3.7 AQUATIC RESOURCES

3.7.1 INTRODUCTION

The analyses presented in this section consider two specific issues associated with aquatic resources. These issues are potential effects to Lake Mead and Lake Powell aquatic species habitat and potential effects to sport fisheries on Lake Powell and Lake Mead.

3.7.2 LAKE HABITAT

The primary lake habitats identified for potential affect within the project area include Lake Powell and Lake Mead. Other reservoirs downstream of Lake Mead (Lake Mohave and Lake Havasu) are expected to be largely unaffected by the proposed interim surplus criteria because operation of the project typically keeps lake levels at specified target elevations to facilitate power generation and water deliveries.

Native Colorado River fishes have not fared well in reservoir environment dominated by non-native predators. While some native species may spawn within the reservoir and others have young that drift into the lakes, predation is believed to eliminate young native fish from the reservoirs and precludes their survival and recruitment. Non-native species, however, have become well-established.

3.7.2.1 METHODOLOGY

Existing literature was reviewed to determine the historic and current status of fish assemblages in Lake Powell and Lake Mead. Literature reviewed included recent publications and drafts on the operations at Lake Powell and Lake Mead, Biological Assessments, Fish Management Plans, and Biological Opinions. Investigation into critical lake elevations, water quality, and temperature limits were made based on the fish species known to inhabit these lakes, including the use of these lakes by endangered species. Because no “threshold” lake elevations associated with significant adverse effects on lake habitat were discovered for any of the fish species, the use of model results was limited to a comparison of the probability of occurrence for given lake levels among the alternatives. A qualitative analysis of potential lake habitat changes was made by comparing the differences between lake level probabilities under various alternatives.

3.7.2.2 AFFECTED ENVIRONMENT

3.7.2.2.1 Lake Powell

Aquatic habitat in Lake Powell is a result of the lake’s physical and geographical characteristics. Lake Powell has a surface area of 255 square miles and contains up

to 24.3 maf of active storage. At full pool, depth of the reservoir near the dam is 561 feet. The thermocline (the boundary layer between a strata of colder and warmer water) changes seasonally, but below approximately 150 feet deep, the cold hypolimnion (a low oxygen, low light, deep water layer of the lake) is consistently maintained due to thermal and chemical properties. Lake Powell exhibits a trophic gradient from the shallow productive inflows where nutrients and sediments are delivered by rivers to the clear nutrient-poor water by the dam. As the reservoir gradually shallows moving away from the dam, the depth and extent of the thermocline and hypolimnion change. Lake elevations change from year to year depending on numerous factors, including Upper Basin runoff. The clear water reservoir offers habitat beneficial to non-native fish. Generally, the reservoir is oligotrophic (characterized by low dissolved nutrients and organic matter); deep, clear, and low in chlorophyll abundance (NPS, 1996).

Non-native fish species became established by intentional and unintentional introductions. Largemouth bass and crappie populations were stocked initially and subsequently proliferated to provide the bulk of the sport fisheries. Both species have declined in recent years due to lack of habitat structure for young fish. Filling, fluctuation, and aging of the reservoir resulted in changing habitat that eliminated most of the vegetation and favored different species. The habitat change led to the introduction of smallmouth bass and striped bass, presently the two dominant predator species in the reservoir, with striped bass being the most dominant. Threadfin shad were introduced to provide an additional forage base and quickly became the predominant prey species (NPS, 1996).

Other species common in Lake Powell include walleye, bluegill, green sunfish, carp and channel catfish. Species that occur in the reservoir, but that are mainly associated with tributaries and inflow include fathead minnow, mosquitofish, red shiner and plains killifish (NPS, 1996). Table 3.7-1 lists fish species present in the project area.

Native fish species were displaced by habitat loss and alteration associated with construction and operation of mainstream dams and reservoirs, as well as competition and predation with introduced non-native species. Bonytail is the native species believed to be in the most peril of imminent extinction because they are virtually eliminated in the Uupper Basin. Bonytail were reported in Lake Powell soon after closure of Glen Canyon Dam; however, annual gill-net surveys conducted by the Utah Department of Wildlife Resources have failed to produce any bonytail in the last 20 years.

Table 3.7-1
Fish Species Present in the Project Area

Species	Scientific Name	Origin
Black bullhead	*Ictalurus melas*	Invading sport fish
Black crappie	*Pomoxis nigromaculatus*	Introduced sport fish
Bluegill	*Lepomis macrochirus*	Invading sport fish
Bluehead sucker	*Catastomus discobolus*	Native to Colorado River
Bonytail	*Gila elegans*	Native to Colorado River
Carp	*Cyprinus carpio*	Invading fish
Channel catfish	*Ictalurus punctatus*	Invading sport fish
Colorado pikeminnow	*Ptychocheilus lucius*	Native to Colorado River
Fathead minnow	*Pimephales promelas*	Invading forage fish
Flannelmouth sucker	*Catostomus latipinnis*	Native to Colorado River
Green sunfish	*Lepomis cyanellus*	Invading fish
Humpback chub	*Gila cypha*	Native to Colorado River
Largemouth bass	*Micropterus salmoides*	Introduced sport fish
Mosquitofish	*Gambusia affinis*	Invading forage fish
Northern pike	*Esox lucius*	Invading sport fish
Rainbow trout	*Oncorhynchus mykiss*	Introduced sport fish
Razorback sucker	*Xyrauchen texanus*	Native to Colorado River
Red shiner	*Notropis lutrensis*	Invading forage fish
Roundtail chub	*Gila robusta*	Native to Colorado River
Smallmouth bass	*Micropterus dolomieui*	Introduced sport fish
Speckled dace	*Rhinichthys osculus*	Native to Colorado River
Striped bass	*Morone saxatilis*	Introduced sport fish
Threadfin shad	*Dorosoma petenense*	Introduced forage fish
Walleye	*Stizostedion vitreum*	Invading sport fish

Other native species that may still persist in Lake Powell include the Colorado pikeminnow, humpback chub, razorback sucker and flannelmouth sucker. Although there have been no reports of Colorado pikeminnow in the lake since 1977, they are believed to still inhabit the Colorado River inflow area. Very few humpback chub have been found in Lake Powell and it is presumed that they are not present in the lake at this time; however, unidentified chub species were collected by seines and light traps in the Colorado River inflow area (NPS, 1996). Small numbers of razorback suckers have persisted in Lake Powell since the closure of Glen Canyon Dam, occurring mainly near the inflows of large tributaries. Flannelmouth suckers are probably the only native fish to inhabit the main body of Lake Powell in detectable numbers. However, there has been a declining trend in population size and reproductive recruitment has not been documented. Additional discussion of special-status fish species is included in Section 3.8.

3.7.2.2.2 Lake Mead

Lake Mead has a surface area of 245 square miles and a storage capacity of 26 maf. Over two-thirds of the volume of Lake Mead remains at 55°F (13°C) throughout the year, resulting in a constant, cool discharge at Hoover Dam (USBR, 1996).

Native fish species that may be found in Lake Mead include razorback sucker and bonytail, both listed as endangered species. Razorback sucker maintain a remnant population in Lake Mead (USBR, 1996). Bonytail populations are supported by specific management activities designed to re-establish this species in Lake Mohave. Remnant populations of these species exist downstream of Lake Mead in Lake Mohave and Lake Havasu, and groups such as the Native Fish Work Group (NFWG) and Lake Havasu Fishery Improvement Project (HAVFISH) are currently engaged in activities conducted under Section 7(a)(1) of the ESA to aid in the conservation and recovery of these species in the lower Colorado River Basin (USBR, 1999).

Introduced fish species found in Lake Mead include largemouth bass, striped bass, rainbow trout, channel catfish, crappie, threadfin shad and carp (USBR, 1996).

Releases from Lake Mead are the predominant influence on inflows to two other reservoirs, Lake Mohave and Lake Havasu. The routine operation of Lake Mohave over the next five years is anticipated to limit reservoir fluctuations as a measure to assure that potential impacts to razorback sucker will be minimized during the spawning season (USBR, 1996).

3.7.2.2.3 General Effects of Reservoir Operation

Lake habitat in both Lake Powell and Lake Mead consists primarily of deep, clear, open water habitats with a cold hypolimnion that is consistently maintained due to thermal and chemical properties. The habitat found in these lakes is drastically different from the habitat that was found prior to the construction of the dams, and is currently more suitable for non-native species than native species. Non-native fish species were introduced into the lakes, and subsequently established naturally reproducing populations. Habitat changes resulting from fluctuating lake levels have favored introduced species tolerant of the temperatures found in the lakes. These species are able to readily reproduce in the lakes and are largely unaffected by fluctuating lake levels.

The ability of native species to adapt to the lake habitat is limited mainly by the decreased survival of eggs and the lack of recruitment of young individuals into the adult population. The primary reason for low recruitment of native fish is predation of eggs and young by the established populations of non-native species. In some cases, nutrition may also influence recruitment (Horn, June 2000).

3.7.2.3 ENVIRONMENTAL CONSEQUENCES

There are no specific "threshold" lake levels that are definitive for evaluation of potential impacts to lake habitat in Lake Powell or Lake Mead. As such, the following sections provide a qualitative comparison of potential effects of the interim surplus criteria compared with baseline conditions. Modeling results indicate a trend toward decreasing pool elevations with varying degrees of probability over time under baseline conditions and for each of the alternatives. Figures 3.3-6 and 3.3-13 show this trend for 90, 50 and 10 percent probabilities associated with Lake Powell and Lake Mead elevations over the 50-year period of analysis, respectively.

Modeling results indicate increased probabilities for Lake Powell and Lake Mead surface elevation declines over the 50-year period of analysis under baseline conditions and each of the alternatives. These modeling projections indicate future habitat conditions at Lake Powell and Lake Mead will continue to be subjected to varying inflows and fluctuating lake elevations primarily based on hydrologic conditions present in the watershed and water diversions in the Upper Basin. Historically, these conditions have resulted in lake habitat that is favorable to non-native species and unfavorable to native species. Projections of increased potential for future reservoir surface declines in both Lake Powell and Lake Mead are similar when comparing baseline conditions to each of the alternatives and are not likely to result in substantial changes to lake habitat.

3.7.3 SPORT FISHERIES

This section considers potential effects of the interim surplus criteria alternatives on sport fisheries in Lake Powell and Lake Mead. Potential effects on recreation associated with sport fisheries are discussed in Section 3.9.5.

3.7.3.1 METHODOLOGY

Existing literature was reviewed to determine the historic and current status of sport fish assemblages in Lake Powell and Lake Mead. Literature reviewed included recent publications on the status of sportfishing in both reservoirs, along with a review of water quality data including limnological reports and journal articles for information on contaminants found within the lakes and in fish tissue. Potential effects on sport fisheries identified herein are based on the analysis of lake habitat discussed in Section 3.7.2. Potential effects on sport fisheries are based on model output showing general trends of reservoir surface elevations, river flow rates and temperature. No specific threshold elevations or flows are used in the analysis.

3.7.3.2 AFFECTED ENVIRONMENT

Currently, Lake Powell and Lake Mead provide habitat for numerous species of introduced (non-native) fish which support outstanding recreational sport fishing opportunities. The fish species present in the GCNRA are listed in Table 3.7-1.

A similar species assemblage exists for Lake Mead. The two most common sportfish species found in Lake Powell and Lake Mead continue to be striped bass and largemouth bass.

3.7.3.2.1 Reservoir Sport Fisheries

The biggest sport fisheries management challenge in the reservoirs is trying to stabilize a striped bass population that reproduces without limit. As a result of unlimited striped bass reproduction, pelagic (open water) stocks of threadfin shad upon which they prey have been decimated. Decimation of the shad population then results in striped bass starvation. Reduction of striped bass numbers allows the shad population to rebound from adult stocks residing in turbid, thermal refuges where they are less vulnerable to striped bass predation. As shad reenter the pelagic zone in large numbers, they are subsequently eaten by young stripers who grow rapidly, mature, and once again eliminate shad from the pelagic zone. This widely fluctuating predator-prey cycle occurred during the 1990s and still occurs today.

Threadfin shad in Lake Powell exist in the northernmost portion of their range. Lower lethal temperatures for shad are reported as 40°F to 41°F (4.5°C to 5°C). Shad currently survive winters where water temperatures consistently range near the lethal limit by seeking deep strata where the water temperature is warmer and stable. An additional temperature reduction of even 2°F (1.0°C) may remove the shad thermal refuge and result in loss of shad over winter. The absence of a pelagic forage fish would be devastating to Lake Powell sport fisheries. The absence of shad would not eliminate striped bass, which now reproduce without limit and subsist on plankton for the first year or two of life, but would eventually result in a permanently stunted striped bass population without quality sport fishing value (NPS, 1996).

Results of recent NPS and Service surveys indicate that some biocontaminants show an increasing trend in aquatic organisms nearing the dam. Selenium in plankton from Wahweap Bay and Warm Creek ranged from 5.3 to 14.6 micrograms per gram (μg/g) dry weight. Striped bass filets taken in Warm Creek and near the dam contained 12.7 to 19.9 μg/g dry weight selenium. Removal of angler catch limits of striped bass as a means of reducing the striped bass population has increased the opportunity for anglers to take and consume large quantities of fish filets containing selenium (NPS, 1996). Although there have been no apparent adverse impacts on reproduction or survival of striped bass, selenium at these levels could pose potential problems to anglers (NPS, 1996).

The sport fishery at Lake Mead has been managed in much the same manner as in Lake Powell and has resulted in many of the same management challenges. The introduction of threadfin shad as a forage species and striped bass as the main predator has produced similar interactions between the two species.

Water quality issues relating to sportfish have also been observed in Lake Mead. Tissue samples from fish caught at Lake Mead have shown evidence of the pesticide endrin, a known carcinogen (Las Vegas Review Journal, 1998). Studies are underway to determine the source for these contaminants, with efforts focussed on water in the Las Vegas Bay area of Lake Mead and water flowing into Lake Mead from the Las Vegas Wash.

3.7.3.2.2 Colorado River Sport Fisheries

The Colorado River below Glen Canyon Dam supports a prized trout fishery that extends from the dam downstream through the Grand Canyon reach. Not native to this stretch of river, trout were originally introduced for sport purposes. Rainbow trout comprise the major portion of the sport fishery, although brook trout, brown trout and cutthroat trout have also been stocked (USDI, 1995).

Rainbow trout are no longer planted in the Grand Canyon because that population is now 100 percent supported by natural recruitment.

Sport fishery resources in the Colorado River between Lake Powell and Lake Mead are managed by the AGFD. Effects of dam releases on the trout fishery are given consideration in the development of recommendations for changes to dam releases formulated through the broader Adaptive Management Program, in which AGFD is a participant.

3.7.3.3 ENVIRONMENTAL CONSEQUENCES

3.7.3.3.1 Reservoir Sport Fisheries

The sport fishery in Lake Powell and Lake Mead is primarily based on the presence of striped bass. Other sport fish found in the lakes include largemouth bass, catfish and trout. Since the predator-prey relationship between striped bass and threadfin shad can result in large variations of the striped bass population, stabilizing the population of striped bass is an ongoing challenge to sport fish management in the lakes.

All of the other sport fish, with the possible exception of trout, are well-adapted to habitats found in the lakes and are largely unaffected by gradually fluctuating lake levels and water temperatures. Trout populations in the reservoirs are sustained by planting fish from hatchery stock.

Under baseline conditions and each of the alternatives, the challenge of stabilizing striped bass populations in the lakes will continue and may include the need to alter the size or catch limit of striped bass. Large fluctuations in the prey base and resultant declines in the striped bass population cause the greatest impact to the sport fishery in the lakes. The occurrence of prey base fluctuations is not directly related to lake levels or fluctuations, and would not be affected by any of the interim surplus criteria alternatives. None of the alternatives would be expected to affect levels of selenium or endrin in sport fish.

3.7.3.3.2 Colorado River Sport Fisheries

The primary sport fish in the Colorado River is rainbow trout. Natural reproduction of rainbow trout in the Grand Canyon is dependent on cooler water temperatures, access to tributaries, and continued availability of suitable main stem habitat for spawning success. These variables are directly related to patterns of flow releases from Lake Powell. Under baseline conditions and each of the alternatives, an increase in the temperature of water released from Glen Canyon Dam could occur if reservoir levels in Lake Powell fall below an elevation of 3590 feet msl. The probability of elevations below 3590 feet msl is limited to the 10 percentile rankings and is not projected to occur until approximately years 2018 to 2028. Water releases from Glen Canyon Dam are controlled by operating criteria contained in the 1996 ROD and are monitored for compliance with the Grand Canyon Protection Act through the Adaptive Management Program. As a result, Colorado River sport fisheries would not be affected by the interim surplus criteria alternatives.