaming Gorge Reservoir by Prior Mitigation, Cultural Resource Site Type, Age, and NRHP Eligibility

Site No.	Prior Mitigation	Age	Cultural Resource Site Type	NRHP Eligibility
42DA026	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW009	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW010	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW011	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW012	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW013	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW014	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW015	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW016	No	Prehistoric	Lithic scatter with feature	Not eligible
48SW017	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW018	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW022	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW028	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW029	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW030	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW036	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW040	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW041	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW042	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW048	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW049	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW051	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW053	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW054	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW055	No	Prehistoric	Lithic scatter with feature	Not eligible
48SW056	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW057	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW058	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW068	Yes	Prehistoric	Lithic scatter with feature	Not eligible
48SW027	No	Prehistoric	Hearth	Not eligible
42DA002	Yes	Prehistoric	Lithic scatter	Not eligible
42DA008	Yes	Prehistoric	Lithic scatter	Not eligible
42DA009	Yes	Prehistoric	Lithic scatter	Not eligible
42DA018	Yes	Prehistoric	Lithic scatter	Not eligible
42DA019	Yes	Prehistoric	Lithic scatter	Not eligible
42DA023	Yes	Prehistoric	Lithic scatter	Not eligible

Table 3-11.—Cultural Resources Inundated by Flaming Gorge Reservoir by Prior Mitigation, Cultural Resource Site Type, Age, and NRHP Eligibility (Continued)

Site No.	Prior Mitigation	Age	Cultural Resource Site Type	NRHP Eligibility
42DA025	Yes	Prehistoric	Lithic scatter	Not eligible
42DA027	Yes	Prehistoric	Lithic scatter	Not eligible
42DA028	Yes	Prehistoric	Lithic scatter	Not eligible
42DA029	Yes	Prehistoric	Lithic scatter	Not eligible
48SW003	Yes	Prehistoric	Lithic scatter	Not eligible
48SW021	Yes	Prehistoric	Lithic scatter	Not eligible
48SW023	Yes	Prehistoric	Lithic scatter	Not eligible
48SW024	Yes	Prehistoric	Lithic scatter	Not eligible
48SW025	Yes	Prehistoric	Lithic scatter	Not eligible
48SW026	Yes	Prehistoric	Lithic scatter	Not eligible
48SW034	Yes	Prehistoric	Lithic scatter	Not eligible
48SW035	Yes	Prehistoric	Lithic scatter	Not eligible
48SW037	Yes	Prehistoric	Lithic scatter	Not eligible
48SW038	Yes	Prehistoric	Lithic scatter	Not eligible
48SW039	Yes	Prehistoric	Lithic scatter	Not eligible
48SW4242	No	Prehistoric	Lithic scatter	Not eligible
48SW4244	No	Prehistoric	Lithic scatter	Not eligible
48SW4245	No	Prehistoric	Lithic scatter	Not eligible
48SW008	Yes	Prehistoric	Lithic scatter	Not eligible
42DA001	No	Prehistoric	Rock shelter	Not eligible
42DA003	No	Prehistoric	Rock shelter	Not eligible
42DA020	Yes	Prehistoric	Rockshelter	Not eligible
48SW047	Yes	Prehistoric	Rockshelter	Not eligible
48SW045	Yes	Prehistoric	Rockshelter with rock art	Not eligible
42DA010	Yes	Prehistoric	Rockshelter with structures	Not eligible
48SW046	Yes	Prehistoric	Rockshelter with structures	Not eligible
42DA468	No	Prehistoric	Storage cist	Not eligible
48SW050	No	Prehistoric	Stratified, multicomponent	Not eligible
48SW059	No	Prehistoric	Stratified, multicomponent	Not eligible
42DA363	No	Historic	Town site	Not eligible
48SW060	No	Prehistoric	Lithic scatter with feature	Not eligible

Table 3-12.—Cultural Resources Immediately Above the Flaming Gorge Reservoir Pool by Prior Mitigation, Cultural Resource Site Type, Age, and NRHP Eligibility

Site No.	Prior Mitigation	Age	Cultural Resource Site Type	NRHP Eligibility
42DA011	Yes	Prehistoric	Lithic and ceramic scatter	Eligible
42DA012	Yes	Prehistoric	Lithic scatter	Eligible
42DA015	Yes	Prehistoric	Lithic scatter with feature	Not eligible
42DA016	Yes	Prehistoric	Lithic scatter with feature	Eligible
42DA017	Yes	Prehistoric	Lithic scatter with feature	Unevaluated
42DA497	No	Prehistoric	Lithic scatter	Unevaluated
48SW00033	Yes	Prehistoric	Lithic scatter	Not eligible
48SW00080	Yes	Prehistoric	Lithic scatter	Eligible
48SW00361	No	Prehistoric	Quarry	Not eligible
48SW04243	No	Prehistoric	Lithic scatter	Not eligible
48SW09382	No	Prehistoric	Habitation with features	Not eligible
48SW10430	No	Prehistoric	Lithic scatter with feature	Eligible
48SW13230	No	Historic	Burial	Not eligible

Table 3-13.—Cultural Resources Within the Reaches 1 and 2 Areas of Potential Effects by Direct or Indirect Impacts, Age, Cultural Resource Site Type, and NRHP Eligibility

Site No.	Effect	Age	Cultural Resource Site Type	NRHP Eligibility
42DA030	Indirect	Prehistoric	Rockshelter	Eligible
42DA040	Indirect	Prehistoric	Campsite	Eligible
42DA196	Direct	Prehistoric	Lithic scatter	Eligible
42DA203	Direct	Prehistoric	Campsite	Eligible/Tested
42DA204	Indirect	Prehistoric	Lithic scatter	Not eligible
42DA225	Indirect	Prehistoric	Lithic scatter	Not eligible
42DA332	Indirect	Multicomponent	Lithic scatter, corral	Not eligible
42DA337	Indirect	Prehistoric	Habitation	Eligible
42DA338	Indirect	Historic	Canal	Not eligible
42DA339	Indirect	Prehistoric	Lithic scatter	Not eligible
42DA341	Indirect	Prehistoric	Lithic scatter	Not eligible
42DA342	Indirect	Historic	Dugout	Eligible/Tested
42DA377	Indirect	Prehistoric	Lithic scatter	Not eligible
42DA394	Direct	Historic	Canal	Eligible
42DA485	Indirect	Prehistoric	Campsite	Eligible

Table 3-13.—Cultural Resources Within the Reaches 1 and 2 Areas of Potential Effects by Direct or Indirect Impacts, Age, Cultural Resource Site Type, and NRHP Eligibility (Continued)

Site No.	Effect	Age	Cultural Resource Site Type	NRHP Eligibility
42DA561	Indirect	Unknown	Unknown	Unknown
42DA562	Indirect	Prehistoric	Lithic scatter	Eligible
42DA564	Direct	Prehistoric	Campsite	Eligible/Tested
42DA661	Indirect	Prehistoric	Lithic scatter	Not eligible
42DA668	Indirect	Prehistoric	Rockshelter	Eligible
42DA750	Indirect	Prehistoric	Lithic scatter	Not eligible
42DA751	Indirect	Prehistoric	Lithic scatter	Not eligible
42UN0054	Direct	Prehistoric	Rockshelter	Tested
42UN0065	Indirect	Prehistoric	Lithic scatter	Not eligible
42UN0136	Direct	Unknown	Unknown	Unevaluated
42UN0256	Indirect	Unknown	Unknown	Unevaluated
42UN0265	Indirect	Prehistoric	Campsite	Eligible
42UN0267	Indirect	Prehistoric	Rock art	Eligible
42UN0271	Indirect	Prehistoric	Rockshelter	Eligible
42UN1563	Indirect	Historic	Bridge	Not eligible
42UN1600	Indirect	Historic	Structure	Not eligible
42UN1746	Indirect	Prehistoric	Campsite	Eligible
42UN260	Direct	Unknown	Unknown	Unevaluated
5MF0067	Indirect	Prehistoric	Structure	Eligible
5MF0605	Direct	Historic	Structure	Listed/Tested
5MF0840	Direct	Prehistoric	Structure	Eligible/Tested
5MF1230	Indirect	Prehistoric	Campsite	Not Eligible
5MF1233	Direct	Historic	Trash scatter	Eligible
5MF1234	Direct	Historic	Building	Eligible/Tested
5MF1238	Indirect	Prehistoric	Lithic scatter	Not eligible
5MF2357	Indirect	Historic	Inscription, cabin	Listed
5MF2388	Indirect	Historic	Cabin	Not eligible
5MF2399	Direct	Historic	Structure	Not eligible
5MF2498	Direct	Unknown	Unknown	Not eligible
5MF2964	Direct	Prehistoric	Rock art	Eligible
5MF2966	Direct	Prehistoric	Rock art	Eligible
5MF2968	Direct	Prehistoric	Rock art	Eligible
5MF3668	Direct	Prehistoric	Lithic scatter	Not eligible/Tested
5MF3669	Indirect	Prehistoric	Lithic scatter	Not eligible

Table 3-14.—Cultural Resources Within the Reach 3 Area of Potential Effects by Direct or Indirect Impacts, Age, Cultural Resource Site Type, and NRHP Eligibility

Site No	Effect	Age	Cultural Resource Site Type	NRHP Eligibility
42Cb220	Indirect	Prehistoric	Rock art	Listed
42Cb228	Indirect	Prehistoric	Lithic scatter with groundstone	Eligible
42Cb235	Indirect	Prehistoric	Rock Art	Eligible
42Cb236	Indirect	Prehistoric	Rock Art	Eligible
42Em0655	Indirect	Prehistoric	Lithic and ceramic scatter	Eligible
42Em0723	Indirect	Prehistoric	Rock art	Eligible
42Em1071	Indirect	Prehistoric	Lithic scatter	Eligible
42Gr0618	Direct	Prehistoric	Lithic scatter	Not eligible
42Gr0655	Direct	Prehistoric	Lithic scatter	Not eligible
42Gr0815	Direct	Multicomponent	Rock art, sheep camp	Eligible
42Gr2552	Indirect	Historic	Building	Not eligible
42Gr2553	Indirect	Historic	Rock alignment	Not eligible
42Gr2558	Indirect	Prehistoric	Lithic scatter	Not eligible
42Gr2559	Indirect	Prehistoric	Lithic scatter	Not eligible
42Gr2560	Indirect	Historic	Building	Not eligible
42Un0137	Indirect	Prehistoric	Lithic quarry	Not eligible
42Un0230	Direct	Unknown	No form, no card	Unevaluated
42Un0349	Indirect	Prehistoric	Rock art	Eligible
42Un0432	Indirect	Prehistoric	Lithic scatter with groundstone	Eligible
42Un0446	Indirect	Historic	Campsite (Powell)	Eligible
42Un0729	Indirect	Prehistoric	Lithic scatter with groundstone	Not eligible
42Un0869	Indirect	Prehistoric	Rock art	Not eligible
42Un0870	Indirect	Prehistoric	Lithic scatter	Not eligible
42Un0967	Direct	Prehistoric	Rock art	Eligible

It should be noted here that all of Desolation Canyon in Reach 3 was designated a National Historic Landmark in 1969. Desolation Canyon was selected based on its exceptional historic value, including the John Wesley Powell expedition which passed through the canyon in 1869.

3.9 PALEONTOLOGICAL RESOURCES

Paleontologists from the Utah Geological Survey assessed the geological formations and the known paleontological resources in the vicinity of Flaming Gorge Reservoir and the Green River downstream from Flaming Gorge Dam that lie within the project area for the Proposed Action (DeBlieux et al., 2002). They concluded that the most sensitive formations for paleontological resources are the Morrison, Cedar Mountain, Uinta, and Duchesne River Formations. Information about the locations of individual paleontological resources is restricted to help preserve and protect these nonrenewable resources.

The current assessment of paleontological resources was taken from DeBlieux et al. (2002). The report assessed the likelihood that paleontological resources would be found in the geologic formations along the shores of Flaming Gorge Reservoir and along the course of the Green River to the confluence of the White River within the State of Utah. The majority of rock units exposed along the shores of the reservoir and the Green River are fossil-bearing. Several geological formations contain significant fossil resources and are ranked in the *very sensitive* and *extremely sensitive* categories for paleontological resources as defined by the State paleontologist of Utah. These include the Morrison, Cedar Mountain, Uinta, and Duchesne River Formations. Several other formations have the potential to contain significant fossil resources based on the occurrence of significant fossils in these formations in other regions, and these formations are placed in the *significant sites known* category. Formations placed in this category are the Park City/Phosphoia, Moenkope, Chinle, Stump, Mowry, Mancos, Wasatch, and Green River and the Mesa Verde Group.

A 2003 pedestrian inventory of 50 miles of shoreline along Flaming Gorge Reservoir in Wyoming concluded that neither paleontological nor cultural resource sites were located between the high and low water marks in that area (Todd, 2003).

Reservoir margins are important sites for erosion and fossil exposure for several reasons. First, wave action along the shore exposes rocks even where they were previously covered by alluvial soils and vegetation. Second, fluctuating water levels expose the shore to a variety of energy and environmental conditions. Finally, reservoir shores are readily accessible to visitors, which can result in the loss of fossils and, much like cultural resources, may be disturbed, destroyed, or stolen, either by unintentional mistreatment or by intentional vandalism and theft.

The report (DeBleuix et al., 2002) involved a literature search and a search of the Utah Paleontological Database. This information was used to construct paleontological sensitivity maps, which are included in the report. A field survey of the most sensitive formation was conducted, using a boat to access potential fossil-bearing strata along the shores of Flaming Gorge Reservoir, and resulted in the discovery of several fossil sites, including a significant vertebrate track site.

Most geologic deposits along the Green River corridor in Reaches 1, 2, and 3 consist of unconsolidated river-deposited sands and gravels that are of low paleontological sensitivity. In regard to fossil sites along the Green River in Dinosaur National Monument, the Utah Geological Survey contacted the Chief of Research and Resource Management at Dinosaur National Monument (written communication, 2002) who stated that as far as park personnel are aware, no significant fossil sites are located along the river corridor within the project area.

3.10 INDIAN TRUST ASSETS

Indian trust assets are legal interests in property held in trust by the United States for Indian tribes or individuals. Examples of trust assets are lands, minerals, hunting and fishing rights, and water rights. The United States has an Indian trust responsibility to protect and maintain rights reserved by or granted to Indian tribes or Indian individuals by treaties, statutes, and Executive orders which are sometimes further interpreted through court decisions and regulations. This trust responsibility requires Reclamation to take all actions reasonably necessary to protect trust assets.

The Uintah and Ouray Reservation was established by the Executive orders of October 3, 1861, and January 5, 1882, and by Acts of Congress approved May 27, 1902, and June 19, 1902. The reservation, reaching from the Utah/Colorado border west to the Wasatch Mountain Range, consists of approximately 4.5 million acres with lands in Carbon, Duchesne, Grand, Uintah, and Utah Counties, Utah. The Northern Ute Indian Tribe of the Uintah and Ouray Reservation, with approximately 3,200 enrolled members, consists of three Ute bands: the Uintah, Uncompahgre, and Whiteriver. Tribal headquarters are located at Fort Duchesne. According to the U.S. Census, the total five-county population of the reservation was 19,182 in 2000 compared to a 1990 population of 17,224. A portion of Reach 2 of the Green River passes through the reservation in Uintah County near Ouray, Utah. Reach 3 continues through reservation lands in Uintah County and adjacent to reservation lands in Grand County. Indian trust assets of concern for this action include the rights to fish, hunt, and gather. The resources that provide for these rights to be exercised include fish, wildlife, and vegetation. In addition, land and mineral rights are important trust assets for the Ute Indian Tribe. The ability to exercise these rights (i.e., agricultural production and the development, operation, and maintenance of oil and gas wells) is of special concern for this action.

3.11 RECREATION

This section describes the geographic impact area and current conditions for recreation. The geographic impact area describes where the majority of impacts are expected to occur as well as the rationale for defining the impact area. The current conditions section presents current information on riverflows and reservoir water levels, recreation visitation, and recreation economic value.

3.11.1 Geographic Impact Area

Flaming Gorge Reservoir and the Green River for approximately 12 miles downstream from the dam comprise the Flaming Gorge National Recreation Area which is managed by the Ashley National Forest, USDA Forest Service (see map at the front of this document). After exiting the Flaming Gorge National Recreation Area, the Green River flows across BLM and State of Utah lands for approximately 18 miles before entering the U.S. Fish and Wildlife Service-managed Browns Park National Wildlife Refuge along the Utah and Colorado border, 30 miles downstream from the dam. Immediately downstream from the refuge, approximately 47 miles downstream from the dam, lies Dinosaur National Monument managed by the National Park Service. The upper portion of Dinosaur Nation Monument, upstream of the confluence with the Yampa River, reflects the end of Reach 1 of the study area.

This recreation visitation and value analysis addresses impacts to both Flaming Gorge Reservoir and the Green River downstream from Flaming Gorge Dam. The analysis focuses upon the effects on recreation visitation and economic value within Reach 1 and, specifically, within the Flaming Gorge National Recreation Area, where the majority of the potentially impacted water-based recreation occurs. Relatively little of the river-oriented recreation activity within the region initiates within the 35-mile stretch of the river between the Flaming Gorge National Recreation Area and Dinosaur National Monument.

In Dinosaur National Monument, water-based recreation is dominated by rafting activities. Rafting within the monument is managed via a permit system that covers both the Green and Yampa Rivers. If flow conditions deteriorated on the Green River to the point of adversely impacting rafting activity, the possibility exists of shifting activity to the Yampa River. While the National Park Service constrains the total number of permits for both commercial and private rafting parties across both rivers to 600 a year and the number of launches from either river to 4 per day, there still exists the potential for rafting substitution between the rivers. In addition, the majority of commercial and private rafting trips are scheduled well ahead of time. Commercial rafting operations are popular, and early reservations are often required since space on these trips tends to fill up quickly. Private rafting permits are limited to one per person annually and must be obtained via a lottery system months prior to the actual trip date. Given the degree of planning and financial commitment required for these rafting trips, a fairly strong incentive exists to take trips even when flow conditions are less than ideal. To substantiate this discussion, attempts were made to model the impact of average monthly flows on rafting visitation within Dinosaur National Monument (see the Recreation Visitation and Valuation Analysis Technical Appendix for more information on the models). Separate models were estimated for commercial and private rafting activity. These models either resulted in insignificant flow variables (commercial model) or significant flow variables with relatively minor impacts on rafting activity (private model). As a result, the assumption was made that rafting activity within Dinosaur National Monument would not vary substantially with the fluctuations in Green River flows associated with the EIS alternatives. Finally, changes in water-based recreation activity within Reaches 2 and 3, based on the EIS alternatives, were also assumed to be relatively minor either due to low levels of recreation use or the overriding effect of the combined flows from the numerous tributaries (e.g., Yampa, Duchesne, and White Rivers, etc.) as compared to dam releases. Given all of the above, the decision was made to focus the recreation visitation and value analysis on water-based effects primarily within the Flaming Gorge National Recreation Area.

The Green River portion of the Flaming Gorge National Recreation Area is located entirely within Daggett County, Utah, in the northeast corner of the State. The southernmost portions of the reservoir are also within Daggett County. This part of the reservoir is relatively narrow since the water is constricted via a series of canyons. The reservoir widens as one travels northward out of the canyons and toward the Utah/Wyoming border. The Wyoming portion of the reservoir, located entirely within Sweetwater County, is relatively wide and extends northward for many miles before narrowing at the confluence of the Green and Blacks Fork Rivers.

Potentially affected recreation facilities within the Flaming Gorge National Recreation Area along both the Green River and Flaming Gorge Reservoir include the following:

Green River:

(1) Boat ramps at the spillway below Flaming Gorge Dam and at the Little Hole recreation complex.

(2) Little Hole National Recreation Trail (from the spillway of Flaming Gorge Dam to the Little Hole recreation complex, 7 miles downstream).

(3) Fishing pier at the Little Hole recreation complex.

(4) Eighteen riverside campgrounds (seven are on BLM lands, outside Flaming Gorge National Recreation Area).

Flaming Gorge Reservoir:

(1) Eleven boat ramps (four associated with marinas).

(2) Three marinas.

(3) Three boat-based campgrounds.

(4) Four swimming beaches.

(5) Cut Through-Horseshoe Canyon Bypass (not evaluated within the recreation analysis since it has only minor impacts on recreation use).

While the Green River recreation analysis emphasizes impacts within the upper portion of Reach 1, primarily within Flaming Gorge National Recreation Area, consideration is also given to recreation facilities downstream, all the way to the confluence with the Colorado River. After passing out of Reach 1 within Dinosaur National Monument, the Green River flows across private lands, State of Utah lands, Federal lands (BLM, U.S. Fish and Wildlife Service including Ouray National Wildlife Refuge), and Ute Indian tribal lands within Reach 2. Very few recreational facilities are found in this reach. Reach 3 of the Green River starts at the confluence with the White River and ends at the Colorado River. This long stretch of river includes Ute Indian tribal lands (including Desolation Canyon), State of Utah lands (including Green River State Park), Federal lands (BLM, National Park Service including Canyonlands National Park), and private lands. Numerous recreational facilities are located within Reach 3. The following represents a list of recreational facilities found along the Green River downstream from Flaming Gorge National Recreation Area within Reaches 1, 2, and 3.

Green River – Reach 1 (downstream from Flaming Gorge National Recreation Area):

BLM:

(1) Three boat ramps (Indian Crossing, Bridge Hollow, and Swallow Canyon—a fourth ramp at the pipeline crossing below Jarvies Ranch, is being phased out).

(2) Twenty campgrounds, of which only one (at Bridge Hollow) may be impacted. Six of these are administered by the USDA Forest Service for BLM.

State of Utah:

(3) One boat ramp (Bridge Port Camp).

(4) Five campgrounds (Gorge Creek, Little Davenport, Bridge Port, Elm Grove, and Burned Tree).

U.S. Fish and Wildlife Service (Browns Park National Wildlife Refuge):

(5) Two boat ramps (Swinging Bridge, Crook).

(6) Two campgrounds (Swinging Bridge, Crook).

(7) Fishing Pier.

National Park Service (Dinosaur National Monument):

(8) Three boat ramps (Lodore, Deerlodge, and Split Mountain).

Note: Facilities located downstream from the Yampa River are technically Reach 2 (e.g., Split Mountain):

(9) Five riverside campgrounds (Lodore, Deerlodge, Echo Park, Split Mountain, and Green River).

(10) One riverside picnic area (Split Mountain).

Green River – Reach 2 (Yampa River to White River:

U.S. Fish and Wildlife Service (Ouray National Wildlife Refuge):

(1) One boat launch site.

Green River – Reach 3 (White River to Colorado River):

BLM:

(1) Five boat ramps/launch sites (Sand Wash, Swasey's Beach ramp, Nefertiti, Butler Rapid, and Mineral Bottom).

(2) One riverside campground (Swasey's Beach).

State of Utah (Green River State Park:)

(3) One boat ramp.

(4) One campground.

Private:

(5) One boat launch site (Ruby Ranch).

National Park Service (Canyonlands National Park):

(6) Eight campsites

3.11.2 Current Conditions

This section describes current conditions within the geographic impact area in terms of Green River flows and Flaming Gorge Reservoir water levels, recreation visitation, and the economic value of recreation. This information should provide some perspective when considering the recreation impacts presented under the environmental consequences section. In addition, the current condition information was used in the analysis process, providing a basis or starting point of the two applied analyses—the facility availability approach for reservoir visitation and the linear interpolation approach for river visitation, river valuation, and reservoir valuation analyses.

Recreation visitation is measured in terms of the number of recreation visits for each recreation activity. A recreation visit reflects a round trip excursion from a recreator's primary residence for the main purpose of recreation. Recreation economic value reflects the sum of individual recreator benefits aggregated across users of a site. Recreator benefits or values per visit are represented by consumer surplus that is measured by estimating recreator willingness-to-pay in excess of per visit costs.

Recreation activities studied were water based, implying they require the use of water for participation. Water-influenced activities, such as picnicking and sightseeing, which do not require water access, but typically benefit from the presence of water, were insignificant compared to the water-based activities at both the Green River and Flaming Gorge Reservoir. Activities studied on the Green River include scenic floating, guide boat fishing, private boat fishing, shoreline fishing/trail use, and boat-based camping. Activities studied on Flaming Gorge Reservoir include power boating and waterskiing, boat fishing, boat-based camping, swimming, and waterplay. These water-based activities represent virtually all of the visitation on the river and nearly 80% of the visitation at the reservoir.

3.11.2.1 Current Hydrology

This section presents information on current Green River and Flaming Gorge Reservoir hydrology in terms of average monthly riverflows and end-of-month reservoir water levels. In this analysis, all riverflows are measured in cfs, and all reservoir water levels are measured in feet above mean sea level (msl). Given that much of the information used to develop the recreation analyses were obtained from a survey conducted across the summer of 2001, and the analyses used current conditions information from the survey as a starting point in the estimation process, it was necessary to link current hydrological conditions to the survey period. The survey was conducted from May to September 2001 and asked recreators about their activity over the prior 12 months. Therefore, depending on when a recreator was contacted, riverflows or reservoir water levels from as early as June 2000 to as late as September 2001 could be relevant. In other words, current hydrology is based on riverflows and reservoir water levels during the June 2000 to September 2001 period reflected by the recreation survey.

Actual conditions allow for the assessment of impacts based on the hydrology modeling for this EIS (see section 4.3). To calculate current average monthly riverflows or reservoir water levels, the percent of the survey sample contacted each month was used as a weight (May: 11.3%, June: 20.5%, July: 29.2%, August: 15.4%, and September: 23.6%). Table 3-15 presents actual flows and water levels by month. Riverflows are included only for the months from March to October since visitation data were only available for those months.

3.11.2.2 Current Annual Recreation Visitation

Recreation visitation has been gathered by USDA Forest Service contractors from March to October on an annual basis since the early 1990s on the Green River portion of the Flaming Gorge National Recreation Area. Visitation counts on the reservoir have been less frequent, with the most recent annual estimates made in fiscal year 1997 (October 1996 to September 1997).

Table 3-15.—Current Hydrology (June 2000 Through September 2001 Survey Period)

Month	Green River Flows (cfs)	Flaming Gorge Reservoir Water Levels (feet above msl)
January	NA[1]	6020.3
February	NA[1]	6020.4
March	1,036	6020.7
April	1,145	6021.5
May	2,478	6021.8
June	1,215	6021.3
July	1,007	6021.3
August	1,122	6020.9
September	1,118	6020.6
October	1,024	6020.4
November	NA[1]	6020.6
December	NA[1]	6020.4

[1] Not applicable due to lack of visitation data.

Current visitation was calculated on a monthly basis based on USDA Forest Service data. As with the hydrology data, to allow for use in the interpolations, current visitation estimates also needed to be consistent with the time period of the recreation survey (May 2000 to September 2001). While the reservoir visitation data was for a different time period compared to the survey data, fortunately, the availability of recreation facilities along the reservoir were identical for both the October 1996-September 1997 and June 2000-September 2001 periods, implying the fiscal year 1997 visitation data could be considered representative of visitation for the survey period. USDA Forest Service monthly visitation data by recreation activity for both the river and reservoir were weighted, using the monthly sampling percentage approach described above, to come up with the estimates of current monthly visitation by activity. Table 3-16 presents estimates of current water-based recreation on the river and reservoir by month and activity.

Reviewing the Green River visitation data in table 3-16 indicates that shoreline fishing, scenic floating, and private boat fishing are the top three recreation activities on the Green River portion of Flaming Gorge National Recreation Area. Combined, these activities account for slightly over 85% of the river visitation. The top three high use months are June, July, and August, with over 60% of the total annual river visitation. As noted below, river visitation accounts for less than 14% of the combined total visitation for the river and reservoir.

Reviewing the Flaming Gorge Reservoir visitation data in table 3-16 indicates that power boating/waterskiing (62.8%) and boat fishing (31.7%) are the dominant activities accounting for nearly 95% of the total water-based reservoir visitation. From a monthly perspective, the months of May through August reflect nearly 75% of water-based visitation. Although not presented in the

Table 3-16.—Current Green River and Flaming Gorge Reservoir Visitation by Month and Activity

Recreation Activity	Months												Total	% by Activity and Site	% of Total by Activity
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec			
I. Current Green River Visitation:															
Scenic Floating	N/A	N/A	42	217	99	5,527	11,063	7,749	62	9	N/A	N/A	24,768	26.8	3.7
Guide Boat Fishing	N/A	N/A	280	1,560	2,018	2,099	1,781	1,814	1,530	318	N/A	N/A	11,400	12.3	1.7
Private Boat Fishing	N/A	N/A	1,265	3,214	3,549	1,767	1,520	1,457	4,827	932	N/A	N/A	18,531	20.0	2.8
Shoreline Fishing	N/A	N/A	1,774	5,892	4,942	5,976	7,708	5,462	2,935	793	N/A	N/A	35,482	38.4	5.3
Boat Camping	N/A	N/A	0	0	0	668	655	600	352	6	N/A	N/A	2,281	2.5	.3
River Total:	N/A	N/A	3,361	10,883	10,608	16,037	22,727	17,082	9,707	2,058	N/A	N/A	92,461	100	13.9
Percent by Month:	N/A	N/A	3.6	11.8	11.5	17.3	24.6	18.5	10.5	2.2	N/A	N/A	100		
II. Current Flaming Gorge Reservoir Visitation:															
Power Boating	583	0	2,694	21,532	57,792	77,943	84,871	49,273	28,250	25,426	6,638	4,276	359,278	62.8	54.1
Boat Fishing	293	0	1,358	10,870	29,170	39,343	42,838	24,870	14,260	12,834	3,352	2,160	181,348	31.7	27.3
Boat Camping	75	0	677	1,761	1,388	1,863	1,386	1,174	536	674	483	357	10,374	1.8	1.6
Swimming	35	0	159	1,277	3,424	4,618	5,028	2,919	1,675	1,508	393	255	21,291	3.7	3.2
Reservoir Total:	986	0	4,888	35,440	91,774	123,767	134,123	78,236	44,721	40,442	10,866	7,048	572,291	100	86.1
Percent by Month:	.2	0	.9	6.2	16.0	21.6	23.4	13.7	7.8	7.1	1.9	1.2	100		
III. Combined Total:	986	0	8,249	46,323	102,382	139,804	156,850	95,318	54,428	42,500	10,866	7,048	664,752		100
Percent by Month:	.2	0	1.2	7.0	15.4	21.0	23.6	14.3	8.2	6.4	1.6	1.1	100		

table, the most used reservoir sites from a water-based activity perspective are Lucerne Valley (52.8%), Buckboard Crossing (15.8%), and Cedar Springs (15.8%). These three sites combine for nearly 85% of the reservoir's total water-based activity.

The combined total of nearly 665,000 water-based activity visits annually is dominated by visitation to the reservoir, reflecting over 86% of the total visitation. May through August are the heaviest use months, with severe drops in visitation prior to April and after October.

3.11.2.3 Current Annual Recreation Economic Value

The current annual total value estimates by activity were developed by simply multiplying the current value estimates per visit by activity, as obtained from the recreation survey, by the estimates of total current visitation by activity, as obtained from USDA Forest Service data. All value per visit estimates were developed using a conservative, frequently applied approach of assuming survey nonrespondents had a value of zero. Table 3-17 presents the estimates of Green River and Flaming Gorge Reservoir total current value by recreation activity.

It is interesting to note the differences when comparing the percent of total visits by activity to the percent of total value by activity. The percent of total value by activity takes into account both the visitation and value per visit components. On the river, while shore fishing/trail use reflects 38.4% of river visitation, it represents only 17.4% of the river value due to the relatively low value per visit. Conversely, guide boat fishing reflects only 12.3% of river visitation, but 43.5% of the river value due to the high value per visit. The differences between the reservoir visitation and valuation percentages are less dramatic compared to those of the river. The largest differentials are for power boating/waterskiing and swimming/waterplay.

When combining Green River and Flaming Gorge Reservoir values, the river represents about 25% of the total recreation value compared to only 14% of the total visitation. This is due to the higher values per visit for river activities. The reservoir obviously still dominates, representing nearly 75% of the combined total value.

3.12 SOCIOECONOMICS AND REGIONAL ECONOMICS

This section includes a brief discussion of the geographic impact area followed by information on current conditions within the area.

3.12.1 Geographic Impact Area

As described in the recreation section (section 3.11), the recreation analysis focuses on effects at Flaming Gorge Reservoir and along the Green River primarily within the FGNRA. Access to the northern portions of the reservoir would likely involve economic activity in the Wyoming towns of Green River and Rock Springs. Conversely, access to the southern reaches of the reservoir and the Green River may involve economic activity in communities further south. Since Daggett County has only small communities, the decision was made to include Uintah County, Utah, within the impact region due to the influence of the town of Vernal. As a result, the socioeconomics geographic impact area for both the reservoir and river recreation analyses includes all three counties: Daggett and Uintah Counties in Utah and Sweetwater County in Wyoming (see the frontispiece map).

Table 3-17.—Current Green River and Flaming Gorge Reservoir Annual Value Estimates by Activity

Recreation Activity	Original Value per Visit (Survey)	No. of Responses	Full Sample	Revised Current Value per Visit	Current Number of Total Visits	% of Total Visits	Current Total Value ($1,000s)	% by Activity and Site	% of Total by Activity
I. Current Green River Valuation:									
Scenic Floating	$ 80.05	38	65	$ 46.80	24,768	3.7	$ 1,159.2	24.2	6.2
Guide Boat Fishing	$ 296.19	21	34	$ 182.94	11,400	1.7	$ 2,085.5	43.5	11.1
Private Boat Fishing	$ 85.00	37	84	$ 37.44	18,531	2.8	$ 693.8	14.5	3.7
Shoreline Fishing/ Trail Use	$ 33.55	105	150	$ 23.49	35,482	5.3	$ 833.5	17.4	4.4
Camping	$ 24.55	8	59	$ 10.78	2,281	0.3	$ 24.6	0.5	0.1
Total:					92,461	13.9	$ 4,796.5	100	25.5
II. Current Flaming Gorge Reservoir Valuation:									
Power Boating/ Waterskiing	$ 50.60	62	122	$ 25.71	359,278	54.1	$ 9,237.0	66.1	49.2
Boat Fishing	$ 57.30	55	125	$ 25.21	181,348	27.3	$ 4,571.8	32.7	24.4
Boat Camping	$ 30.10	46	106	$ 13.06	10,374	1.6	$ 135.5	1.0	0.7
Swimming/ Waterplay	$ 35.00	4	97	$ 1.44	21,291	3.2	$ 30.7	0.2	0.2
Total:					572,291	86.1	$ 13,975.0	100	74.5
III. Combined Total:					664,752	100.0	$ 18,771.5		100.0

3.12.2 Current Conditions

The latest available data for the IMpact analysis for PLANning (IMPLAN) regional input-output model used in the analysis reflects regional economic activity for calendar year 1999. (For information on the IMPLAN model, see section 4.12.1.1, "Regional Economics Modeling Methodology.") Table 3-18 presents "current" base year 1999 conditions from the IMPLAN three-county model for total industry output, employment, and labor income. The table is broken down by major aggregated industry as well as the eight most directly impacted recreation-oriented economic sectors identified in the analysis. The eight directly impacted sectors are shown separately, but under their associated major industry (e.g., "air transportation" is presented under transportation; each directly impacted sector is preceded by a dash). To estimate totals for the primary industries listed in the table, add the separately presented sectors to the major industry estimates (e.g., adding "air transportation" with "other transportation" estimates total transportation).

Reviewing table 3-18, the most important industries vary depending on the measure. From an output perspective, the top five industries include mining (33.8%), transportation (12.0%), services (9.7%), construction (8.4%), and manufacturing (8.1%). From an employment perspective, the top five industries include services (20.9%), retail trade (17.6%), government (17.3%), mining (10.8%), and manufacturing (8.3%). The top five industries from the perspective of labor income include mining (22.1%), government (16.1%), transportation (14.8%), services (13.1%), and construction (8.7%).

The eight most affected sectors, from a recreation expenditure perspective, combined to provide 5.4% of total industry output, 16.6% of employment, and 7.3% of labor income. These directly impacted sectors are fairly significant contributors to regional employment but relatively insignificant in terms of output and income. Food stores, automobile dealers and service stations, eating and drinking establishments, miscellaneous retail stores, and hotels and lodging places, in particular, combine for 16.1% of total regional employment.

3.13 PUBLIC SAFETY AND PUBLIC HEALTH

This section elaborates further on the affected environment in relation to safety and public health. The existing environment for recreation is described in section 3.11, and potential safety consequences as they relate to recreation activities are described in sections 4.11.2 and 4.11.4. This section describes elements of public safety that are not directly related to recreation, including risks associated with high riverflows and disease vectors.

3.13.1 Public Safety Considerations for the Reservoir and the River Immediately Below the Dam

Public safety at Flaming Gorge Reservoir relates to the area between the high water elevation and the elevation of the reservoir at a given point in time. Hazards on the reservoir can occur at all elevations, but generally increase as the reservoir goes down. Distances from roads and parking lots to the reservoir increase at lower reservoir elevations. Access to the reservoir at lower elevations is not developed and may be steep, uneven, and covered with rocks and debris.

When flows exceed the powerplant capacity of 4,600 cfs, there could be some additional danger to the public in the area immediately below the dam. However, public access is restricted in this area. The area between the spillway boat ramp and the dam is controlled

Table 3-18.—Current Conditions
(Impact Area Counties: Daggett and Uintah, Utah; Sweetwater, Wyoming)
(Data Year: 1999)

Primary Industries/Sectors	IMPLAN Industry Number	Total Industry Output		Employment		Labor Income	
		Millions of Dollars ($M)	% of Total	No. of Jobs	% of Total	Millions of Dollars ($M)	% of Total
Agriculture, Forestry, Fishing	1-27	50.8	1.3	1,340	3.5	15.9	1.2
Mining	28-47, 57	1,349.7	33.8	4,146	10.8	283.9	22.1
Construction	48-56	335.5	8.4	3,210	8.3	111.3	8.7
Manufacturing	58-432	322.1	8.1	1,728	4.5	85.4	6.7
Other Transportation	433-436 438-440	471.8	11.8	2,899	7.5	187.4	14.6
- Air Transportation:	437	6.4	0.2	74	0.1	2.7	0.2
Communications	441-442	45.7	1.1	194	0.5	11.1	0.9
Utilities	443-446	285.2	7.1	625	1.6	45.4	3.5
Wholesale Trade	447	89.3	2.2	1,074	2.8	36.9	2.9
Other Retail Trade	448-449 452-453	52.9	1.3	1,579	4.1	25.8	2.0
- Food Stores: - Automotive Dealers and Service Stations: - Eating and Drinking: - Miscellaneous Retail:	450 451 454 455	32.2 55.4 66.5 17.1	0.8 1.4 1.7 0.4	882 1,076 2,292 921	2.3 2.8 6.0 2.4	18.9 25.3 22.6 8.4	1.5 2.0 1.8 0.7
Finance, Insurance, and Real Estate (FIRE)	456-462	206.2	5.2	1,769	4.6	27.2	2.1
Other Services	464-476 478-487 489-509	345.7	8.7	6,891	17.9	152.1	11.9
- Hotels and Lodging Places: - Automobile Rental and Leasing: - Amusement and Recreation Services:	463 477 488	36.1 .4 3.2	0.9 0.0 0.1	1,004 13 149	2.6 0.0 0.4	14.4 0.1 1.4	1.1 0.0 0.1
Federal, State, and Local Government	510-515 519-523	261.7	6.6	6,659	17.3	207.1	16.1
TOTAL:		3,993.7	100	38,523	100	1,283.3	100
MOST AFFECTED SECTORS:		217.3	5.4	6,410	16.6	93.8	7.3

during high use periods, which contributes to public safety. Signage along the river access road indicates that the river may fluctuate at any time up to 4 feet in elevation.

3.13.2 Public Safety Considerations for the Green River

Riverflows in Reach 1 up to 4,600 cfs do not pose any safety problems relative to structures (buildings, bridges, and roads) over or near the river. Prior to 1992, releases of 4,600 cfs for power generation occurred more often than they have since 1992. Problems can arise at the bridges that cross the Green River; high flows can inundate bridge approaches. If these areas are inundated for more than a few days, then questions of structural stability can arise. The river in Reach 1 has exceeded 8,000 cfs two times in the past 10 years and four times since the dam was constructed. The Greendale gauge was installed 12 years prior to dam construction. During that time Reach 1 exceeded 8,000 cfs in 9 of the 12 years.

Reach 2 of the Green River is greatly influenced by the essentially unregulated flows of the Yampa River. In Reach 2, the river has exceeded 18,000 cfs 5 times in the past 10 years and 10 times in the past 20 years. The effects of dam operations are even further attenuated in Reach 3. In general, higher flows in the Green River can be said to increase hazards to the public.

3.13.3 Public Health: Disease Vectors

Common vectors, such as mosquitoes, deer mice, bats, and ticks, can transmit serious diseases to people. Mosquitoes can transmit malaria, West Nile virus, and encephalitis; deer mice can transmit hanta virus; bats and other mammals can transmit rabies; and ticks can transmit Lyme disease.

During the EIS scoping sessions, individuals expressed concerns that the proposed changes to the operation of Flaming Gorge Dam may produce conditions that benefit mosquitoes and exacerbate the potential problems with the encephalitis virus. In the Jensen, Utah, area, the Saint Louis virus and the Western Equine Encephalitis virus are potential threats of the disease; and perhaps the West Nile virus may be a problem. West Nile virus was discovered in the Uintah Basin in 2003. Similar levels of concern for the nonaquatic vectors were not expressed at the scoping meetings, and it is not anticipated that the operational changes would cause similar impacts on nonaquatic vectors. Therefore, this EIS will only assess the mosquito vector. There are many species of mosquitoes living along the Green River. Two common mosquito species in the Jensen, Utah, area are the *Aedes* and the *Culex* species, which are major mosquito nuisances in the area (Romney, 2002). A common mosquito, *Culex tarsalis,* is considered to be one of the principal vectors of the Western Equine Encephalitis virus (American Mosquito Control Association, Inc., 1990). The floods that result from the operation changes may impact other aquatic vectors such as other biting insects.

Meteorological conditions such as temperature and humidity are important factors in determining the longevity of mosquitoes (American Mosquito Control Association, Inc., 1990). High temperatures and low humidity can shorten the life span of mosquitoes. Under the right conditions, mosquitoes can live many months. However, many mosquitoes do not live past 2 weeks. The number of mosquitoes present at a location is generally dependent on the amount of habitat available. A good breeding site is one where standing water is present for about 2 weeks and protected from the elements such as wind. Vegetation and shallow depressions along rivers provide good habitat for mosquitoes, especially after a rain or flood. The female mosquito requires a blood meal for egg development, and the blood meal can be taken from a variety of sources including birds, cattle, horses, and people. Diseases can be transferred at the same time the blood meal is taken. In order to transmit the encephalitis virus to people, the mosquito must make two successful feedings. One feeding must be from the infected source and the second feeding will infect the new host. A potential mosquito vector is one that lives more than 10 days and takes two or more blood meals (American Mosquito Control Association, Inc., 1990).

Procedures exist to control mosquitoes in the larval, pupal, or adult life stages. Federal, State, and local regulations govern the use of insecticides and have limited the number of chemical controls in and near waters. Applications of insecticides must comply with the labeling requirements for that product. The Uintah County Mosquito Abatement District applies *Bacillus thuringiensis* (BT) by aircraft to control mosquitoes at the larval stage. BT must be applied before the mosquito develops into the pupal stage. BT produces a toxin that kills the mosquito.

BT is a naturally occurring soil bacterium, and anyone coming in contact with soils may encounter the microorganism. BT is registered for use to control mosquito larval in waters. Current information on the toxicity and exposure data of BT indicates that the use of pesticide products containing BT should not be harmful to endangered mammals, birds, fish, and plants (U.S. Environmental Protection Agency [EPA], 1998). The use of pesticide products with BT should not pose a threat to human health (EPA, 1998). BT does show some toxicity to honey bees and water fleas (*Daphnia)* (EPA, 1998).

Irving and Burdick (1995) conducted an inventory, largely based on aerial photography, of potential flooded bottomland habitats in the Green River. They determined that approximately 1,591, 8,648, and 8,154 acres of potential mosquito habitat were present in Reaches 1, 2, and 3, respectively. In Reach 3, about 2,718 acres were present in the portion of the reach between the White River confluence and Pariette Draw, and about 1,878 acres were present in Canyonlands. They did not determine the relationship of flood plain inundation to flow.

Bell et al. (1998) used aerial photography to determine the relationship between flow and flood plain inundation in Reach 2 from Split Mountain Canyon to the White River and the upper portion of Reach 3 from White River to Pariette Draw. In Reach 2 at 19,988; 22,037; and 24,897 cfs, approximately 5,189; 8,648; and 12,108 acres, respectively, would be flooded. In the upper portion of Reach 3, Bell et al. (1998) indicated that at flows of 22,001; 24,014; and 32,490 cfs, about 655; 1,050; and 1,895 acres, respectively, would be flooded.

The Uintah County Mosquito Abatement District provides mosquito control treatment for about 50 river miles of Green River between the Dinosaur National Park boundary and Ouray, Utah (Romney, 2002). Reach 2 covers most of this area. Generally, the higher the flows in the river, the more adjacent lands will be flooded, and more mosquito habitat is created. Mosquito habitat would be sustained as long as the river is running high. The Uintah County Mosquito Abatement District has provided an estimate of the number of aggregate acres they may have to treat based on the flows in the river at the Jensen Station. Since BT has a relatively short active period, repeat treatments of the same area are usually required. The Uintah County Mosquito Abatement District indicated that within the 50-mile (80.4-kilometer) affected area, they consider treating 10,000 acres when flows reach 10,000 cfs. When flows reach 15,000; 18,000; and 26,000 cfs, treatment is considered on about 15,000; 30,000; and 40,000 acres, respectively (Romney, 2002). The acre numbers, provided by the Uintah County Mosquito Abatement District, include multiple treatments of the same area.

Since 1964, the Centers for Disease Control and Prevention reported that there have been 639 confirmed cases of Western Equine Encephalitis and 4,478 reported cases of St. Louis Encephalitis in the United States. In 1978, an outbreak of Western Equine

Encephalitis affected 68 horses in the Jensen, Utah, area (Romney, 2002). Birds are known carriers of the encephalitis virus, and monitoring chicken populations would provide important information. Since 1983, the local abatement districts employ chicken plots to monitor the incidence of the encephalitis virus in the area. The plots indicated that the Jensen, Utah, area is considered to be one of the principal areas where the virus could become established (Romney, 2002). The virus would be difficult to eliminate from the area since the encephalitis virus could be imported by migrating bird populations.

As of November 19, 2003, the Centers for Disease Control and Prevention reported 8,470 mild and severe human disease cases of West Nile virus nationwide (Centers for Disease Control and Prevention, 2003). In 2003, the virus has been reported throughout much of the United States, including the States of Utah, Colorado, and Wyoming.

3.14 AIR QUALITY

The Flaming Gorge region generally has good air quality that is affected both by weather and industry, which includes electric utility generation. Changes in pollution discharges can have an impact, but these changes are also dependent on the ability of the environment to disperse and absorb the pollutants. Electric generation by fossil-fired powerplants provides significant levels of some pollutants; any change in the production of such powerplants due to the Action Alternative can affect the air quality of the region.

This region is semi-arid, with wide variations in climate due to varying topography. It is affected by warm air masses moving from the Pacific Ocean eastward and Canadian air masses that occasionally settle over the region. Wind flows generally occur from west to east but often are modified by local topographic features. Topography also affects the speed of wind flows, with western exposed mountain slopes having high wind speeds but protected valleys experiencing relatively low wind speeds. High pressure weather systems with light wind conditions occur often. High winds occur during the winter and spring seasons.

Temperatures can vary widely through this region, depending on elevation and season of the year. Annual precipitation averages 12 inches a year, with generally higher levels in the mountain areas. Precipitation from Pacific storms occurs more often between October and April. Summer storms from the Gulf of Mexico occur between July and September. Evaporation rates are high throughout the river basins due to high temperatures, low humidity, clear skies, and moderate winds. Atmospheric dispersion of pollutants improves with increases in wind speed and precipitation.

While the air quality is generally good in this region, pockets of nonattainment of Clean Air Act standards do exist in Utah. These occur around the Salt Lake County area and other industrial portions of Utah for pollutants such as sulfur dioxide, carbon monoxide, ozone, and total suspended particulates/small particulate matter. Also, an industrial region east of the reservoir in Wyoming has nonattainment pockets for total suspended particulates/small particulate matter. From 1981 to 1990, the electric utility industry generated from 23% to 51% of the sulfur dioxide levels in the Southwestern part of the United States and from 34% to 56% of the nitrogen oxides. The electric utility industry also generated up to 39% of the total carbon dioxide levels for the six-State region in the Southwestern United States during the same timeframe. Substantial changes in output by the electric utility industry could have significant effect on the air quality around the Flaming Gorge region and the Southwestern United States area if weather patterns do not disperse these pollutants.

3.15 VISUAL RESOURCES

Flaming Gorge Reservoir is situated on the eastern slope of the scenic Uinta Mountains in northeastern Utah. The concrete arch dam was constructed during the mid-1960s. The heart of the Flaming Gorge National Recreation Area is a 91-mile long reservoir, created by Flaming Gorge Dam. There are over 300 miles of shoreline. An estimated 3,000 acres of shoreline are involved.

The Green River flows out of the dam, down through the lower reaches of Red Canyon, and into Browns Park. The stretch of river covers approximately 20 miles. An estimated 100 acres of riverbank are involved.

The landscape consists of a high plateau, about 8000 feet in elevation, covered by ponderosa pine, pinion pine, and Utah juniper, and is dissected by the Red Canyon. The Green River flows through the deep Red Canyon beginning at Flaming Gorge, near Sheep Creek Flats, and exits at Browns Park, a broad open valley near the Utah-Colorado State line. Rock formations are prominent, and soils are reddish in color. The Uinta Mountains form a high, scenic backdrop to the west.

The Wyoming portion consists of a different land type, prominent grayish ledges and bluffs, where the Green River corridor is not as deeply defined. Vegetative patterns are of a sage nature. Soils consist of shale or clay type material. Open spaces are prominent.

3.15.1 Scenic Integrity

Visual qualities are perceived by those who normally recreate or spend time in a particular area, who, in this case, would be the casual forest visitor. Much of their recreational experience relates to their concern for scenic quality and the condition of the view shed.

Scenic values and qualities within the FGNRA and along the Green River corridor are high. With a background of the Uinta Mountains and distant vistas, this is the premier scenic showcase for northeastern Utah and southwestern Wyoming.

The Recreation Opportunity Spectrum calls for this area to be managed for a Roaded-Natural or Roaded-Modified setting. The Recreation Opportunity Spectrum for the area around Flaming Gorge Dam is close to an "Urban" setting.

The Scenic Integrity Level for the southern end of the FGNRA, including Cedar Springs, the dam, Dutch John, Antelope Flats, and Little Hole, is considered high to moderate. Scenic Integrity Levels for the Wyoming portion and Green River corridor, below Little Hole, would be considered as high to moderate. The desired scenic condition for the entire FGNRA and Green River corridor would be natural appearing and cultural.

BLM-administered lands from Little Hole to the Colorado State line are being managed as Class II areas. The objective of Class II is that management actions may cause alternations to the natural settings, but they shouldn't attract the attention of the casual observer.

3.15.2 Constituent Information

Visitors to the FGNRA come from Utah, Wyoming, Colorado, and all over the United States. Most international visitors are from England, Germany, France, and Japan. They expect to view outstanding scenery, visit the dam, and catch trophy fish. The majority of recreation use occurs during the summer months, between Memorial Day and Labor Day, or approximately 100 days.

Recreational opportunities include driving for pleasure, viewing scenery, fishing, boating, floating, waterskiing, swimming, scuba diving, hunting, mountain biking, and hiking. Winter activities include cross-country skiing, snowmobiling, and ice fishing on the reservoir and stream fishing on the river. Facilities include visitor centers, boat ramps, campgrounds, trails, commercial lodges, service stations, and marinas.

3.15.3 Landscape Visibility

Most areas within the FGNRA are seen by the public from one point or another. People in boats scrutinize all parts of the reservoir and shoreline from the water level. Other forest visitors and fishermen view the reservoir from above and points around the FGNRA, such as Red Canyon Visitor Center, Flaming Gorge Dam and Visitor Center, campgrounds, marinas and dispersed areas.

People floating the Green River and hiking the trails have the perspective of Red Canyon at the water level. Only a few vista points along the river are available from roadways. These include views from Flaming Gorge Dam, spillway, boat ramp, Little Hole area, and at Browns Park.

3.16 ENVIRONMENTAL JUSTICE

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," dated February 11, 1994, requires agencies to identify and address disproportionately high and adverse human health or environmental effects of their actions on minorities and low-income populations and communities as well as the equity of the distribution of the benefits and risks of their decisions.

Table 3-19 presents population data by race and Hispanic origin for the States of Utah and Wyoming, the Uintah and Ouray Reservation, and the counties which may potentially be affected by changes in the flows of the Green River. Moffat County, Colorado, and San Juan and Wayne Counties, Utah, were not included since the lands adjacent to the Green River within those counties are publicly owned and no one lives on them. Carbon County, Utah, was not included because the lands adjacent to the Green River in this county are part of, and are included in, the data for the Uintah and Ouray Reservation. The study area is predominately white. In 1990, the white population in the area ranged from 83.3% to 98.0%. The range of percentages for 2000 changed slightly, from 81.2% to 95.6%. The American Indian and Alaskan Native population is the largest minority group in the study area, with the highest percentage of total population ranging from 15.4% in 1990 to 14.5% in 2000 on the Uintah and Ouray Reservation. The Hispanic population is a minority ethnic group which can be of any race. Sweetwater County, Wyoming, had the greatest percentage of Hispanic population—8.9% in 1990 and 9.4% in 2000.

The percentages of all people in poverty for the States of Utah and Wyoming, the Uintah and Ouray Reservation, and the study area counties are shown in table 3-20. The reservation and all of the counties, except Emery and Grand Counties, showed a decrease in the percentage of people in poverty from 1989 to 1999. All of the study area is considered to be nonmetropolitan. When compared to the percentage of people in poverty for the nonmetropolitan areas in 1999, the reservation and Grand and Uintah Counties had greater percentages of people in poverty.

Table 3-19.—Population by Race and Hispanic Origin

Area	Year	Total Population	Race							Ethnicity
			White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Some Other Races	Two or More Races	Hispanic or Latino (of Any Race)
State of Utah	1990	1,722,850	1,615,845	11,576	24,283	25,696	7,675	37,775	(NA)	84,597
	% Total Population	100.0	93.8	0.7	1.4	1.5	0.4	2.2	(NA)	4.9
	2000	2,233,169	1,992,975	17,657	29,684	37,108	15,145	93,405	47,195	201,559
	% Total Population	100.0	89.2	0.8	1.3	1.7	0.7	4.2	2.1	9.0
Uintah and Ouray Reservation	1990	17,224	14,355	12	2,650	34	19	154	(NA)	459
	% Total Population	100.0	83.3	0.1	15.4	0.2	0.1	0.9	(NA)	2.7
	2000	19,182	15,585	25	2,780	33	19	278	462	673
	% Total Population	100.0	81.2	0.1	14.5	0.2	0.1	1.5	2.4	3.5
Dagget County	1990	600	674	–	9	5	–	2	(NA)	15
	% Total Population	100.0	97.7	–	1.3	0.7	–	0.3	(NA)	2.2
	2000	921	871	6	7	1	–	22	14	47
	% Total Population	100.0	94.5	0.7	0.8	0.7	–	2.4	1.5	5.1
Emery County	1990	10,332	10,127	4	44	30	6	121	(NA)	219
	% Total Population	100.0	98.0	–	0.4	0.3	0.1	1.2	(NA)	2.1
	2000	10,860	10,386	20	71	34	11	203	135	568
	% Total Population	100.0	95.6	0.2	0.7	0.3	0.1	1.9	1.2	5.2

Table 3-19.—Population by Race and Hispanic Origin (Continued)

Area	Year	Total Population	Race							Ethnicity
			White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Some Other Races	Two or More Races	Hispanic or Latino (of Any Race)
Grand County	1990	6,620	6,341	7	203	19	5	45	(NA)	291
	% Total Population	100.0	95.8	–	3.1	0.3	–	0.7	(NA)	4.4
	2000	8,485	7,861	21	327	19	4	141	112	471
	% Total Population	100.0	92.6	0.2	3.9	0.2	–	1.7	1.3	5.6
Uintah County	1990	22,211	19,537	9	2,335	61	21	248	(NA)	691
	% Total Population	100.0	88.0	–	10.5	0.3	0.1	1.1	(NA)	3.1
	2000	25,224	22,130	29	2,365	56	20	264	360	894
	% Total Population	100.0	87.7	0.1	9.4	0.2	0.1	1.0	1.4	3.5
State of Wyoming	1990	453,588	427,061	3,606	9,479	2,638	168	10,636	(NA)	25,751
	% Total Population	100.0	94.2	0.8	2.1	0.6	–	2.3	(NA)	5.7
	2000	493,782	454,670	3,772	11,133	2,771	302	12,301	8,883	31,669
	% Total Population	100.0	92.1	0.8	2.3	0.6	0.1	2.5	1.8	6.4
Sweetwater County	1990	38,823	36,564	289	305	247	7	1,411	(NA)	3,470
	% Total Population	100.0	94.2	0.7	0.8	0.6	–	3.6	(NA)	8.9
	2000	37,613	34,461	275	380	240	16	1,349	892	3,545
	% Total Population	100.0	91.6	0.7	1.0	0.6	–	3.6	2.4	9.4

[1] "–" represent zero or rounds to zero.

[2] Because individuals could only report one race in the 1990 census and could report more than one race in the 2000 census, data on race for 1990 and 2000 are not directly comparable.

Source: U.S. Census Bureau, Census 1990 and 2000.

Table 3-20.—Poverty[1]

Area	1989 Percent	1999 Percent
Utah – State	11.4	9.4
Utah – Metro Areas	10.8	8.8
Utah – Nonmetro Areas	15.4	13.5
Uintah and Ouray Reservation	22.9	20.2
Daggett County	14.8	5.5
Emery County	10.5	11.5
Grand County	14.6	14.8
Uintah County	18.7	14.5
Wyoming – State	11.9	11.4
Wyoming – Metro Areas	11.0	10.3
Wyoming – Nonmetro Areas	12.2	11.9
Sweetwater County	8.0	7.8

[1] All people in poverty.
Source: U.S. Census Bureau, 1990 and 2000 Census Population.