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 at Lake Powell, Lake Mead, and the Colorado River between Lake Powell and Lake Mead. The interim surplus criteria are not expected to result in any changes to aquatic resources below Hoover Dam.

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 not expected to be affected by the proposed interim surplus criteria because operation of the system keeps lake levels at specified target elevations to facilitate power generation and water deliveries (Reclamation, 2000).

Native Colorado River fishes have not fared well in the reservoirs. Non-native fish species, which prey on and compete with native species, have become well-established in both lakes. While some native species may spawn within the reservoirs and others have young that drift into the lakes, predation and competition is believed to eliminate young native fish from the reservoirs and precludes their survival and recruitment. A discussion of native Colorado River fishes is presented in Section 3.8, Special-Status Species.

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 draft documents 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 identified for any of the fish species, the use of system modeling relied upon a comparison of general reservoir surface elevation trends under baseline conditions and the alternatives, shown in Figures 3.3-6 and 3.3-13. A qualitative analysis of potential lake habitat changes was made by comparing the differences between lake level trends under baseline conditions and the 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 with and predation by 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 Upper 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
Brown Trout	*Salmo trutta*	Introduced sport fish
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
Spotted sculpin	*Cottus bairdi*	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 and humpback chub. 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 inflow of the San Juan River. 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, 1996d). At full pool, depth of the reservoir near the dam is approximately 550 feet. Because of its physical similarity to Lake Powell, the limnological characteristics of Lake Mead are also similar. The thermocline changes seasonally and a cold hypolimnion is consistently maintained due to thermal and chemical properties. Surface 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.

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. Razorback sucker, federally listed as an endangered species, is the only native species that maintains a remnant population in Lake Mead (USBR, 1996a,b).

Non-native fish species became established by intentional and unintentional introductions. Introduced fish species found in Lake Mead include largemouth bass, striped bass, rainbow trout, channel catfish, crappie, threadfin shad and carp (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 Wok Group (NFWG) and Lake Havasu Fishery Improvement Project (HAVFISH) are currently engaged in activities conducted under Section 7(a)(l) of the ESA to aid in the conservation and recovery of these species in the lower Colorado River Basis (USBR, 1999).

Releases from Lake Mead are the predominant influence on inflows to two other reservoirs, Lake Mohave and Lake Havasu. Operations at Lake Mead typically keep lake elevations at the downstream reservoirs at specific target elevations to facilitate power generation and water deliveries. The operation of Lake Mohave through 2002 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 riverine habitat that existed prior to the construction of the dams, and is 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 conditions and temperatures found in the lakes. These species are able to reproduce in the lakes and are not expected to be affected by fluctuating lake levels. In Lake Powell for example, striped bass have experienced "unprecedented natural reproduction and survival" that allowed them to become "the most numerous sport fish and dominate the fish community of Lake Powell" (NPS, 1996).

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. Projections of Lake Powell and Lake Mead surface the elevations are discussed in Sections 3.3.4.2 and 3.3.4.4, respectively. These reservoirs will continue to be subjected to varying inflows and fluctuating surface elevations, primarily due to hydrologic conditions present in the watershed and increasing water use in the Upper Basin. Historically, reservoir conditions have resulted in lake habitat that is favorable to non-native species and unfavorable to native species. Because the projected declines in reservoir surface elevation in both Lake Powell and Lake Mead are within the normal operational range of fluctuations, they 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, Lake Mead and below Hoover Dam. Potential effects on recreation associated with sport fisheries are discussed in Section 3.9.5.

The sport fishery within the Colorado River corridor from Glen Canyon Dam to Separation Canyon is not analyzed in detail in this FEIS because annual release patterns from Glen Canyon Dam are determined in accordance with the 1996 ROD and are monitored through the Glen Canyon Dam Adaptive Management Program. Through this process, the effects of dam operations on downstream resources, including sport fish, are monitored and studied. The results are used to formulate potential recommendations on refinements to dam operations, to ensure that the purposes of the Grand Canyon Protection Act are met.

The possibility of changes in river water temperature downstream of Hoover Dam was also investigated. Reclamation conducted an analysis predicting water temperatures downstream of Hoover Dam with a Lake Mead water surface elevation of 1120 feet msl and a steady release of 62,000 cfs (30 percent higher than powerplant capacity). Under

these conditions, the warmest temperature predicted was 58.5°F in late summer. The midsummer discharge temperature was predicted to be 58.5°F (Reclamation, 1991). Under actual conditions with a reservoir elevation of 1120 feet msl, however, maximum discharge would be equal to the powerplant capacity of 49,000 cfs. At this lesser flow, discharges would be cooler than the temperatures predicted in the analysis, since less discharge water would be drawn from the warm upper portion of the reservoir than at higher flows. Therefore, it is assumed that increases of release temperatures corresponding to the median decline of lake levels under baseline conditions and the action alternatives would result in temperatures less than those predicted in the 1981 analysis.

Staff from the Willow Beach Federal Fish Hatchery, located about 12 miles downstream of Hoover Dam, reported that over the long term, river water temperatures have typically ranged from 56°F to 58°F, with occasional lows of 54°F. Modeled Hoover Dam discharges are not significantly different from those during periods when water temperatures were measured by hatchery personnel. It is expected that the minor changes in river water temperature described above would not be expected to adversely affect fish populations or the sport fishery in the river below Hoover Dam. The hatchery rears both trout and native fish. For native species, the hatchery warms the river water with solar panels. The projected increase in river temperatures may be a benefit to the hatchery's native fish program. River temperatures are not addressed further in this section.

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 are striped bass and largemouth bass.

3.7.3.2.1 Reservoir Sport Fisheries

The primary sport fisheries management challenge in the reservoirs is trying to stabilize a striped bass population that reproduces beyond the limits of available forage. 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 striped bass 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 thermal refuge and result in loss of shad over winter. The absence of a pelagic forage fish would not eliminate striped bass, which now 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).

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.

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 and maintaining the threadfin shad population is an ongoing challenge to sport fish management in the lakes.

Although the occurrence of prey base fluctuations is more directly related to striped bass populations, a thermal refuge for adult threadfin shad is critical. Under baseline conditions and each of the alternatives, the challenge of stabilizing striped bass and threadfin shad populations in the lakes will continue and may include the need to alter the size or catch limit of striped bass or planting of fish from hatchery stock. 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 fluctuating lake levels and water temperatures. Trout populations in the reservoirs are sustained by planting fish from hatchery stock.

3.7.3.3.2 Colorado River Sport Fisheries

The primary sport fish in the Colorado River between Glen Canyon Dam and the Lake Mead inflow is rainbow trout. Natural reproduction of rainbow trout in the Grand Canyon is dependent on cool water temperatures, access to tributaries for spawning and continued availability of suitable main stem habitat. 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.