3.0 Affected Environment and Environmental Consequences

This section describes the potential changes to the environment due to implementation of the alternatives. It presents the scientific and analytical basis for comparison of alternatives. Resource analysis includes a consideration of direct, indirect, and cumulative impacts in accordance with CEQ and Interior regulations. Each impact topic or issue is analyzed for direct, indirect, or cumulative effects from each of the alternatives, and in consideration of related actions, projects, plans, and documents (Section 1.7). Impacts are described in terms of context (site specific, local or regional), duration (short- or long-term), timing (direct or indirect), and type (adverse or beneficial). Issues related to natural resources are described first, followed by socioeconomic and cultural resources. Any cumulative effects that may be present are discussed in their respective resource areas and not in a stand-alone cumulative effects section. There are relatively few actions that cumulatively impact the affected environment because the location of the proposed action is the Colorado River in Glen, Marble, and Grand Canyons, almost entirely in national parks, GCNP and GCNRA, areas protected and managed for their natural resources and scenic beauty and thus not likely to be subject to many project impacts.

3.1 *General Setting*

The action area or geographic scope of this environmental assessment is a 294-mile reach of the Colorado River corridor from Glen Canyon Dam downstream to the Lake Mead inflow near Pearce Ferry (Figure 1). Glen Canyon Dam impounds the Colorado River about 16 miles upstream from Lees Ferry, Coconino County, Arizona. This action area includes GCNRA in a 16-mile reach from Glen Canyon Dam to the Paria River; and GCNP, a 277-mile reach from the Paria River downstream from Lees Ferry to the Grand Wash Cliffs near Pearce Ferry. In terms of geomorphic features, Glen Canyon encompasses a 16-mile reach from the dam to the Paria River; Marble Canyon is a 61-mile reach from the Paria River to the LCR; and Grand Canyon is a 217-mile reach from the LCR to near Pearce Ferry. The Glen Canyon segment of the action area is also commonly referred to as the Lees Ferry reach. Additional description of the action area and its associated resources can be found in Gloss et al. (2005).

3.2 *Natural Resources*

Natural resources are those physical, chemical, and biological components of the action area that individually and collectively comprise the ecosystem and contribute to the values of GCNP and GCNRA. These typically include water resources, water quality, air quality, sediment, vegetation, terrestrial invertebrates and herptofauna, aquatic food base, fish, birds, and mammals. Based on a review of all natural resources in the action area, only those resources likely to be directly, indirectly, or cumulatively affected by the proposed action are described herein. Of the natural resources, the alternatives considered in this EA would only have effects to fish, so the other resources are not considered further.

3.2.1 *Fish*

Altogether, 20 species of fish occur in Grand Canyon, including 15 non-native (Table 2) and five native species. Five of the eight fish species native to the Colorado River in Grand Canyon have persisted, including humpback chub, flannelmouth sucker, bluehead sucker, and speckled dace (Valdez and Carothers 1998). The razorback sucker is extirpated from Grand Canyon, but is found as a small reproducing population downstream from the canyon, in and below the Colorado River inflow to Lake Mead (Abate et al. 2002, Albrecht and Holden 2006).

Table 2. Non-native fish species presently found in the Colorado River and lower end of tributaries from Glen Canyon Dam to near Pearce Ferry (Ackerman 2008).
0 = absent, R = rare, L = locally common, N = numerous, A = abundant.

Common Name	Scientific Name	Lees Ferry	Marble Canyon	Grand Canyon
Black bullhead	*Ameiurus melas*	0	R	L
Brown trout	*Salmo trutta*	R	R	L
Largemouth bass	*Micropterus salmoides*	0	0	R
Mosquitofish	*Gambusia affinis*	0	0	L
Red shiner	*Cyprinella lutrensis*	0	0	L
Channel catfish	*Ictalurus punctatus*	0	R	N
Common carp	*Cyprinus carpio*	L	N	N
Fathead minnow	*Pimephales promelas*	0	0	L
Green sunfish	*Lepomus cyanellus*	0	0	R
Plains killifish	*Fundulus zebrinus*	0	0	L
Rainbow trout	*Oncorhynchus mykiss*	A	A	L
Redside shiner	*Richardsonius balteatus*	R	R	R
Smallmouth bass	*Micropterus dolomieu*	R	R	R
Striped bass	*Morone saxatilis*	R	R	R

Walleye	*Sander vitreus*	R	R	R

3.2.1.1 Humpback Chub

The humpback chub is currently listed as endangered under the ESA. The humpback chub recovery plan was approved on September 19, 1990 (U.S. Fish and Wildlife Service 1990), and recovery goals were developed in 2002 (U.S. Fish and Wildlife Service 2002a). The recovery goals were set aside as a result of litigation and are in the process of being revised by the USFWS. Designated critical habitat exists in two reaches near the action area (U.S. Fish and Wildlife Service 1994); the lower 8 miles of the LCR and 173 miles of the Colorado River and its 100-year floodplain in Marble and Grand Canyons from Nautiloid Canyon (RM 34) to Granite Park (RM 208). There are six extant populations, five in the upper Colorado River Basin and one in the lower Colorado River Basin. The largest of these populations is the Grand Canyon population, the population that occurs in the action area. The Grand Canyon population consists of nine aggregations, with most individuals in and near the LCR (Valdez and Ryel 1995). Although there is evidence that the humpback chub spawns in other aggregations, the species spawns primarily in the LCR, although young are also found in the Fence Fault Warm Springs at RM 30 (Valdez and Masslich 1999) and further downstream in Middle Granite Gorge. Juvenile humpback chub occur downstream from Glen Canyon Dam at most aggregations (Figure 2), but it is uncertain if these fish originated from the LCR or from local reproduction.

Young and juvenile humpback chub are found primarily in the LCR and the Colorado River near the LCR confluence, although many are found upstream of the LCR, presumably from spawning near the Fence Fault Warm Springs (Valdez and Masslich 1999; Anderson et al. 2010). Humpback chub reproduction occurs annually in spring in the LCR and the young fish either remain in the LCR or disperse downstream into the Colorado River. Dispersal of these young fish has been documented as nighttime larval drift during May through July (Robinson et al. 1998), as density dependent movement during strong year classes (Gorman 1994), and as movement with summer floods caused by monsoonal rain storms during July through September (Valdez and Ryel 1995). Survival of these young fish in the mainstem is thought to be low because of cold mainstem water temperatures (Clarkson and Childs 2000; Robinson and Childs 2001), but fish that survive and return to the LCR contribute to recruitment in this population. Predation by rainbow trout and brown trout in the LCR confluence area has been identified as an additional source of mortality affecting survival and recruitment of humpback chub (Valdez and Ryel 1995; Marsh and Douglas 1997; Yard et al. 2011).

Population estimates using an age-structured, mark-recapture (ASMR) method show that the population has ranged from about 11,000 adults (4 years old and older and capable of reproduction) in 1989 to 5,000 adults in 2001 (Coggins and Walters 2009). The number of adults decreased from 1989 to 2001, but increased by approximately 50 percent between 2001 and 2008 to an estimated 7,650 adults (Figure 4). Inter-relationships between river flow and humpback chub habitat show a close association of juveniles (less than 4 years old and 200 mm total length) with certain reaches of river having shoreline cover, including large rock talus, debris fans, and vegetation (Converse et al. 1998). Adults also show an affinity for the same river reaches and generally remain in low-velocity pockets within large recirculating eddies (Valdez and Ryel 1995). The principal area occupied by the Grand Canyon population of humpback chub is in and around the LCR, about 77 mi (123 km) downstream from the dam.

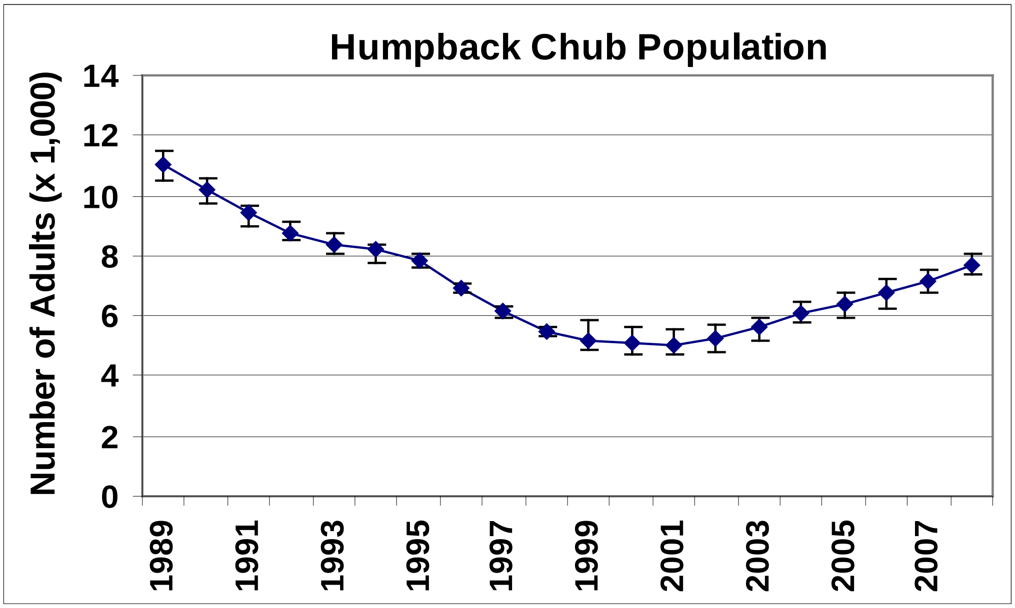


Figure 4. Estimated adult humpback chub abundance (age 4+) from ASMR, incorporating uncertainty in assignment of age. Point estimates are mean values among 1,000 Monte Carlo trials, and error bars represent maximum and minimum 95-percent profile confidence intervals among 1,000 Monte Carlo trials. All runs assume the coefficient of variation of the von Bertalanffy L∞ was CV (L∞) = 0.1 and adult mortality was M∞ = 0.13 (Coggins and Walters 2009).

3.2.1.2 Razorback Sucker

The razorback sucker is currently listed as “endangered” under the ESA (56 FR 54957). Designated critical habitat includes the Colorado River and its 100-year floodplain from the confluence with the Paria River (RM 1) downstream to Hoover Dam, a distance of nearly 500 miles, including Lake Mead to the full pool elevation. A recovery plan was approved on December 23, 1998 (U.S. Fish and Wildlife Service 1998) and recovery goals were approved on August 1, 2002 (U.S. Fish and Wildlife Service 2002b). Primary threats to razorback sucker populations are streamflow regulation and habitat modification and fragmentation (including cold-water dam releases, habitat loss, and blockage of migration corridors); competition with and predation by non-native fish species; and pesticides and pollutants (Bestgen 1990; Minckley 1991).

The razorback sucker has not been reported in Grand Canyon since 1990 and only 10 adults were reported between 1944 and 1995 (Gloss et al. 2005). Carothers and Minckley (1981) reported four adults from the Paria River in 1978-1979. Maddux et al. (1987) reported one female razorback sucker at Upper Bass Camp (RM 107.5) in 1984, and Minckley (1991) reported five adults in the lower LCR from 1989-1990. The razorback sucker is probably extirpated from the Colorado River and its tributaries between Glen Canyon Dam and the Lake Mead inflow, although a small reproducing population occurs in Lake Mead (Albrecht and Holden 2006).

3.2.1.3 Non-Listed Native Fishes

The Colorado River from the Glen Canyon Dam to the Paria River supports small numbers of bluehead sucker, flannelmouth sucker, and speckled dace. Flannelmouth sucker spawn in this reach and in the lower Paria River (McIvor and Thieme 2000; McKinney et al. 1999; Thieme 1998). Bluehead sucker, flannelmouth sucker, humpback chub, and speckled dace occur in moderate numbers in the river between the Paria and Little Colorado rivers (Ackerman 2008; Lauretta and Serrato 2006; Johnstone and Lauretta 2007; Trammell et al. 2002;). Most native fish in the mainstem from the dam to the LCR are large juveniles and adults. Earlier life stages rely extensively on more protected nearshore habitats, primarily backwaters (Lauretta and Serrato 2006; Trammell et al. 2002). The 174 miles from the LCR to Bridge Canyon has six large tributaries and supports a diverse fish fauna of cool- to warm-water species to about Havasu Creek, including the three non-listed native species. Non-listed native fish are also well represented in Bright Angel, Shinumo, Tapeats, Kanab, and Havasu creeks (Johnstone and Lauretta 2007; Leibfried et al. 2006), especially during spawning periods.

The Grand Canyon fish community shifted over the past decade from one dominated by non-native salmonids to one dominated by native species (Ackerman 2008; Johnstone and Lauretta 2007; Lauretta and Serrato 2006; Makinster et al. 2010; Trammell et al. 2002). Catch rates of flannelmouth and bluehead suckers increased four to six-fold from 2000 through 2008, and speckled dace catch rates were steady but generally higher than historical levels (Johnstone and Lauretta 2007; Lauretta and Serrato 2006; Makinster et al. 2010). It is hypothesized that recent shifts from non-native to native fish are due in part to warmer than average water temperatures and declines of coldwater salmonids (Ackerman 2008; Andersen 2009). Despite the fact that the warmer water temperatures have somewhat dissipated and non-native fish numbers, especially trout, have dramatically increased, the high abundance of native fish has persisted.

3.2.1.4 Trout

Two species of non-native trout are found in Grand Canyon, the rainbow trout and brown trout. The population of rainbow trout in the 15-mile long Lees Ferry tailwater reach has undergone large changes in abundance since standardized monitoring began in 1991. Recruitment and population size appear to be governed largely by dam operations (Arizona Game and Fish Department, 1996; McKinney et al. 1999, 2001; Wright and Kennedy 2011). Rainbow trout are also found fairly consistently in the mainstem Colorado River between the Paria River and the LCR confluence (Makinster et al. 2010). Below that point, small numbers are found associated with tributaries, including Bright Angel Creek, Shinumo Creek, Deer Creek, Tapeats Creek, Kanab Creek, and Havasu Creek. Brown trout are found primarily near and in Bright Angel Creek, where there is a spawning population. Small numbers are found elsewhere in the canyon.

The rainbow trout population in the Lees Ferry reach has been monitored since 1991. From 1993 to 1997, the population increased and remained high until 2001 (Figure 5). McKinney et al (1999) attributed the dramatic increase from 1991 to 1997 to increased minimum flows and reduced daily discharge fluctuations. After 2001, there was a steady decline in the Lees Ferry population until 2007. A similar decline in rainbow trout abundance below the Paria River was observed during that same time period (Makinster et al. 2010). The 2001–2007 decline is attributed to increased water temperatures (associated with low reservoir elevations) and trout metabolic demands coupled with a static or declining food base, periodic oxygen deficiencies and nuisance aquatic invertebrates (New Zealand mudsnails; Behn et al. 2010). Concurrent with these declines in abundance, however, trout condition (a measure of plumpness or optimal proportionality of weight to fish length) has increased, reflecting a strongly density dependent fish population where growth and condition are inversely related to fish abundance (McKinney et al. 1999, 2001).

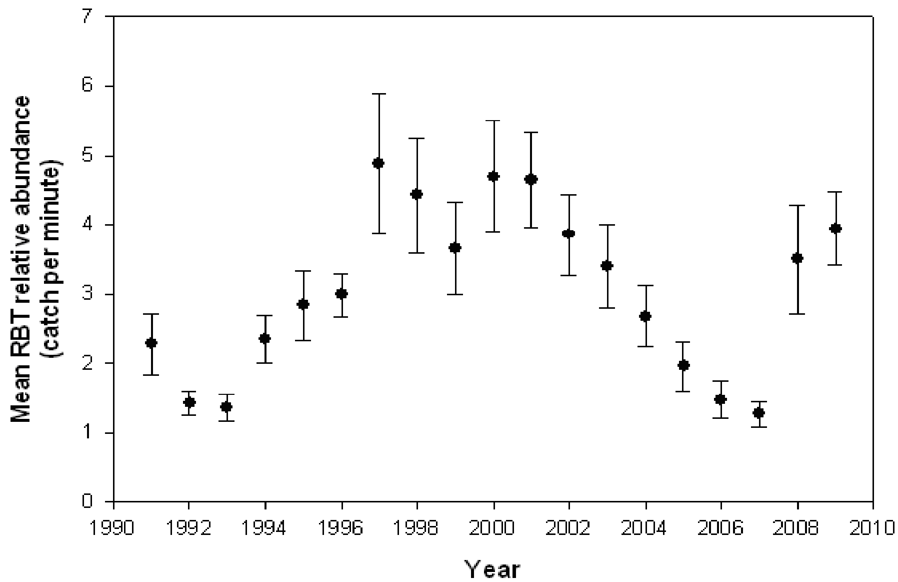


Figure 5. Average annual electrofishing catch rates of rainbow trout in the Lees Ferry reach (Glen Canyon Dam to Lees Ferry) for 1991-2010 (Makinster et al. 2010).

During 2003-2005, "nonnative fish suppression flows" were released from the dam to evaluate these flows in controlling the trout population in the Lees Ferry reach with high and low flows to reduce survival of eggs and young. In addition, a program of mechanical removal was conducted in the vicinity of the LCR during 2003–2006 and 2009 to determine if electrofishing could be used to control trout and minimize competition and predation on humpback chub in that reach. Although the "non-native fish suppression flows" did result in a total redd loss estimate of 23% in 2003 and 33% in 2004, this increased mortality did not lead to reductions in overall recruitment due to increases in survival of rainbow trout at later life stages (Korman et al. 2005; Korman et al. 2011). Removal of non-native fish using boat-mounted electrofishing in the LCR reach was effective for both rainbow trout and brown trout removal. Of 36,500 fish captured from 2003-2006, 23,266 were non-native, including 19,020 rainbow trout and 470 brown trout. Levels of both trout species were effectively suppressed in the LCR reach using this method, especially rainbow trout, which dropped from an initial estimated abundance of 6,466 in January of 2003 to a low of 617 in February 2006 (Coggins et al. 2011). An increase in rainbow trout in the LCR reach since 2006 has been attributed to the increased survival and growth of young trout following the March 2008 HFE (Wright and Kennedy 2011). The 2008 HFE likely benefitted rainbow trout by flushing fine sediment from spawning gravels, thus improving survivorship of young trout, and also appears to have resulted in an increase in available food for trout (Korman et al. 2010; Rosi-Marshall et al. 2010). An even larger increase in trout appears to have occurred in 2011, likely as a result of high steady flow releases under the 2007 Colorado River Interim Guidelines (J. Korman, Ecometric, pers. comm., 2011).

3.2.1.5 Other Non-Native Fishes

Fifteen non-native fish species are currently found in Grand Canyon (Table 2, GCMRC unpublished data; Valdez and Carothers 1998). The majority are warm-water species; only two are true cold-water species—rainbow trout and brown trout. The fish population in Glen Canyon (Lees Ferry) is dominated by rainbow trout, with small numbers of brown trout and local abundances of common carp (Ackerman 2008). The fish population in Marble Canyon is dominated by rainbow trout and carp with small numbers of seven other species. In Grand Canyon, dominant warm-water species are channel catfish and carp with local abundances of small minnows and sunfishes.

Recently, a few smallmouth bass (*Micropterus dolomieu*) and striped bass (*Morone saxatilis*) were collected in the vicinity of the LCR (GCMRC unpublished data), but no population-level establishment has been documented to date. There are also recent records of green sunfish, black bullhead, yellow bullhead (*Ameiurus natalis*), red shiner (*Cyprinella lutrensis*), plains killifish (*Fundulus zebrinus*) and largemouth bass (*Micropterus salmoides*) downstream from the LCR, usually associated with warm springs, tributaries, and backwaters (Johnstone and Lauretta 2007; GCMRC unpublished data). Striped bass are found in relatively low numbers below Lava Falls (Valdez and Leibfried 1999; Ackerman 2008). Common carp are relatively common downstream from Bright Angel Creek, although numbers declined from 2000 through 2006 (Makinster et al. 2010).

Non-native fish collected below Diamond Creek in 2005 (Ackerman et al. 2006) were comprised primarily of red shiner (28 percent), channel catfish (18 percent), common carp (12 percent), and striped bass (9 percent); smallmouth bass, mosquitofish (*Gambusia affinis*), and fathead minnow (*Pimephales promelas*) were also present in low numbers. Bridge Canyon Rapid (RM 235) impedes upstream movement of most fish species, except for the striped bass, walleye, and channel catfish (Valdez 1994; Valdez et al. 1995; Valdez and Leibfried 1999). Above Bridge Canyon Rapid, the red shiner was absent, but below the rapid it comprised 50 percent and 72 percent of all fish captured in tributaries and the mainstream, respectively (Valdez 1994; Valdez et al. 1995). Other common fish species found below Bridge Canyon Rapid include the common carp, fathead minnow, and channel catfish; however, very little fish habitat exists in this reach due to declining elevations of Lake Mead and subsequent downcutting of accumulated deltaic sediments in inflow areas.

3.2.1.6 Effects of High Flow Experiments on Fishes

Reclamation is developing an the HFE Protocol EA for the purpose of promoting more natural sediment dispersal throughout the Canyon and improving conditions for sediment-derived resources such as camping beaches. The HFE Protocol is being developed with the intention to allow for multiple high flow tests over a period of 10 years. The HFE Protocol would have effects to fishes under either no action or the proposed action if implemented. The SDM Project analysis results, along with other recent scientific findings, suggest that there is a close relationship between the decision to conduct high flow experiments and to implement non-native fish control because of the apparent effect that spring HFE flows have on trout recruitment in Lees Ferry. The coupled trout-chub models developed as part of the

SDM Project assessment provided some valuable predictions about the effects of HFEs on fishes (see Appendix A, Table 7). Wright and Kennedy (2011) also concluded available evidence indicates that HFEs may impact juvenile humpback chub due to the positive effect of HFEs on trout abundance and the negative effect of trout competition and predation on humpback chub and other native fishes. Wright and Kennedy (2011) reported that rainbow trout abundance in the LCR reach increased as a result of the 2008 HFE. They attribute this increase to downriver migration of the large 2008 rainbow trout cohort spawned in the Lees Ferry tailwater reach immediately after the 2008 HFE, together with local recruitment along downriver sections.

Results from the 1996 and 2008 spring HFEs indicate that high flow experiments have the potential to increase numbers of rainbow trout in Lees Ferry and likely influence the abundance of rainbow trout throughout Grand Canyon due to several factors. Korman et al. (2010; 2011) found multiple lines of evidence indicating that the March 2008 HFE resulted in large increases in abundance of rainbow trout in Lees Ferry due to improved habitat conditions for young-of-year rainbow trout. Numbers of young-of-year rainbow trout in July of 2008 were four-fold greater than would be expected based on numbers of eggs produced during the 2008 spawn based on stock-recruitment analysis. Survivorship was also greater for fish that hatched after the HFE based on hatch-date analysis, also indicating that habitat conditions were improved after the HFE. Growth rates of young-of-year rainbow trout were also as high as has been recorded in Lees Ferry, despite the fact that abundance was also much greater than previous years, suggesting a greater carrying capacity for young trout in Lees Ferry following the HFE (Korman et al. 2010; 2011). Korman et al. (2010; 2011) speculate that the 2008 HFE (41,500 cfs for 60 hours) resulted in these effects because the high flow increased interstitial spaces in the gravel bed substrate and food availability or quality, resulting in higher early survival of young-of-year rainbow trout, as well as improved growth of young trout. This improved habitat effect of the 2008 HFE also apparently carried over into 2009; trout abundance in 2009 was more than two fold higher than expected from egg counts (Korman et al. 2010; 2011).

Although there is less data from the 1996 and 2004 HFEs, those events appeared to have effects to rainbow trout as well. Trout abundance in Lees Ferry appeared to increase following the 1996 event which was conducted in April (Makinster et al. 2009b). During a three-week period that spanned the November 2004 HFE, abundance of age-0 trout, estimated to be approximately 7 months old at that time, underwent a three-fold decline; a two-fold decline was also observed in November-December 2008 (Korman et al. 2010). The decline observed during the 2004 HFE may have been due to either increased mortality or displacement/disbursal as a result of the higher flow (Korman et al. 2010). However, long-term trout monitoring data indicated that trout started to decline system-wide in 2001-2002 and declined through the period of the 2004 HFE and only began to recover in about 2007 (Makinster 2009b). Also, key monitoring programs to detect ecosystem pathways that affect rainbow trout in Lees Ferry were not in place at the time of the 2004 HFE (Wright and Kennedy 2011). Higher water temperatures and lower dissolved oxygen in fall 2005 also may have increased mortality and reduced 2006 spawning activity (Korman et al. 2010). Thus the overall effect of fall HFEs on rainbow trout abundance is unclear.

The HFE Protocol currently under development by Reclamation would provide for the opportunity to conduct multiple high flows over a 10-year period of from 31,500 cfs to 45,000 cfs for 1-96 hours. Proposed time frames are March/April and October/November, periods following the primary sediment-input season are of late summer/early fall and winter. A more detailed description of the proposed action can be found in the HFE Protocol EA (Bureau of Reclamation 2011). High flows conducted in the March/April period likely would result in improved conditions for rainbow trout based upon observations from the 1996 and 2008 HFEs. Given the increase in rainbow trout that apparently resulted from the 2008 spring HFE (Korman et al. 2010, Wright and Kennedy 2011), multiple HFEs over a 10-year period would reasonably be predicted to increase rainbow trout abundance system-wide including in the LCR Reach.

3.2.2 *Fish and Fish Habitat under No Action*

Under the no action alternative, no actions to control non-native fish would be taken for the 10-year period. The No Action alternative would implement MLFF for the 10-year period with steady flows in September and October 2011 and 2012. These dam operations have been previously evaluated through prior NEPA compliance, the 1995 EIS and 1996 ROD and the 2008 EA for Glen Canyon Dam operations (Bureau of Reclamation 1996, 1996, 2008). HFEs could also be conducted as an additional dam operation as described in HFE Protocol EA if the protocol is implemented (Bureau of Reclamation 2011). In general, the no action alternative is predicted to result in a potential deterioration of native fish species, including the humpback chub, and habitat for these species, including humpback chub and razorback sucker critical habitat, because non-native fish would be more likely to proliferate and predation losses of young native fish increase, reducing recruitment of these species.

Non-native fish predation has long been identified as a key threat to humpback chub in Grand Canyon (Minckley 1990, Valdez and Ryel 1995, Marsh and Douglas 1996). Wright and Kennedy (2011) found that rainbow trout appear to have a causal link to adult humpback chub population abundance, which is seen in population abundance trends for both species (Figure 3). When rainbow trout populations are large, humpback chub populations generally decline. Wright and Kennedy (2011) ascribe this relationship to a probable combination of increased competition and predation (citing Coggins, 2008; 160 Coggins and Walters, 2009; Coggins and Yard, 2010; Coggins et al. 2011; Yard et al. 2011). Currently both rainbow trout numbers and humpback chub numbers are high. This suggests that either the adult humpback chub population has not yet been affected by predation from the trout because it takes four years for juveniles to mature and recruit into the adult population, trout predation ultimately has no effect on the adult humpback chub population, or other factors, such as water temperature or flow volume are also effecting trout and humpback chub abundance.

Results from previous non-native fish removal efforts (Yard et al. 2011) of diet content analysis showed that although rainbow trout predation rate on humpback chub was relatively low, the overall loss of young humpback chub to predation by rainbow trout was substantial due to the high density of rainbow trout in the reach. Yard et al. (2011) found that during the 12 removal trips conducted from 2003-2004, 9,326 juvenile humpback chub were eaten by trout. Therefore reducing numbers of rainbow trout in the LCR reach (19,020 rainbow trout were removed) effectively reduced predation losses of young humpback chub, a clear beneficial effect to the species, although other factors, such as warmer mainstem water temperatures in Grand Canyon during this period, confounded the overall effect of removal on humpback chub recruitment in the system (Andersen 2009; Coggins et al. 2011; Yard et al. 2011). Also during this period, rainbow trout declined system-wide, indicated both by abundance estimates from the control reach of the non-native control project and from monitoring throughout the system (Coggins et al. 2011; Makinster 2007). No action would not implement any removal efforts, and because numbers of rainbow trout are similar to abundances seen at the begging of the previous removal efforts (i.e. Yard et al. 2011 in 2003), losses of humpback chub due to predation would be similar.

An interesting early finding of the nearshore ecology study is that juvenile chub that occupy eddy complexes and talus slopes of the mainstem approximately 1.5 miles downstream from the LCR mouth have survivorship rates of 50-60 percent across 3 years of sampling (2008-2010; S. Vanderkoi, USGS, pers. comm. 2011). This suggests that high numbers of trout in this reach have apparently had little effect on juvenile survivorship, at least in the small percentage of habitats examined in the nearshore ecology study. Yard et al (2011) illustrates that clearly if non-native fish are not removed and controlled, then young humpback chub would continue to be consumed by non-native fish, predominantly trout, and trout would continue to compete with humpback chub for food and space. However, there is also evidence that there may be more factors at work which ultimately determine juvenile survival, recruitment, and adult humpback chub abundance. Juvenile humpback chub that survive (are not lost to predation or other causes) may have better survival because there are few humpback chub to compete against (known as compensatory survival). This survival may offset losses of young humpback chub to predation. This is an important aspect of non-native fish control to understand, because if predation on young humpback chub is high, but it ultimately has little effect on recruitment, removal of trout would have no effect on humpback chub recovery, and at great expense. One way to test this hypothesis would be to postpone removal long enough to detect an effect on adult humpback chub abundance, approximately four years, the length of time for humpback chub to mature into adults. The no action would provide for this experiment, because no removal would be implemented. However, if humpback chub adult abundance does decline over time due to trout predation, this alternative would provide no means to counteract this effect.

Thus the loss of young humpback chub to predation could have an effect on the population of humpback chub in Grand Canyon by reducing recruitment (Coggins and Yard 2009; Yard et al. 2011). The effect on the humpback chub population cannot be fully analyzed due to incomplete knowledge of the complexity of survival rates associated with a large number of variables that would translate to adult recruitment, including the uncertainty of numbers and sizes of chub eaten by trout, affects of cold mainstem water temperatures on young humpback chub, various annual densities of juvenile chub depending on year class strength, relationship of predator and prey densities, the causes and levels of other sources of mainstem chub mortality, and the contribution of young humpback chub reared in the mainstem to the adult population.

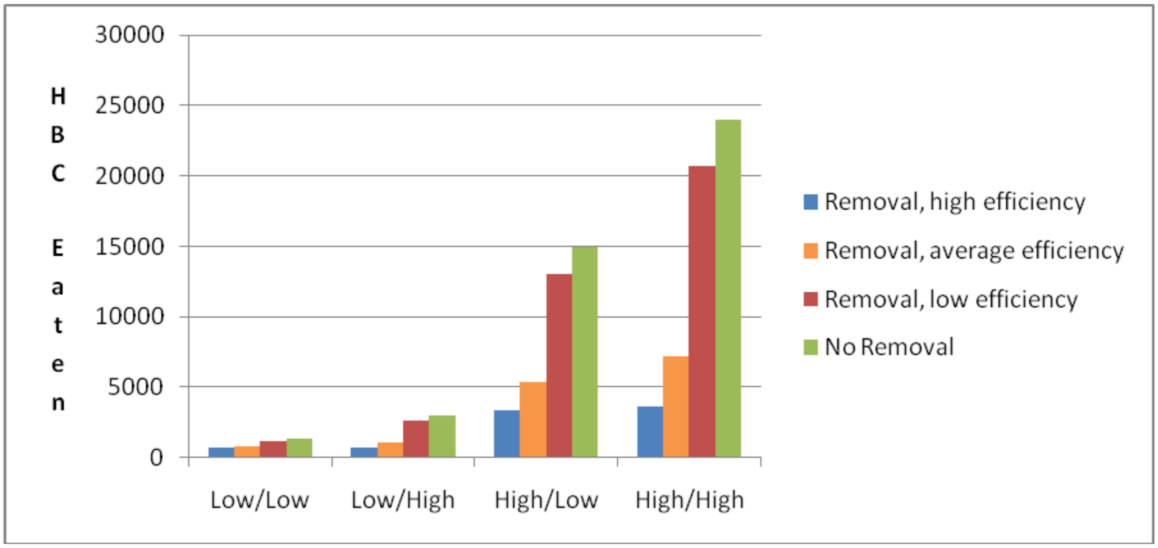


Figure 6. Expected predation of age-0 and subadult humpback chub by trout in the absence of non-native fish removal (green bars) and over a range of removal efficiencies (blue, orange and red bars). X-axis labels refer to assumptions on predator density and piscivory rates. For example, "Low/Low" refers to low levels of predatory density (as a function of trout immigration rates) and low piscivory rates (Yard et al. 2008). The amount of humpback chub that would theoretically be saved through removal efforts is represented by the difference between the green vertical bars and bars of other colors representing the various assumptions on immigration and predation rates (Bureau of Reclamation 2010).

Nevertheless, taking no action would result in losses of young humpback chub due to predation by rainbow trout and other non-native fishes that would not be removed which in turn could result in reductions in humpback chub recruitment and declines in the adult population. Using data from prior removal efforts, we can estimate what effect the no action may have humpback chub recruitment. An analysis of the effects of conducting two removal trips in the LCR reach is provided in Appendix C. Evaluation of population level effects was conducted by converting losses of age-1 humpback chub to losses of adult humpback chub, which is the metric identified in the Recovery Goals (U.S. Fish and Wildlife 2002) and the incidental take statement from the 2009 Supplemental and the 2010 ITS (U.S. Fish and Wildlife Service 2009, 2010). We applied published survival rates for humpback chub (Valdez and Ryel 1995; Coggins et al. 2006) to estimate numbers of preyed-upon humpback chub as described above. We then compared these losses to the minimum population size contained in the incidental take statement (6,000 adult humpback chub; U.S. Fish and Wildlife Service 2010b).

Depending on electrofishing efficiency, estimates of not conducting two non-native fish removal electrofishing trips in the LCR reach could increase predation pressure by rainbow trout substantially (Figure 6). An estimated 129-3,292 young humpback chub (age-0 and age-1) would be theoretically lost to predation under the low efficiency scenario, 532-16,851 humpback chub in the average efficiency scenario and 637 to 20,384 humpback chub in the high efficiency scenario. Losses of age-0 and age-1 humpback chub due to predation from not conducting two electrofishing trips would theoretically translate into losses of adult fish (Figure 7). Four to 96 fish would be lost as a result of predation in the low efficiency scenario, 15 to 491 fish in the average efficiency scenario and 19 to 594 humpback chub in the high efficiency scenario. The grand mean of estimated fish lost from predation across all variables (predation and immigration rates as well as electrofishing efficiency) is 169 fish. Note that this estimate is for two LCR reach removal trips. The cost of not conducting additional trips would result in additional losses of young humpback chub, which would translate into fewer adult humpback chub in the adult population.

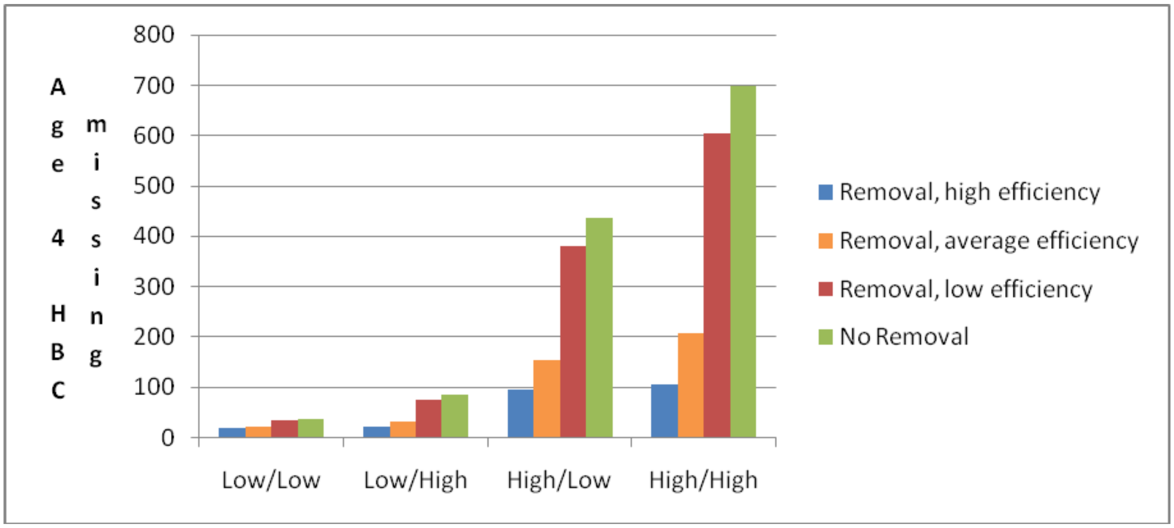


Figure 7. Expected losses of adult humpback chub (age 4+) due to predation by trout in the absence of non-native fish removal (green bars) and over a range of removal efficiencies (blue, orange and red bars, Bureau of Reclamation 2010).

Coggins and Walters (2009) estimated adult (age-4+) humpback chub population size in 2008 to be 7,650 fish. Based on annual mortality rates for humpback chub developed by Coggins et al. (2006) and Valdez and Ryel (1995), and the adult population estimate provided by Coggins and Walters (2009), to arrive at the 2008 population estimate, about 4,511 age-3 humpback chub would have had to be alive in 2007 to produce 2,346 age-4 fish in 2008, because mortality rates would result in a total loss of 2,165 fish (annual mortality of about 48%) between age 3 to 4. Assuming the population size is constant and rates of change remain the same for the next few years, the percentage of total annual mortality due to predation would be average adult fish lost to predation (315) divided by total fish lost to all mortality sources (2,165), or about 15% (a range of 2 – 32%). Thus if recruitment remains sufficient to keep total adult numbers stable or increasing over the next few years, effects of not conducting removal would likely not lead to a large decline in population size. Given the wide range of potential decline due to predation (2 - 32%) there is also some question as to whether a reduction in age-4 humpback chub in the main channel would be detectable under current protocols in the short term. However, over the 10 years of analysis for this EA, losses of humpback chub adults due to not conducting removal could be substantial and exceed incidental take as described in the 2010 revised Incidental Take Statement[7].

[7] On June 29, 2010, the U.S. District Court for the District of Arizona remanded the incidental take statement contained within the 2009 Opinion on Glen Canyon Dam operations back to the USFWS. USFWS reissued the incidental take statement as ordered on September 1, 2010, which essentially stated that take would be exceeded if the estimate of the adult humpback chub population dropped below 6,000 fish, using the Age-Structured

Losses of humpback chub due to brown trout could be large if their abundance would be comparable to those observed during 2003 and 2004 as described by Yard et al. (2011). Recent electrofishing data through 2009 shows that catch of brown trout in the LCR reach has increased little since a system-wide decline and catch per unit effort is lower than levels observed during 2003-2004 removal efforts (see Makinster et al. 2010, figure 4-C). Recolonization rates of brown trout into the LCR reach are also presumably low, partly because the nearest source population is about 25 miles downstream.

The NPS Bright Angel Creek removal project is ongoing and would continue under the no action alternative. Removal of rainbow and brown trout from Bright Angel Creek with a fish weir in fall of 2002 and 2006 has been shown to be an effective means of non-native fish control for both rainbow and brown trout (Leibfried et al. 2003, 2006). The Bright Angel Creek removal would be expected to continue to be effective at reducing brown trout in what is considered to be the primary source of brown trout to the LCR reach. The NPS will also be conducting removal in Shinumo Creek as part of a project to translocate humpback chub from the LCR to that stream. Both of these actions have been previously addressed through other compliance processes and are incorporated by reference herein. NPS removed from Bright Angel Creek 525 brown trout from 2006-2007, and 454 rainbow trout and 594 brown trout from 2010-2011 using a combination of a fish weir trap and electrofisihing; NPS also removed 1,220 rainbow trout and one brown trout from Shinumo Creek in 2009, and 929 rainbow trout in 2010. The cumulative effects of these actions are analyzed here, along with related effects of humpback chub translocations.

Other actions that could have a cumulative effect on fishes include translocations of humpback chub above Chute Falls in the Little Colorado River, to Shinumo and Havasu Creeks, and establishment of humpback chub refuge, all Reclamation conservations measures in ongoing section 7 biological opinions (U.S. Fish and Wildlife Service 2008, 2009). Translocation of humpback chub within the LCR has been occurring since 2003 and translocations from the LCR to Shinumo Creek has been occurred in 2009 and 2010. These actions appear to have benefited the species, as survivorship and growth of fish translocated above Chute Falls have been high (Stone 2009), and fish translocated into Shinumo Creek have exhibited rapid growth, have overwintered in Shinumo Creek, and have been detected moving into the mainstem Shinumo inflow aggregation (B. Healy, NPS, pers. comm. 2010). Additional translocations are planned for these creeks and for Havasu Creek. These projects are expected to continue to benefit the species by improving survivorship and expanding the range of the humpback chub. Reclamation has also assisted USFWS in creating a refuge population at Dexter National Fish Hatchery and Technology Center. This refuge serves as potential brood stock in the event a catastrophic loss of humpback chub in the Grand Canyon population should occur. Also worth considering are various planning documents of the NPS. The CRMP identified the potential of river running activities to adversely affect fishes, primarily from disturbance by recreational boat use, and the fish management plan that NPS is developing could also have direct effects to fishes.

Mark Recapture Model (Coggins and Walters 2009, U.S. Fish and Wildlife Service 2010). This revised ITS was subsequently upheld as in compliance with the ESA by the U.S. District Court.

Another potential effect of no action is increased competition between adult humpback chub and non-native fishes that would have been removed by the trips, in particular adult rainbow, and brown trout. Valdez and Ryel (1995) found that simulids, chironomids, and *Gammarus* were the three most prevalent diet items in 158 adult humpback chub stomachs sampled by gastric lavage in the mainstem Colorado River in Grand Canyon. Yard et al. (2011) also found that these same three types of aquatic invertebrates were important components of both rainbow and brown trout diets, often accounting for 40 to 90 percent of the diet by weight over a 1.75 year study from 2003-2004. Thus it appears that there is competition for food resources between trout and humpback chub, although the extent of this not fully understood in relation to overall food availability (i.e., if food resources are unlimited, then there would be no effect from competition). Ongoing food base research should provide insight into the effect of competition with trout in light of food availability.

As discussed above, conducting future HFEs under the proposed HFE Protocol could have adverse effects to humpback chub due to increased numbers of rainbow trout (Korman et al. 2010, Wright and Kennedy 2011). Under the no action alternative, there would be no means of controlling these increasing numbers of rainbow trout. This could further increase losses of young humpback chub to predation by rainbow trout. Although about 20,000 rainbow trout were removed from LCR reach from 2003-2006 (Coggins, 2008a; Coggins and Yard 2010), the large 2008 rainbow trout cohort that resulted from the March 2008 HFE , perhaps combined with local recruitment along downriver sections, contributed to an increase in rainbow trout densities in the vicinity of the Little Colorado River since 2006 (figure 3; Makinster and others, 2010; Wright and Kennedy 2010). Under these densities, losses of humpback chub to rainbow trout predation are likely to be similar to those observed by Yard et al. (2011). Yard et al. (2011) found that predation rates by rainbow trout varied from 1.7 to 7.1 prey/rainbow trout/year, and 27.3 percent of fish consumed were humpback chub. Assuming a trout population of 7,000 adult rainbow trout in the LCR reach, annual losses of juvenile humpback chub would be within a range of 2,820-13,568. However, as described in the science plan (Appendix B), although these studies illustrate that losses of humpback chub to rainbow trout predation are occurring, the ultimate effect of rainbow trout predation on the adult humpback chub is not known. Although humpback chub status has continued to improve since the late 1990s, a period that includes mechanical removal of rainbow trout (2003-2006 and 2009), a number of other factors, including warmer mainstem water temperatures during this period, may have contributed to the improvement in the humpback chub’s status (Andersen 2009).

Critical habitat for both humpback chub and razorback sucker would likely deteriorate under 10 years of the no action alternative. Critical habitat for these species includes a biological environment primary constituent element (PCE; U.S. Fish and Wildlife Service 1994). The biological environment includes food base, and predation and competition from non-native species. Because the no action alternative would only included limited removal of non-native fishes in Bright Angel Creek and Shinumo Creek, non-native fishes would likely proliferate in the mainstem and in the LCR reach. These increases in non-native fish would reduce the quality of the biological environment PCE of critical habitat due to increased predation and competition from non-native fish species, and potential reductions in food base due to competition with non-native fish species.

The no action alternative is expected to have adverse effects to humpback chub and to humpback chub and razorback sucker critical habitat. This is because no non-native fish control would be conducted, with the exception of small-scale removal projects ongoing by the NPS in Bright Angel and Shinumo Creeks. Because no mainstem Colorado River removal efforts would be conducted, non-native fish species, especially trout, could proliferate to high densities. This effect could potentially be magnified if the HFE Protocol is implemented (Korman et al. 2011). Increases in non-native fish species would lead to increased predation and competition on endangered humpback chub (Yard et al. 2011), resulting in increased losses of humpback chub and potentially reduced recruitment, and reductions in adult abundance. The value of critical habitat for humpback chub and razorback sucker would also be reduced.

3.2.3 *Fish and Fish Habitat under the Proposed Action*

Dam operations for the 10-year proposed action would be MLFF with steady flows in September/October 2011 and 2012, and would also continue in accordance with the 1996 and 2007 RODs and 2007 Colorado River Interim Guidelines. These operations were previously evaluated through prior NEPA compliance, the 1995 EIS and 1996 ROD and the 2008 EA of Glen Canyon Dam operations (Bureau of Reclamation 1996, 1996, 2008). HFEs may also be conducted as an additional dam operation as described under in HFE Protocol EA (Bureau of Reclamation 2011).

The Proposed Action utilizes boat-mounted electrofishing to remove all non-native fish species in the PBR and LCR reaches of the mainstem Colorado River in Marble and Grand Canyons. Up to 6 LCR reach removal trips and up to 10 PBR reach removal trips could be conducted in any one year. Removal of non-native fish in the LCR reach would only take place if monitoring and modeling data indicate that a trigger has been reached as defined in the 2011 Opinion (U.S. Fish and Wildlife Service 2011).

The proposed action would also include research to improve understanding of several aspects of the fishery in the action area related to improve understanding the effects of non-native fish predation. Research efforts would be implemented to improve estimates of young humpback chub (juveniles less than 150 mm in total length) to potentially refine a trigger for non-native fish control based on abundance of these young fish. This research would also help determine the overall importance of mainstem habitats to humpback chub recruitment. To better determine the degree to which emigration of rainbow trout from Lees Ferry is the source of rainbow trout in the LCR reach, a marking study would be initiated in the fall in Lees Ferry. Also, three to four downstream monitoring trips in the summer would monitor trout occurrence in Marble Canyon to attempt to detect marked fish from Lees Ferry moving downstream. PBR reach removal would begin testing in the winter months with two removal trips in the first year. The marking and PBR removal trips would enable researchers to begin to answer science questions associated with the numbers of trout emigrating from Lees Ferry, and in evaluating the effectiveness of PBR removal at limiting trout emigration to downstream areas. LCR Removal would be reserved for implementation only if adverse effects are detected, if monitoring and modeling data indicate that a trigger has been reached as defined in the 2011 Opinion (U.S. Fish and Wildlife Service 2011). . Removal and research actions in out years would be implemented through adaptive management based on monitoring and research results.

Two electrofishing removal trips in the PBR reach would have unknown effects on trout predation and competition effects to humpback chub downstream in the LCR reach. This is because removal has never been attempted in this reach. This is why the proposed action also included LCR reach removal in the event the 2011 Opinion trigger is reached. In results of the SDM Project analysis, adding PBR reach removal to LCR reach removal improved performance of an alternative on maintaining the adult humpback chub population. The predictive population models used to evaluate the consequences of policy alternatives on humpback chub and rainbow trout objectives in the SDM Project analysis involved a set of 3 coupled models. The elements of this coupled model included: (1) Emigration from Lees Ferry into Marble Canyon, (2) dynamics of rainbow trout during movement from Lees Ferry to LCR, and (3) the interaction between rainbow trout and humpback chub in the LCR (Fig. 4). Rates of rainbow trout emigration from Lees Ferry into Marble Canyon were based on analysis of Lees Ferry recruitment in year *t* and monthly emigration in year *t*+1. The proposed action was the best performing alternative in the SDM Project analysis because these models indicated emigration from Lees Ferry can be at least partially controlled by removal in the PBR reach.

As with no action, we analyzed the effect of the proposed action by assessing the effect of doing two non-native fish removal trips in the LCR reach, should LCR removal be necessary because the humpback chub trigger in the LCR reach had been exceeded. Additional LCR reach trips would have a stronger effect, and the effect of PBR trips is unknown because removal there has not been attempted. Conducting even two LCR removal trips could reduce predation pressure by rainbow trout substantially. If the removal has low efficiency, total humpback chub predation would be reduced by 10-14% depending on immigration rates and individual trout predation rates. Assuming average electrofishing efficiency, total humpback chub predation would be reduced by 41-70%, and 49-85% under high efficiency conditions depending on immigration rates and individual trout predation rates. Similarly, 129-3,292 humpback chub would be theoretically saved from predation under the low efficiency scenario, 532-16,851 humpback chub in the average efficiency scenario and 637 to 20,384 humpback chub in the high efficiency scenario.

Two LCR reach removal trips have been estimated to prevent losses of age-0 and age-1 humpback chub due to reduced predation year classes, and would theoretically translate into more adult fish (Figure 7). Four to 96 fish would survive due to reduced predation in the low efficiency scenario, 15 to 491 fish in the average efficiency scenario, and 19 to 594 humpback chub in the high efficiency scenario. The grand mean of estimated fish saved from predation across all variables (predation and immigration rates as well as electrofishing efficiency) is 169 fish. Note that this estimate is for two LCR reach removal trips. Additional removal trips would likely not result in a linear increase in adult humpback chub saved, but would result in substantial additional increases in fish saved. However, as discussed in the no action section, questions remain concerning the degree of effect of predation on humpback chub. The proposed action would only implement removal in the

LCR reach if monitoring and modeling data indicate that a trigger has been reached as defined in the 2011 Opinion (U.S. Fish and Wildlife Service 2011). . By taking this approach, the proposed action would provide the opportunity to better understand the effects of predation on humpback chub, and would only implement removal in the culturally-sensitive LCR reach if necessary.

This alternative would not affect other aquatic resources other than the collateral effects of electrofishing on native fish species and macroinvertebrates. The effects of electrofishing on Colorado River endangered fishes including humpback chub were reviewed by Snyder et al. (2003). Electrofishing can result in harmful effects on fish. Spinal injuries and associated hemorrhages have been documented in fish examined internally. These injuries are thought to result from convulsions of the body musculature, likely caused by sudden changes in voltage. Fewer spinal injuries have been reported with the use of direct current and low-frequency pulsed direct current, as opposed to alternating current. However, Snyder et al. (2003) found that endangered cyprinids of the Colorado River Basin, including humpback chub, are generally much less susceptible to these effects than other fishes. Mortality, when it has been documented, is usually due to asphyxiation, a result of excessive exposure to electrodes or poor handling of captured specimens. Effects of electrofishing on reproduction are contradictory, but electrofishing over spawning grounds can harm embryos. Snyder et al. (2003) concluded from the review that:

> "The survival and physical condition of endangered and other native cypriniforms (including razorback sucker) that had been electrofished in recapture and radiotag investigations… suggest that electrofishing injuries or mortality are probably not a serious problem. Even so, the sensitivity of the matter warrants a heightened awareness of the potential for electrofishing injuries, a continuing effort to minimize any harmful impacts by every practical means, and a readiness to adjust, alter, or abandon electrofishing techniques if and when potentially serious problems are encountered… Electrofishing is a valuable tool for fishery management and research, but when resultant injuries to fish are a problem and cannot be adequately reduced, we must abandon or severely limit its use and seek less harmful alternatives. This is our ethical responsibility to the fish, the populace we serve, and ourselves."

For the proposed action, ESA section 10(a)(1)(A) recovery permits from the USFWS would be required to conduct removal activities. These recovery permits would address the take associated with collateral effects of electrofishing and handling to humpback chub from the proposed action.

The NPS ongoing actions of removal of non-native fish, predominantly trout, from Bright Angel and Shinumo creeks would be expected to continue under the proposed action. Removal of rainbow and brown trout from Bright Angel Creek with a fish weir in fall of 2002 and 2006 has been shown to be an effective means of non-native fish control for both rainbow and brown trout (Leibfried et al. 2003, 2006). The NPS Bright Angel Creek removal project is ongoing and is expected to continue to be effective at reducing brown trout in what is considered to be the primary source of brown trout to the LCR reach. Reclamation has also committed to continuing to fund and to help expand this effort as a conservation measure in the 2011 Opinion (U.S. Fish and Wildlife Service 2011)Removal of trout from Bright Angel Creek would augment removal actions of the proposed action and potentially reduce numbers of predators in the LCR reach to the benefit of humpback chub and other native fish. Bright Angel Creek also appears to be the primary spawning ground for brown trout in the system, so this project could substantially reduce predation by brown trout.

As described in our analysis of no action, other actions that could have a cumulative effect to fishes include translocations of humpback chub above Chute Falls in the Little Colorado River, to Shinumo and Havasu Creeks, and establishment of humpback chub refuge, all Reclamation conservations measures in ongoing section 7 biological opinions (U.S. Fish and Wildlife Service 2008, 2009, 2011), as well as NPS implementation of planning documents described in section 1.7.3. Translocation of humpback chub within the LCR has been occurring since 2003 and translocations from the LCR to Shinumo Creek has been occurred in 2009 and 2010. These actions appear to have benefited the species, as survivorship and growth of fish translocated above Chute Falls have been high (Stone 2009), and fish translocated into Shinumo Creek have exhibited rapid growth, have overwintered in Shinumo Creek, and have been detected moving into the mainstem Shinumo inflow aggregation (B. Healy, NPS, pers. comm. 2010). Additional translocations are planned for these creeks and for Havasu Creek. These projects are expected to continue to benefit the species by improving survivorship and expanding the range of the humpback chub. Reclamation has also assisted USFWS in creating a refuge population at Dexter National Fish Hatchery and Technology Center. This refuge serves as potential brood stock in the event a catastrophic loss of humpback chub in the Grand Canyon population should occur. Reclamation has committed to continue to support maintenance of this refuge as a conservation measure of the 2011 Opinion (U.S. Fish and Wildlife Service 2011).

Rainbow trout abundance in Lees Ferry could be affected by the proposed action. Although the trout in Lees Ferry would not be directly affected, there could still be effects to the population if fish removed in the PBR reach, and perhaps the LCR reach, reduce overall abundance in the system. Reducing the numbers of trout in the system could result in both positive and negative effects to the Lees Ferry sport fishery which are discussed in Section 3.4.2.1.

In addition to the actions described above, Reclamation would also continue to investigate other alternatives under the proposed action. As part of the adaptive management process, Reclamation plans to evaluate development of other non-native fish suppression options, with stakeholder involvement, that reduce recruitment of non-native fish at, and emigration of those fish from, Lees Ferry. Both flow and non-flow experiments focused on the Lees Ferry reach may be conducted to test their ability to reduce the recruitment of trout in Lees Ferry, and lower trout emigration from Lees Ferry. These actions could benefit humpback chub by reducing numbers of rainbow trout in the system, and could also improve conditions of the recreational trout fishery at Lees Ferry. Additional environmental compliance may be necessary for these experiments.

Critical habitat for both humpback chub and razorback sucker would likely improve under 10 years of the proposed action alternative. Critical habitat for these species includes a biological environment PCE (U.S. Fish and Wildlife Service 1994). The biological environment PCE includes food base, and predation and competition from non-native species. Because the proposed action alternative would implement potentially both PBR and LCR reach removal, and would include the NPS ongoing actions of removal of non-native fishes in Bright Angel Creek and Shinumo Creek, non-native fish abundance would likely decrease in the mainstem and in the LCR reach. These decreases in non-native fish would increase the quality of the biological environment PCE of critical habitat due to reduced predation and competition from non-native fish species, and potential increases in food base available to native fish.

The proposed action alternative is expected to have beneficial effects to humpback chub and to humpback chub and razorback sucker critical habitat. This is because non-native fish control would be conducted potentially in both the PBR and LCR reaches, augmenting ongoing removal projects by the NPS in Bright Angel and Shinumo Creeks which Reclamation will also continue to help fund and implement through the GCDAMP as conservations measures of the 2011 Opinion. Abundance of non-native fish species, especially trout, would be expected to decline. The potential adverse effect of HFEs resulting in increases in rainbow trout would potentially be mitigated by removal efforts. Decreases in non-native fish species would lead to decreased predation and competition on endangered humpback chub, resulting in increases in young humpback chub and potentially increased recruitment, and increases in adult abundance. The value of critical habitat for humpback chub and razorback sucker would also be improved. Reclamation has reviewed the best available science, and, using our technical expertise to interpret the science, our conclusion is that the proposed action represents the best option to implement the non-native fish control conservation measure in a way that satisfies our legal commitments and responsibilities under the ESA, is protective of the humpback chub, and is least damaging to cultural and other resources.

3.3 *Cultural Resources*

The Grand Canyon of the Colorado is significant for its human history and its ongoing role in the lives and traditions of American Indians of the Colorado Plateau. Cultural resources include historic properties which are defined as districts, sites, buildings, structures, and objects that are eligible for listing on the National Register of Historic Places. Cultural resources also include Indian sacred sites as defined by Executive Order 13007.

Cultural resources include historic properties which the National Historic Preservation Act (NHPA) defines (16 USC 1470w) as districts, sites, buildings, structures, and objects that are eligible for listing on the National Register of Historic Places.

Cultural resources also include Indian sacred sites as defined by Executive Order 13007. Under Executive Order 13007, an Indian sacred site is defined as a specific, discrete, narrowly delineated location on Federal land that is identified by an appropriately authoritative representative of an Indian religion as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion.

3.3.1 *Sacred Sites under No Action*

The Hopi Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, Navajo Nation, and the Pueblo of Zuni are concerned with the taking of life in the Grand Canyon and particularly in the vicinity of the confluence of the Colorado and Little Colorado rivers.

Under no action, both Reclamation and the NPS, as the executive branch agencies with statutory or administrative responsibility for the management of the Indian sacred sites, have continuing obligations under EO 13007 to ensure that, where practicable and appropriate, reasonable notice is provided of any proposed actions that might restrict future access to the site or adversely affect its physical integrity. Under no action, no non-native fish would be removed or killed, thus there would be no effect to sacred sites.

3.3.2 *Sacred Sites under the Proposed Action*

The Hopi Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, Navajo Nation, and the Pueblo of Zuni consider the proposal an adverse effect on an Indian sacred sites due to the taking of life associated with the proposed action. These tribes are being consulted with on a government-to-government basis regarding how these adverse effects might be minimized or mitigated.

3.3.3 *Historic Properties under No Action*

Section 106 of the NHPA requires Federal agencies to consider the effects of their actions on historic properties and to seek comments from an independent reviewing agency, the Advisory Council on Historic Preservation (Council). Under section 106, review is also required by the Arizona State Historic Preservation Officer and the Hualapai and Navajo Nation Tribal Historic Preservation Officers (see 36 CFR 800).

With the 1992 amendments to the NHPA, Congress added section 101(d)(6)(A) specifying that properties of traditional religious and cultural importance to an Indian tribe may be determined to be eligible for inclusion on the National Register of Historic Places. These are termed Traditional Cultural Properties (TCPs). Congress also added section 101(d)(6)(B), directing Federal agencies, in carrying out their responsibilities under section 106 of the NHPA, to consult with any Indian tribe that attaches religious and cultural importance to historic properties.

Under no action, no effects are anticipated to occur to historic properties. The Navajo Nation has indicated that they believe conservation of the humpback chub, including non-native fish control, is essential.

3.3.4 *Historic Properties under the Proposed Action*

The area of potential effect of the proposed action is the Colorado River, and that portion of the adjacent shoreline that might be affected by related research and monitoring. Reclamation and the NPS agree with the tribes that the Colorado River and floodplain are considered eligible historic properties (TCPs) under the NHPA and the eligibility determinations have been submitted to the Arizona State Historic Preservation Officer (SHPO).

The APE includes two historic districts, one a National Register listed district at Lees Ferry in GCNRA; the other an historic district in GCNP that has been determined eligible to the Register through consensus. Appendix F is the consultation letter with the Arizona State Historic Preservation Officer. Identical letters were sent to other consulting parties.

Application of the criteria of effect and the NPS's policies in National Register Bulletin 15 resulted in a finding of adverse effect for the proposal, given the concerns of the tribes. The Governor of the Pueblo of Zuni sent Reclamation a Zuni Tribal Council Resolution, No. M70-2010-C086, that states that the Zuni Tribe's position is that the Grand Canyon and Colorado River are Zuni traditional cultural properties eligible to the National Register of Historic Places. The Hopi tribe has also submitted documentation to the Bureau of Reclamation identifying the Grand Canyon, including the project area, as a Traditional Cultural Property. The Arizona State Historic Preservation Office concurred with Reclamation's determination of eligibility and effect on July 28, 2011.

Consultation to complete a Memorandum of Agreement to resolve adverse effects is underway in accordance with 36 CFR 800.6. Reclamation is committed to completing the process of resolving adverse effects with the tribes and other interested parties prior to implementation of the proposed action.

3.4 *Socioeconomic Resources*

Social and economic conditions were examined to determine whether the proposed action would affect them. The indicators reviewed include Indian trust assets, recreation, and environmental justice (E.O. 13175).

3.4.1 *Recreation under No Action*

Recreational resources of concern include trout fishing and recreational boating from Glen Canyon Dam to Lees Ferry, whitewater boating through Grand Canyon, and the Hualapai Tribe's boating enterprise at the western end of Grand Canyon and into Lake Mead.

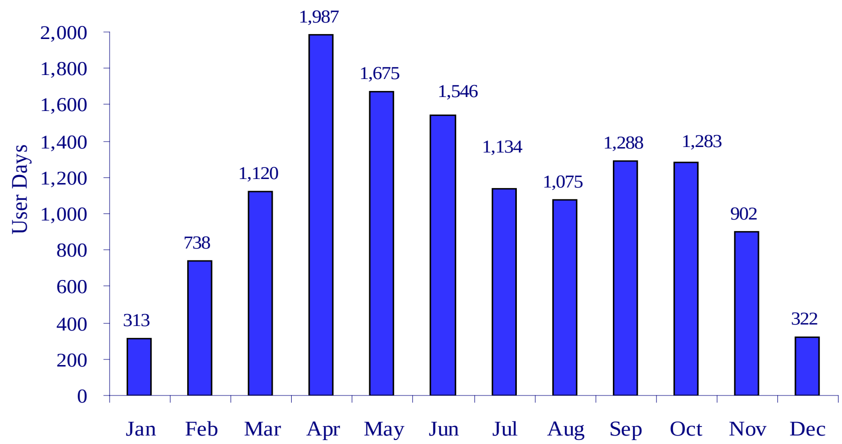
3.4.1.1 Fishing under No Action

The approximately 15-mile reach between Glen Canyon Dam and Lees Ferry is heavily used by visitors.[8] Most of the whitewater boating trips through the Grand Canyon launch from

[8] This reach of the Colorado River is known as the Lees Ferry reach and is also known as the Glen Canyon reach.

Lees Ferry. Many hiking, fishing, day-use boating, and some camping trips also take place in this reach of the Colorado River.

The AGFD and NPS manage the tailwater (the Colorado River from below the Glen Canyon Dam to Lees Ferry) for sport fishing. There is a popular non-native rainbow trout fishery in the Lees Ferry reach and for some distance downstream. Most fishing occurs from boats or is facilitated by boat access, including guide services, but some anglers wade in the area around Lees Ferry and fish downstream into the PBR reach. As described in Loomis et al. (2005), the quality of the fishery had fallen and angler use had declined dramatically in recent years, from more than 20,000 anglers in 2000 to less than 6,000 in 2003. Fishing use increased to approximately 13,000 user days in 2006 (Henson 2007) and fell to approximately 9,800 user days in 2009 (G. Anderson, NPS, pers. comm. 2010). Heaviest fishing use occurs in April and May (Figure 8).



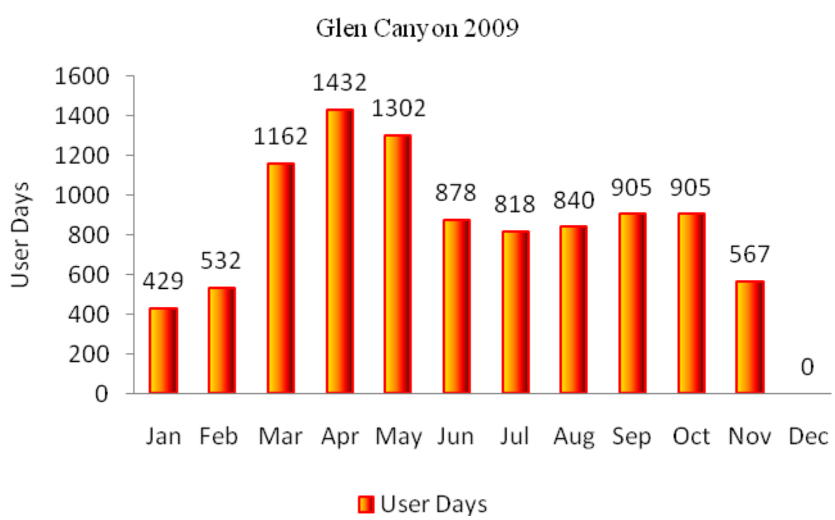


Figure 8. Fishing user days by month in the Lees Ferry reach for 2006 (top) and 2009 (bottom).

Under the no action alternative, there would be no effect on the fishery. No control actions would be implemented.

3.4.1.2 Recreational Boating under No Action

For river management purposes, the Colorado River is divided into two reaches. The upper reach runs from Lees Ferry (river mile (RM) 0) to Diamond Creek (RM 226) and is known as the Marble/Grand Canyon reach or upper river. The lower reach or lower river, starts at Diamond Creek (RM 226) on the Hualapai Reservation and goes to Lake Mead (RM 277).

The 15-mile reach between Glen Canyon Dam and Lees Ferry is heavily used by day-use boaters who take one-half day scenic boat trips offered by a NPS concessionaire. Day-use boating in Glen Canyon is a trip in a motorized or oar powered boat in a reach of the Colorado River that is without any noticeable rapids or rough water. The trip leaves from the town of Page, AZ and begins with a ride down the two-mile long Glen Canyon access tunnel. These scenic trips are on calm water without rapids and launch at the base of Glen Canyon Dam and are a motorized float through the 15-mile reach to Lees Ferry.

There were about 50,411 user days of day-use boating during 2009 and 53,340 user days of day-use boating in 2010 (J. Balsom, NPS, pers. comm. 2011). The majority of the day-use boating visitation takes place during the summer months and June is typically the peak use month. There is little or no day use boating in the winter months.

Under the no action alternative, there would be no effect on day-use rafting. No control actions would be implemented.

Boating (kayaking, boating, canoeing, etc.) in the upper reach below Lees Ferry is internationally renowned. In 2006, the NPS completed a new *Colorado River Management Plan* (CRMP) for whitewater boating through Grand Canyon National Park (National Park Service 2006c). This management plan governs use in both the reach from Lees Ferry to Diamond Creek and the reach from Diamond Creek down to Lake Mead. Under this plan, total whitewater boating use was increased and the distribution of that use during the year was altered. Annual use in the Marble/Grand Canyon reach is expected to be no more than 115,500 commercial user-days and approximately 113,500 private user-days (National Park Service 2006c). Highest-use months for commercial operations extend from May through September, but are relatively consistent throughout the year for noncommercial boating (Figure 9). The CRMP allows up to 1,100 total yearly launches (598 commercial trips and 504 noncommercial trips). Up to 24,567 river runners could be accommodated annually if all trips were taken and all were filled to capacity.

Under the no action alternative, there would be no effect on the number of visitors participating in rafting. No control actions would be implemented.

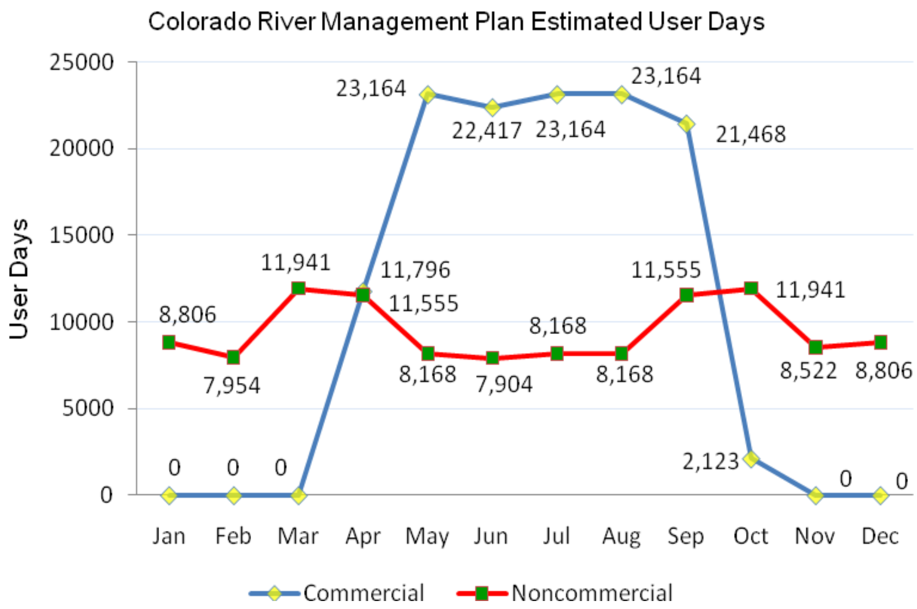


Figure 9. Recreational boating in the Grand Canyon, annual use by month (National Park Service 2006c).

3.4.1.3 Net Economic Use Value of Recreation under No Action

Recreation and the tourism industry are important economic sectors on the Hualapai Indian Reservation. Hualapai River Runners (HRR), the commercial rafting operation run by the Hualapai Tribe, provides guided day use and overnight use trips as well as the separate concession run day-use boat operation directly depend upon the Colorado River for their existence. Other recreation and hospitality operations (restaurant, hotel, skywalk, etc.) also have connections to the Grand Canyon if not the river itself. The various recreational-related enterprises generate a large proportion of the total revenue earned by the Hualapai Tribe. This revenue supports the tribal economy and creates jobs for its members. Much investment in infrastructure has been made to induce increased tourism on the reservation, e.g. the skywalk.

Visitors to Lees Ferry and the Grand Canyon spend large sums of money in the region purchasing gas, food and drink, lodging, guide services, and outdoor equipment while visiting the region. These expenditures impact the regional economy through direct effects, indirect effects, and induced effects. Direct effects represent a change in final demand for the affected industries caused by the change in spending. Indirect effects are the changes in inter-industry purchases as industries respond to the new demands of the directly affected industries. Induced effects are the changes in spending from households as their income increases or decreases due to the changes in production.

The regional economic activity that results from nonresident anglers, recreational boaters, and day boaters who visit Glen and Grand Canyons was estimated in a previous study at approximately $25.7 million in 1995 dollars (Bureau of Reclamation 1995). Douglas and Harpman (1995) estimated that Glen Canyon and Grand Canyon recreational use in the region comprised of Coconino and Mojave Counties supports approximately 585 jobs. A more recent study by Hjerpe and Kim (2003) estimated that recreational use in Coconino County (alone) supports approximately 394 jobs.

The region as defined in this analysis is Mohave and Coconino Counties in Arizona which corresponds with past economic studies of the impacts of changes in Glen Canyon Dam operations. Flagstaff, in southeast Coconino County, is the largest city in this nearly 32,000 square mile mostly rural region. In 2007 the area supported over 138,000 jobs and produced more than $15 billion worth of goods and services (Table 3). Labor earned more than $4.8 billion in total compensation.

Table 3. Mohave and Coconino Counties, Arizona – Baseline Socioeconomic Data (in 1,000's; Minnesota IMPLAN Group, Inc. 2008).

Industry Category	Employ ment	Output	Employee Compensati on	Proprietor Income	Other Property Type Income	Indirect Business Taxes
Agriculture	753	$90,035	$12,054	$3,149	$9,072	$2,684
Mining	257	$67,968	$11,338	$3,173	$23,070	$3,811
Construction	11,621	$1,541,069	$376,239	$126,497	$91,944	$9,856
Manufacturing	7,695	$2,491,463	$435,518	$13,374	$261,766	$12,462
TIPU	4,321	$684,106	$177,976	$32,383	$108,207	$27,217
Trade	22,485	$1,670,373	$604,674	$106,965	$175,621	$250,340
Service	65,943	$6,714,451	$1,838,582	$369,220	$1,326,742	$318,646
Government	25,193	$1,777,551	$1,346,715	$0	$200,779	$0
Total	138,268	$15,037,014	$4,803,097	$654,761	$2,197,201	$625,018

Economic impacts on the Navajo were not estimated in previous evaluations of changes of operations at Glen Canyon Dam on recreation and recreation economics because it was thought that there was no connection between the river flows and recreation and the Navajo Nation and fiscal or economic benefits. However, representatives of the Navajo indicated they believe there is a connection.

Navajo tradespeople who make their living selling jewelry and souvenirs to the traveling public along routes 89 and 89A have seen their business decline in recent years. The relatively high income clientele of the fishing guides were especially important (R. Lovett 2010, Marble Canyon Outfitters, pers. comm. 2010; W. Gunn, Lees Ferry Anglers Guides and Fly Shop, pers. comm. 2010). The reduction in the fishing guide business has been felt by the Navajo tradespeople and crafts workers. The Navajo vendors selling jewelry and souvenirs along highways 89 and 89A have had their sales and income greatly reduced in recent years. The recent recession added to the decline in visitation to Lees Ferry to further reduce the traffic along routes 89A and 89 reducing the potential customer base for Navajo made products sold by Navajo vendors at the roadside stands resulting in increased economic hardship. Any loss of income or jobs affects not only the individual but usually other workers (the makers of the products sold) and the worker's extended family.

In the last ten years there have been as many as 99 individual vending stands where handmade Navajo jewelry and souvenirs were sold at the 33 pullouts along highways 89 and 89A (M. Christie, Antelope Valley Trade Association, pers. comm. 2010). Now this number has been reduced to 80 stands. Four of these stands are affiliated with the Antelope Trails Vending Organization (ATVO).[9] The other stands are individually owned. Each pullout may have from one to 10 selling stands with one to two people or perhaps a whole family participating in the business. Jewelry vending and production is a primary employment sector of the economy in this part of the Nation for the Navajo people providing 400 to 700 jobs (Table 4). Jobs held by the Navajo people are especially important due to the long-term high rate of unemployment on the Nation and due to the fact that wage earners usually are supporting extended families.[10]

Table 4. Navajo Roadside Vending and Employment (Employment numbers are estimates, M. Christie, Antelope Valley Trade Association, pers. comm. 2010).

Highway	Location	# of Pullouts with Vending Businesses	# of Employed People Vending**	# of Employed People Producing Products
Route 89	Page to Bitter Springs	3	4 + family members helping	–
Route 89A	Marble Canyon to Bitter Springs	6	12	12 to 20
Route 89A	Marble Canyon to Jacob Lake	3	12 to 20	200 + family members
Route 89	Bitter Springs to Gray Mountain	21	65 to 140	130 to 280
		33	93 to 176	342 to 500

Members of the Bodaway/Gap Chapter of the Dine′ Nation have indicated that non-native fish control may affect their way of life (the Navajo use the beaches for sacred ceremonies and they fish for recreation and for food) and adversely affect their sales of items to the visiting tourists.

There are many other factors affecting the amount of traffic and numbers of potential souvenir buyers on the roads. Right now unemployment and economic uncertainty are huge factors in people's decisions to travel or vacation in northern Arizona and whether or not to purchase items from Navajo roadside stands. However, even though non-native fish control may or may not negatively affect the rainbow trout fishery at Lees Ferry the perception by the Navajo is that many actions taken at Glen Canyon Dam in Lees Ferry and Grand Canyon can negatively impact their souvenir sales.

Under the no action alternative, there would be no effect on the net economic value of recreational use. No control actions would be implemented.

[9] ATVO has 170 individual members. The members rotate among the four sites so each has a chance to sell their merchandise. Each business may sell at a different site on different days of the month. Not all members sell every day.

[10] The Nation is an area that has chronic high unemployment and high poverty rates. In 1999 per capita income was $7,578, only 35 percent of the national average of $21,587. While the national poverty rate for individuals in 1999 was 12.4 percent; the Nation's poverty rate was 41.9 percent.

3.4.1.4 Nonuse Economic Value under No Action

Social scientists have long acknowledged the possibility that humans could be affected by changes in the status of the natural environment even if they never visit or otherwise use these resources. These individuals may be classified as non-users, and economic expressions of their preferences regarding the status of the natural environment are termed "nonuse" or "passive use" value. A straightforward and readily available overview of this topic is provided by King and Mazzotta (2007).

Aquatic and riparian resources along the Colorado River are directly affected by the operations of Glen Canyon Dam. Although visitation to Glen Canyon National Recreation Area and the Grand Canyon National Park is quite extensive, only a very small proportion of these visitors physically use these riverine resources. Nonetheless, visitors to the Grand Canyon and members of the general public hold strong preferences about the status of these resources.

In the late 1980's, the National Academy of Science Committee to Review the Glen Canyon Environmental Studies recommended that a study be commissioned to estimate nonuse value for Grand Canyon resources (National Academy of Sciences 1987). As related in Harpman et al. (1995), the Bureau of Reclamation retained an independent consulting company to complete an analysis of total economic value for the Glen Canyon EIS. Welsh et al (1995) undertook a comprehensive study of nonuse value for Glen and Grand Canyon resources. Their research encompassed both individuals residing within the area where electricity from the dam is sold and all citizens of the United States. The survey instrument was painstakingly designed following a series of focus groups, a peer review, and an extensive pilot-test. Survey response rates were exceptional; 83% and 74% for the power marketing area and national samples respectively. In many respects, these response rates demonstrated the saliency of these resources to stakeholders and members of the public.

As shown in Table 5, Welsh et al, (1995) estimated the average nonuse value (that is, when asked what they were willing to pay to implement certain actions, the response, for three flow regimes) for U.S. households was $18.74 (indexed to 2008 dollars) for the moderately low fluctuating flow alternative. When expanded by the pertinent population, this yields an aggregate estimate of $3,159.21 million per year (in 2008 dollars) for the national sample.

Table 5. Estimates of Nonuse Value for Three Flow Scenarios Relative to Historical Operations (Welsh et al. 1995).

Flow Scenario	National Sample Value Per Household (2008 $)	National Sample Aggregate Value (millions of 2008 $)
Moderate fluctuating flow	$18.74	$3,159.21
Low fluctuating flow	27.84	4,660.88
Seasonally Adjusted Steady flow	$28.39	$4,756.22

The findings of this study clearly illustrate the significance of Grand Canyon resources and the value placed upon them by members of the public. Although the results of the nonuse value study were unavailable for inclusion in the *Operation of Glen Canyon Dam EIS*, they were cited and summarized as Attachment 3 in the Record of Decision (U.S. Department of the Interior 1996). Although the NPS is currently in the process of a new study of nonuse values for the park units along the Colorado River, which will likely update some of the findings of the 1995 study, this study was not completed for use at the time of this EA.

The Hopi Tribe believes that its cultural values for the Grand Canyon should be considered within the Western analysis framework as non-use values. Management actions that occur there can have effects at Hopi that do not depend on whether Hopi people enter (use) the Grand Canyon or not. The no action alternative would have no effect to Hopi non-use values.

The effect of no action may have an effect on nonuse values considering that the ecosystem would not benefit from the removal on non-native fish species and humpback chub adult abundance could decline. This could result in a decline in nonuse value.

3.4.2 *Recreation under Proposed Action*

3.4.2.1 Fishing under Proposed Action

The Colorado River from below the dam to Lees Ferry is an important recreational rainbow trout fishery, attracting anglers from the state and beyond. Most angling occurs from boats in the Lees Ferry reach, i.e., the 15 miles of river below the dam. Navajo Nation tribal members also periodically fish for trout in the Lees Ferry area. The NPS does not allow any commercialization of fishing below Lees Ferry. The Arizona Game and Fish Department sets bag limits for trout below Lees Ferry through Grand Canyon. Current fishing regulations allow for the harvest of six rainbow trout and unlimited harvest of all other sportfish from the Paria riffle to Navajo Bridge. Below Navajo Bridge (to Separation Canyon) there is no limit on angler harvest of sportfish species.

With regard to sport fishing in the Lees Ferry reach, the SDM Project analyzed the effect of this and the other alternatives on both catch rate and the percent of fish captured over 20 inches in total length. This alternative had no effect on either of these variables. Removal in the LCR reach is far enough away that it would have no effect on trout numbers or size classes in Lees Ferry. Although removal in the PBR reach is much closer, trout removed are predicted to be of young fish that are emigrating out of the Lees Ferry reach downstream. Removing these fish is not expected to have any effect on the adult population of trout in Lees Ferry. However, if this assumption is false, and PBR-reach removal does have an effect on the overall population of adult trout in Lees Ferry, the net result could conceivably be a reduction in catch rates and an increase in the size of adult fish caught. This effect was seen in the SDM Project analysis for alternatives that contain actions which more directly affected the overall Lees Ferry population (as opposed to fish that are emigrating) such as flow manipulations designed to strand young trout. Such a result could be beneficial to the Lees Ferry trout fishery because it could result in a healthier, more sustainable population with a balanced age-structure with larger trout of better condition.

For PBR reach removal, each trip is anticipated to take place over up to 12 nights. Researchers would be land-based with no riverside camping, and boats would launch for nightly work late in the day, only after all recreational trips have launched and traveled downstream. The work would take place between the Paria River and Badger Rapids only. Boats would return to Lees Ferry at the conclusion of their nightly work. Care would be taken to avoid disturbance to walk-in recreationists and anglers at the Paria River confluence beach. For LCR reach removal trips, duration would likely be several weeks, with removal teams camped and working in the LCR reach for approximately two weeks.

Although the proposed action is not expected to result in any adverse or beneficial effect on the quality of sport fishing in Lees Ferry, because there may be up to 10 removal trips in the PBR reach each year, and these trips would operate out of Lees Ferry, there could be some effect in the form of disturbance to anglers and fishing guides in Lees Ferry. However, removal crews would be working the 7-mile PBR reach downstream from Lees Ferry. Lees Ferry anglers and fishing guides utilize the Glen Canyon section of Lees Ferry, that is the 15 miles of the river from Lees Ferry upstream to Glen Canyon Dam. Fisherman also utilize the section of the river downstream of Lees Ferry to about Jackass Canyon for shore fishing, as well as other hike in sites downstream, such as Soap Creek, Salt Creek, Houserock, and South Canyon. Removal in the PBR reach is likely to cause some level of disturbance to the angling community that shore fishes in this area, and a reduction in fish numbers may also affect catch rates for these anglers. The primary aspect of disturbance would be in the form noise and visual intrusion from boats launching from Lees Ferry either to perform short duration PBR removal trips, or to engage longer-term LCR removal trips, and from electrofishing operations in the Lees Ferry Reach (i.e. noise from boat motors and generators, and lights).

3.4.2.2 Recreational Boating under Proposed Action

For PBR reach removal, each trip is anticipated to take place over up to 12 nights. Researchers would be land-based with no riverside camping, and boats would launch for nightly work late in the day, after recreational trips have launched and traveled downstream. The work would take place between the Paria River and Badger Rapids only. Boats would return to Lees Ferry at the conclusion of their nightly work. Care would be taken to avoid disturbance to walk-in recreationists and anglers at the Paria River confluence beach. For LCR reach removal trips, duration would likely be several weeks, with removal teams camped and working in the LCR reach for approximately two weeks

An important part of the recreational experience enjoyed by visitors to Grand Canyon National Park is the opportunity to be in a wilderness setting with minimal contact with other people and few sights and sounds associated with human activities. Non-native fish removal activities have the potential to disturb the wilderness experience for others, particularly those rafting the river, or hiking and camping near the river. These impacts include the noise and lights associated with removal actions, especially when they occur at night, the competition for camping sites along the river, and the simple presence of more people on the river.

The SDM Project analysis utilized an NPS metric for the purpose of evaluating non-native fish control methods. Penalized user-days per year in the GCNP wilderness during administrative trips were used to assess this affect, an NPS metric. Penalized user-days per year is calculated by using the staff size (number of people on a river trip administering science, in this case, non-native removal) multiplied by the number of days in the wilderness (this is the basic measure); this is adjusted by a penalty factor multiplier for activities that result in greater disturbance. Penalty factors include: boat (motor) user-days during motor season, penalty factor of 1 as a multiplier; boat (motor) user-days during non-motor season, 2; helicopter trips, 2; nighttime management activities, 3. Thus, for example, a 14-day removal trip with a staff of 8, conducted by boat during the non-motor season, with management activities primarily at night would have a score of 672 penalized user-days (14 days x 8 users x 2 [non-motor multiplier] x 3 [night multiplier]). If helicopter removal of live fish was required, with, say, 2 trips daily for 8 of the 14 days, an additional 32 penalized user-days (2 trips/day x 8 days x 2 [helicopter penalty multiplier]) would be added. The number of boats is not included in the calculation; presumably the number of users is tied to the number of boats. The proposed action scored poorly in this category, with 6,824 penalized-user days. This is understandable because of the amount of effort using motorized boats to remove non-native fish in two different areas of the parks.

Noise from outboard motors and gas generators would occur and the presence of researchers would add more people to the PBR reach and the LCR reach when removal activities are occurring. This alternative would result in direct, short-term, effects on wilderness character due to noise and visual intrusion. Despite the fact the SDM Project found that there would be disturbance effects to recreation from the proposed action in terms of increased disturbance, and that this effect would be substantial, these effects were minimal in terms of economic effects; in other words, the disturbance effects from the proposed action are not expected to affect the actual number of visitors to GCNP for wilderness or recreational rafter experiences.

The effects would be different for the PBR reach than for the LCR reach. The PBR reach includes 4 miles of wilderness (50% of reach) while the LCR includes 100% wilderness. In addition, very little hiking and riverside camping occurs in the first 8 miles, and overnight camping is not permitted in the first 4 miles (to Navajo Bridge). The effects would be of moderate intensity for visitors camping in the LCR reach, and of minor intensity for visitors rafting in the PBR reach. Effects would be on wilderness character and experience and include intrusion to site, sound, and smell (gasoline), especially when these activities occur during the non-motorized boating season. Live removal in either reach will necessitate more boats and equipment use than would euthanizing fishes, and more activity of boats moving up and down the river, which will add to the disturbance effects described above, and disturbance effects would more noticeable during the non-motor season.

3.4.2.3 Net Economic Use Value of Recreation under Proposed Action

Angling in Glen Canyon National Recreation Area (Lees Ferry) provides economic benefits to local economies, particularly in the areas of Vermilion Cliffs, Page, and Flagstaff, Arizona, and Kanab and surrounding areas of southern Utah. These economic and social benefits are to both small rural communities and to the region. A number of businesses (lodges, restaurants, guides, outfitters, and others) and individuals derive their income from anglers who have come to Marble Canyon for the fishing experience. Economic benefits are associated with factors such as the number of days anglers visit the area, and the number of white water rafting trips that occur in a given year.

A key aspect of economic benefits from visitation to the area is associated with wilderness and park experiences. Grand Canyon National Park provides benefits to both local and regional economies, and, with regard to non-native fish control, businesses that could be affected such as those associated with wilderness recreation that originates at Lees Ferry, such as recreational rafting. Non-native fish control would affect the experience of wilderness recreation, but in the SDM Project, the affect of disturbance from removal activities of the proposed action was not anticipated to affect the economic value derived from recreational rafting.

The proposed action would result in impacts to local economies resulting from effects, or perceived effects by the public, resulting from the disturbance to visitors to GCNRA or GCNP to fish, hike, boat, or otherwise recreate in these parks. In the SDM Project, although substantial disturbance effects to boaters were recognized, this was estimated to have no effect on the contribution of white water rafting to local and regional economies.

The effect of the proposed action on the contribution of fishing in the Lees Ferry area is less clear. The proposed action is not anticipated to have an effect on the fishery itself, but would, as described in previous sections, result in disturbance effects to local anglers. This could result in less fishing activity in Lees Ferry, although this seems unlikely, given that there is some distance between the PBR reach and areas commonly fished in Lees Ferry. However, if fishing user days are affected, this could negatively affect local businesses that benefit from fishing in Lees Ferry, the fishing guides, local area businesses, and the Navajo Nation vendors. The local fishing guides informed Recreation that they believe their business has been affected directly by Reclamation's actions in the past (predominantly flow manipulations associated with HFEs). Data provided by the guides do indicate that their business has diminished in recent years (Figure 9). But nationwide economic conditions also may have contributed to this decline. Conversely, removing fish in the PBR reach, if it reduces abundances in the Lees Ferry reach, could improve the quality of the Lees Ferry fishery by creating a fishery with fewer but larger, healthier fish. This could positively affect local businesses if the improvement in the fishery results in more anglers visiting the area.

Local businesses in the Marble Canyon area may also benefit from increased business resulting from researchers and technicians working in the PBR reach to remove non-native fish, as these individuals would likely use lodging in the area, eat meals at local restaurants, and purchase fuel and equipment in local stores.

Figure 9. Numbers of anglers served by one fishing guide business.

3.4.2.4 Nonuse Economic Value under Proposed Action

There are different possible outcomes in terms of nonuse on values from the proposed action that are difficult to predict. If the public at large values the improvement in the native ecosystem that the non-native fish control would likely bring about, then nonuse values could benefit. This seems plausible, given that the natural beauty and native wilderness are values for which GCNP and GLNRA were established, and NPS management policies support removing non-native fish from the GCNP.

The Hopi Tribe believes that its cultural values for the Grand Canyon should be considered within the Western analysis framework as non-use values. Management actions that occur there can have effects at Hopi that do not depend on whether Hopi people enter (use) the Grand Canyon or not. The proposed action would have effects to Hopi non-use values as described in section 3.3.

3.5 *Indian Trust Assets*

Indian trust assets are legal interests in property held in trust by the US government for Indian tribes or individuals. Examples of such resources are lands, minerals, or water rights. The action area is bounded on the east by the Navajo Indian Reservation and on the south in part by the Hualapai Indian Reservation and the Havasupai Indian Reservation. Reservation land is a trust asset.

3.5.1 *Indian Trust Assets under No Action*

Reclamation has ongoing consultation with these tribes regarding potential effects of the proposed action on their trust assets. The no action alternative would have no effect on Indian trust assets.

3.5.2 *Indian Trust Assets under the Proposed Action*

The proposed action, with its focus on the Colorado River itself and on lands managed by the NPS would not impact Indian lands, minerals, or water rights. There is a possibility that the related science plan and future monitoring efforts would require access to Navajo Nation lands, particularly those in the LCR. All necessary consultations, permits and permissions would be obtained from the BIA and Navajo Nation prior to undertaking any work on Navajo lands.

3.6 *Wild and Scenic Rivers*

Wild and scenic rivers were not noted as an evaluation need during development of this EA, but is considered here as an issue per 16 USC 1271 and 40 CFR 1508.27(b)(3). The Wild and Scenic Rivers Act of 1969 calls for preservation and protection of free-flowing rivers. Pursuant to §5(d) of the Wild and Scenic Rivers Act, the NPS maintains a nationwide inventory of river segments that potentially qualify as wild, scenic, or recreational rivers. Within the action area, overlapping study segments have been proposed: (1) from the Paria Riffle (RM 1) to 237-Mile Rapid in Grand Canyon, and (2) from Glen Canyon Dam (RM -15) to Lake Mead. Grand Canyon National Park (National Park Service 1995, 2005b:18) acknowledges that the Colorado River meets the criteria for designation under the Wild and Scenic Rivers Act as part of the nationwide system; however, formal study and designation have not been completed.

3.7 *Wilderness*

Pursuant to the 1964 Wilderness Act, Grand Canyon National Park was evaluated for wilderness suitability. After the park was enlarged in 1975, Grand Canyon's Wilderness Recommendation was updated following a study of the new park lands. The most recent update of Grand Canyon's Wilderness Recommendation occurred in 2010 and recommended Wilderness designation for approximately 94 percent of the park. In accordance with NPS Management Policies, these areas are managed in the same manner as designated wilderness, and the NPS will take no action to diminish wilderness suitability while awaiting the legislative process.

The issue of effects to wilderness was evaluated in the SDM Project. The analysis for wilderness experience in this EA is contained in section 3.12.2 above. In addition to a wilderness experience as defined by the Wilderness Act as "outstanding opportunities for solitude or a primitive and unconfined type of experience," the Act also defines wilderness character as "untrammeled," undeveloped land retaining its "undeveloped land retaining primeval character in influence without permanent improvements or human habitation.

The No Action will continue to have a long-term adverse impact to wilderness character by allowing non-native populations to increase and as endangered populations decline.

The Proposed Action would have varying effects on other qualities and characteristics of wilderness depending upon implementation in the PBR or LCR. These would be of similar intensity described in 3.12.2 for wilderness character, but overall the proposed action would be expected to have long-term beneficial effects to wilderness if native fish species are protected.

3.8 *Environmental Justice Implications under No Action*

Environmental justice refers to those issues resulting from a proposed action that disproportionately affects minority or low-income populations. To implement Executive Order 12898, *Environmental Justice in Minority Populations and Low Income Populations*, the Council on Environmental Quality (1997) instructs agencies to determine whether minority or low-income populations or Indian tribes might be affected by a proposed action, and if so, whether there might be disproportionate high and adverse human health or environmental effects on them. There would be no Environmental Justice impacts from the no action alternative.

3.9 *Environmental Justice Implications under the Proposed Action*

Coconino County Arizona has a disproportionate number of low income populations per the 2000 U.S. Census data. Reviewing each of the resources affected by the proposed action, there would be no human health effects. There would be environmental effects but these would not be disproportionally high and adverse with one exception. American Indian tribes consider the proposed action to have a substantial effect on their sacred sites and traditional cultural properties. Also, the local Navajo community, especially those living in the Bodeway-Gap Chapter, uses trout as a subsistence resource. Removal of trout could result in a reduction in catch rates in portions of the action area. Alternatively, removal of trout may also improve the overall fishery by improving population dynamics of the population, and increasing the number of larger healthier trout. Regardless, these impacts would occur to all anglers equally, thus not resulting in a high and disproportionate adverse effect to minority populations. We do not anticipate any other Environmental Justice impacts from the proposed action.