Distribution and Abundance

As seen in Table 15 below, the numbers of cuckoos detected have fluctuated widely since surveying began in 1993 on the Bill Williams River. In 1997, on the Kern River in California, numbers of cuckoos detected declined in a similar manner as that seen on the Bill Williams River during the same time period, 1994-1997. On the Kern River, cuckoos detected declined from 14 pairs in 1996 to 6 pairs in 1997 (Halterman, 1998); on the Bill Williams, cuckoos detected declined from 26 pairs to 12 pairs. In 1990, numbers detected were back up on the Bill Williams, but down again in 1999. In other areas of the lower Colorado River, Cuckoos have been detected as far south as Gadsden and Imperial National Wildlife Refuge (Carman and Magill, 2000; McKernan and Braden, 1999).

Table 15. Cuckoos detected from 1993-2000

Survey Results BWRNWR	1993	1994	1997	1998	1999
Pairs Detected	22	26	12	20	6
Single Birds Detected	11	14	11	11	8
Nests Found	6	5	3	4	2
Date First Pair Encountered	25 Jun	27 Jun	20 Jun	18 Jun	5 Jun

Without complete and standardized surveys, it can only be speculated that the birds are present across the border in the Colorado River Delta in Mexico. The range of this species includes the Colorado River Delta (AOU, 1998).

Effects Analysis

Yellow-billed Cuckoos utilize mature riparian habitat with some mid- and under-story present. Flood control releases are the only condition under which riparian habitats are established on the lower Colorado River, and a high ground water table is needed to maintain this habitat. At Lake Mead, declining elevations may increase riparian habitat for Yellow-billed Cuckoos, although the habitat may be ephemeral due to possible high inflows in the future that could inundate the area. Differences in impacts to Yellow-billed Cuckoo habitat between the No Action Alternative and the California Alternative for the ISC below Hoover Dam are negligible.

Yellow-billed cuckoo habitat consisting of mature cottonwood and willow trees is dependent on groundwater. A change in point of diversion of 400 kaf under the SIAs may affect Yellow-billed Cuckoo habitat by lowering river and groundwater elevations.

B. Marsh

Brown Pelican (Pelecanus occidentalis)
Federally Endangered

Description and Life Requisites

Easily recognized by its large pouch, a fully grown brown pelican can have a wingspan of 7 feet. Although they usually inhabit coastal waters, the birds sometimes forage as far as 100 miles offshore. In California, brown pelicans feed mainly on northern anchovy, Pacific sardine, and Pacific mackerel (Thelander and Crabtree, 1994).

Brown pelicans were added to the Federal endangered species list in 1970. In the late 1960s, biologists discovered that pesticide-caused eggshell thinning had decimated brown pelican populations including those in southern California. Populations have rebounded since the banning of DDT, and the question of whether to reclassify the pelican is currently a contested issue.

Distribution and Abundance

The majority of California's brown pelicans nest south of the border, mostly on islands along the Pacific coast of Baja California, Mexico, and in the Gulf (between 50,000 and 75,000 pairs) (Thelander and Crabtree, 1994).

Along the lower Colorado River, the brown pelican is a rare but annual post-breeding wanderer from Mexico in late summer and early fall. It is most frequently seen around Imperial Dam, but individuals have occurred north to Davis Dam and even to Lake Mead. Virtually all records are of lone immature birds, undoubtedly dispersing from breeding colonies in the Gulf or perhaps via the Salton Sea (Rosenberg et al, 1991). Along the river, they prefer large open-water areas near dams.

Effect Analysis

This species will not be affected as the proposed action will not change the character of aquatic habitat potentially utilized by this species. Any change in the status of this species (e.g., breeding) would initiate a reexamination of potential operational effects.

Yuma Clapper Rail (Rallus longirostris yumanensis)
Federally Endangered

Description and Life Requisites

Yuma clapper rails are found in emergent wetland vegetation such as dense or moderately dense stands of cattails (Typha latifolia and T. domingensis) and bulrush (Scirpus californicus) (Eddleman, 1989; Todd, 1986). They can also occur, in lesser numbers, in sparse cattail-bulrush stands or in dense reed (Phragmites australis) stands (Rosenberg et al., 1991). The most productive clapper rail areas consist of a mosaic of uneven-aged marsh vegetation interspersed with open water of variable depths (Conway et al., 1993). Annual fluctuation in water depth and residual marsh vegetation are important factors in determining habitat use by Yuma clapper rails (Eddleman, 1989).

Yuma clapper rails may begin exhibiting courtship and pairing behavior as early as February. Nest building and incubation can begin by mid-March, with the majority of nests being initiated between late April and late May (Eddleman, 1989; Conway et al., 1993). The rails build their nests on dry hummocks, on or under dead emergent vegetation and at the bases of cattail or bulrush. Sometimes they weave nests in the forks of small shrubs that lie just above moist soil or above water that is up to about 2 feet deep. The incubation period is 20-23 days (Ehrlich et al., 1988; Kaufman, 1996) so the majority of clapper rail chicks should be fledged by August. Yuma clapper rails nest in a variety of different micro habitats within the emergent wetland vegetation type, with the only common denominator being a stable substrate. Nests can be found in shallow water near shore or in the interior of marshes over deep water (Eddleman, 1989). Nests usually do not have a canopy overhead as surrounding marsh vegetation provides protective cover.

Crayfish (Procambarus clarki) are the preferred prey of Yuma clapper rails. Crayfish comprise as much as 95 percent of the diet of some Yuma clapper rail populations (Ohmart and Tomlinson, 1977). Availability of crayfish may be a limiting factor in clapper rail populations and is believed to be a factor in the migratory habits of the rail (Rosenberg et al., 1991). Eddleman (1989), however, has found that crayfish populations in some areas remain high enough to support clapper rails all year and that seasonal movement of clapper rails can not be correlated to crayfish availability.

One issue of concern with the Yuma clapper rail is selenium. Eddleman (1989) reported selenium levels in Yuma clapper rails and eggs and in crayfish used as food were well within levels that will cause reproductive effects in mallards. Rusk (1991) reported a mean of 2.24 ppm dry weight selenium in crayfish samples from six lower Colorado River backwaters from Havasu National Wildlife Refuge, near Needles, CA to Mittry Lake, near Yuma, AZ. Over the past decade, there has been an apparent two-to five fold increase in selenium concentrations in crayfish, the primary prey species for the Yuma Clapper Rail (King et al., 2000). Elevated concentrations of selenium (4.21- 15.5 ppm dry weight) were present in 95 percent of the samples collected from known food items of rails. Crayfish from the Cienega de Santa Clara in Mexico contained 4.21 ppm selenium, a level lower than those in the U. S., but still above the concern threshold. Recommendations from this latest report on the subject conclude that if selenium concentrations continue to rise, invertebrate and fish eating birds could experience selenium induced reproductive failure and subsequent population declines (King et al., 2000).

Yuma clapper rail may be impacted by man-caused disturbance in their preferred habitat. In recent years the use of boats and personal watercraft has increased along the lower Colorado River. This has led to speculation that the disturbance caused by water activities such as those may have a negative impact on species of marsh dwelling birds.

Distribution and Abundance

This subspecies is found along the Colorado River from Needles, California, to the Gulf, at the Salton Sea and other localities in the Imperial Valley, California, along the Gila River from Yuma to at least Tacna, Arizona, and several areas in central Arizona, including Picacho Reservoir (Todd, 1986; Rosenberg et al., 1991). In 1985, Anderson and Ohmart (1985) estimated a population size of 750 birds along the Colorado River north of the international boundary. FWS (1983) estimated a total of 1,700 to 2,000 individuals throughout the range of the subspecies. Based on the most recent call count surveys (Table 16), the population of Yuma clapper rail in the United States appears to be holding steady (FWS, Phoenix, Arizona, unpublished data). Due to the variation in surveying over time, these estimates can only be considered the minimum number of birds present (Eddleman, 1989; Todd, 1986). The range of the Yuma clapper rail has expanded in the past 25 years and continues to do so (Ohmart and Smith, 1973; Monson and Phillips, 1981; Rosenberg et al., 1991; SNWA, 1998; McKernan and Braden, 1999,), so there is a strong possibility that population size may increase. Yuma clapper rails are known to expand into desired habitat when it becomes available. This is evidenced by the colonization of the CFG Finne-Ramer habitat management unit in Southern California. This unit was modified to provide marsh habitat specifically for Yuma clapper rail and a substantial resident population exists there. There is also recent documentation of the species in Las Vegas Wash, Virgin River and the lower Grand Canyon (SNWA, 1998; McKernan and Braden, 1999).

A substantial population of Yuma clapper rail exists in Colorado River Delta in Mexico. Eddleman (1989) estimated a total of 450 to 970 Yuma clapper rails were present there in 1987. The birds were located in the Cienega, Sonora, Mexico (200-400 birds), along a dike road on the delta proper (35-140 birds), and at the confluence of the Rio Hardy and Colorado River (200-400 birds). Piest and Campoy (1998) detected a total of 240 birds responding to taped calls in the Cienega. From these data, they estimate a total population of approximately 5000 rails in the cattail habitat in the Cienega. Hinojosa-Huerta et al. (2000) estimated approximately 6,300 rails in 1999.

Crayfish were introduced into the lower Colorado River about 1934. This food source and the development of marsh areas resulting from river control such as dams and river management helped to expand the breeding range of the Yuma clapper rail. The original range of the Yuma clapper rail was primarily the Colorado River delta. The southernmost confirmed occurrence of Yuma clapper rail in Mexico was three birds collected at Mazaltan, Sinaloa; Estero Mescales, Nayarit; and inland at Laguna San Felipe, Puebla (Banks and Tomlinson, 1974).

Yuma clapper rail were thought to be a migratory species, the majority of them migrating

Table 16. Yuma Clapper Rail Survey Data 1990-1999

Location	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Mohave Division	0	0	0	0	0	0	0	0	0	0
Havasu NWR										
Topock Marsh	59	52	66	30	14	NC	33	32	48	NC
Topock Gorge	111	98	122	97	NC	NC	20	36	37	45
Havasu Division	6	3	3	8	6	NC	4	0	1	9
B.Williams NWR	6	15	16	18	10	7	15	14	NC	11
Parker Division	0	9	9	2	4	NC	0	0	NC	5
Palo Verde Div.	4	0	4	NC	0	NC	0	0	NC	2
Cibola Division	11	14	21	27	28	NC	NC	NC	NC	NC
Cibola NWR	52	39	29	34	109	NC	NC	41	61	89
Imperial Division	64	69	91	107	72	86	117	104	1	10
Imperial NWR	38	24	NC	127	113	50	43	31	59	51
Laguna Division										
S. Imperial Dam	NC	NC	7	16	32	NC	NC	29	3	NC
West Pond	NC	3	2	1	7	17	13	NC	NC	16
Mittry Lake	21	18	16	16	27	NC	NC	18	NC	NC
Teal Alley	44	50	38	20	18	38	53	35	34	40
YPG Slough	43	70	68	65	38	31	36	37	28	31
Yuma Division	17	14	10	4	0	3	11	1	NC	6
Limitrophe Div.	2	7	27	13	3	4	17	6	NC	0
Yuma Vy. Drains	NC	11	11	14	5	NC	NC	NC	NC	NC
Lower Gila River										
N. Gila Valley	NC	NC	7	3	NC	NC	NC	0	0	NC
Wellton-Mohawk	11	NC	13	10	6	5	9	7	0	1
Dendora Valley	NC	NC	4	4	5	NC	NC	NC	NC	NC
Citrus Valley	NC	NC	4	0	0	0	NC	NC	NC	NC
Buckeye-Arling.	11	52	45	39	48	26	32	20	7	15
Salt-Verde Conf.	NC	0	0	0	0	NC	0	NC	NC	NC
Picacho Reservoir	0	0	2	7	2	5	1	2	2	0
Imperial Wildlife Area: Wister Unit	90	259	331	302	309	307	239	211	185	191
Salton Sea NWR	16	13	40	96	102	80	83	63	61	67
Salton Sea Area										
Barnacle Beach	NC	9	6	16	2	20	33	24	20	13
Salt Creek	0	4	NC	NC	NC	0	0	0	0	0
Holtville Drains	0	NC	NC	NC	NC	12	10	5	6	5
Bard Valley	4	4	NC	NC	NC	NC	NC	NC	NC	NC
C. de Santa Clara									240	6300
TOTALS	**610**	**837**	**1012**	**1076**	**969**	**691**	**769**	**716**	**553***	**607***

* Rails in Cienega de Santa Clara not included in total for year (US birds only)
1999 Cienega figure is population estimate for all Cienega and Lower Colorado River habitats in Mexico
NC = No survey conducted
Figures represent number of birds
(USFWS, Ecological Services Office, Phoenix, Arizona)

south into Mexico during the winter, with only a small population resident in the United States during the winter. Eddleman (1989) concluded the Yuma clapper rail was not as migratory as once thought and estimated approximately 70 percent remained in or near their home range during the winter.

A Recovery Plan was implemented in 1983 for the Yuma clapper rail. The criteria for downlisting of the species states there must be a stable breeding population of 700-1000 individuals for a period of 10 years. Other goals to be met include:

- Clarifying the breeding and wintering status in Mexico.
- Obtaining an agreement with Mexico for management and preservation of the species.
- Development of management plans for Federal and State controlled areas where the rails are known to breed.
- Written agreements are made with Federal and State agencies to protect sufficient wintering and breeding habitat to support the proposed population numbers.

As of 1999, not all of the above recovery actions had been met, and FWS recommended the Yuma clapper rail remain classified as endangered. In 1999 the Yuma Clapper Rail Recovery Team recommended the existing recovery criteria be examined and brought up to date.

Effect Analysis

The ISC would result in slightly reduced probability of flood flow releases below Hoover Dam. The Cienega de Santa Clara, where the largest population of Yuma clapper rail exist in the Colorado River Delta is sustained by irrigation return flows originating in the U.S. The Cienega is not directly connected to the Colorado River channel. Yuma clapper rail adjacent to the Colorado River from Imperial Dam to Parker Dam may be affected by the reduction in backwater acreage resulting from a change in point of diversion of 400 kaf.

California Black Rail (*Laterallus jamaicensis coturniculus*)
Federal Species of Concern, State Threatened - California

Description and Life Requisites

Black Rails are most often found in shallow salt marshes, but also utilize freshwater marshes, wet meadow-like areas and riparian habitat along rivers. Both males and females of this species exhibit slate black plumage with narrow, white barring on the back and flanks and a chestnut nape with a very short tail and a small black bill. Juveniles look much the same as adults, but their eyes are brown or olive rather than red like those of adults. Full grown birds measure about 5 to 6 inches in length.

The life history and status of the California black rail are poorly known (Wilbur, 1974; Todd, 1977; Evens et al., 1991), due to its secretive nature and tendency to inhabit densely vegetated marshes. The preferred habitat of the California black rail is characterized by minimum water fluctuations that provide moist surfaces or very shallow water, gently sloping shorelines, and dense stands of marsh vegetation (Repking and Ohmart, 1977). California black rails are most often found in areas where cattails (Typha sp.) and California bulrush (*Scirpus californicus*) are the predominant plant species (Rosenberg et al., 1991). While California black rails are more commonly associated with cattail and bulrush, habitat structure as described above was more effective than plant composition in predicting California black rail use of habitat. Water depth appeared to be a limiting factor, as the California black rails prefer shallow water (Flores and Eddleman, 1995). The breeding season along the lower Colorado River extends from April through July (Flores and Eddleman, 1995). California black rails eat mainly aquatic insects and some seeds (Ehrlich, 1988; Rosenberg et al., 1991; Kaufmann, 1996).

Distribution and Abundance

This subspecies of California black rail occurs along the California coast from Tomales Bay in Marin County, south to San Diego and extreme northern Baja California and Veracruz. It also occurs in interior California around the Salton Sea and along the Colorado River from Imperial National Wildlife Refuge south to the international boundary (Peterson, 1990; Rosenberg et al., 1991; AOU, 1998). The species has also been recorded as recently as 1997 at the Bill Williams River National Wildlife Refuge and at Havasu National Wildlife Refuge. Historically, the California black rail primarily occurred along the California coastline. In the mid-1970s, an estimate of between 100 and 200 individuals was given for the area between Imperial National Wildlife Refuge and Mittry Lake, Arizona (Repking and Ohmart, 1977). No quantitative data are yet available on the current populations of the California black rail along the lower Colorado River or in the Colorado River Delta area, although the species is present in both areas. Surveys are currently underway on the Lower Colorado River between Havasu National Wildlife Refuge and Yuma, Arizona. Various agencies including BLM and FWS survey California black rail concurrently during surveys for the Yuma clapper rail.

Effect Analysis

The effect analysis for the California black rail are the same as for the Yuma clapper rail. The ISC would result in slightly reduced probability of flood flow releases below Hoover Dam. California black rail adjacent to the Colorado River from Imperial Dam to Parker Dam may be affected by the reduction in backwater acreage resulting from a change in point of diversion of 400 kaf.

C. Aquatic

Razorback Sucker (*Xyrauchen texanus*)
Federally Endangered

Description and Life Requisites

The razorback sucker is a large fish, reaching over 2 feet in length and 8 pounds in weight. Sexual dimorphism is present, with males being smaller, slimmer, and having larger fins than females. During the breeding season males have nuptial tubercles covering posterior fins and portions of the body. Females tend to be larger, heavier-bodied and have fins that are somewhat smaller in proportion to their body size (Minckley, 1973).

During the non-reproductive season adults may be found widely dispersed throughout lakes and in riverine sections. Radiotelemetry work in both the upper and lower basins show wide ranges in movement. However, some individuals were relatively sedentary and over the course of a year strayed no more than a few miles from their original point of capture (Minckley et al., 1991).

Reproduction in the lower basin has been studied in Lakes Mead and Mohave. Spawning in Lake Mohave typically begins in January or February, while in Lake Mead it begins slightly later (Jonez and Sumner, 1954). Spawning typically runs 30-90 days, at water temperatures ranging from 55° to 70° F. In reservoirs, spawning aggregations can contain up to several hundred fish. Spawning areas tend to be wave-washed, gravelly shorelines and shoals. Fish spawn in water from 3 to 20 feet in depth with the majority of fish in the 5-10 foot range. Razorback suckers apparently spawn continuously throughout the spawning season, with females releasing only a portion of their gametes at each event. Spawning occurs both day and night on Lake Mohave (USBR, file data). There is considerable fidelity based on recapture data, and fish often show up on the same spawning site year after year (Minckley et al., 1991). Recent sonic tracking data on Lake Mohave showed some fish visiting three or four spawning sites in a single season (Gordon Mueller, pers. comm.).

The following observations on Lake Mead by Jonez and Sumner (1954) clearly describe the spawning act:

> "The period of spawning activity of suckers in Lake Mead was between the 1st of March and 15th of April.... The areas of spawning activity seemed widespread about gravel shores.... A number of male suckers were seen to converge upon a ripe female. They completely surrounded her, then closed in upon her sides. At the proper time a convulsive movement spontaneously erupted throughout the formation. This movement resembled the effects of a mild electric shock, and was a series of rapid successive sidewards undulations. The duration of these convulsions usually was approximately 2 minutes. During this time the spawning act, extrusion of eggs and milt, was consummated. The unit then normally moved away in a less confining formation. No attempt was made to guard the nest site. In a number of instances the same female was observed to consummate this action several times during an hour or so. This was accomplished with the same and/or other male suckers in attendance."

Eggs hatch in 5 to 10 days depending on water temperature. Optimal hatching success is around 68°F; hatching does not occur at extremes of cold or hot (50° or 86°F) (Marsh and Minckley, 1985). Larvae swim up within several days and begin feeding on plankton. As the terminal mouth migrates to a sub-terminal position, larvae begin to feed on benthos as well. Growth is variable. Within a single cohort some individuals may attain 14 inches in length in their first year while others may not reach 7 inches. Males generally reach maturity in their second year, and females mature at 3 years of age. However, sexual maturity has been noted for males at 10 months of age for fish raised in backwaters of Lake Mohave by the NFWG (USBR, file data).

Larval stages of razorback suckers are positively phototactic and readily come to bright lights suspended over spawning sites at night. Fish up to ¾ of an inch have been captured by this technique. Older juveniles (generally over 1 inch) switch from being positively phototactic to being negatively phototactic, or nocturnal. Juvenile razorback suckers in lakeside rearing ponds hide during the day in dense aquatic vegetation and under brush and debris and in rock cavities (USBR, file data). It is not known at exactly what age/stage/size the nocturnal behavior ends. Adults are found throughout the river/reservoir system during non-spawning periods and are observed during daytime hours all year long. Intuitively then, the nocturnal behavior must end by the fish's first spawn because spawning behavior occurs both day and night during the spawning period.

These observations on nocturnal behavior, as well as the documented rapid growth in predator-free rearing ponds, suggest that razorback sucker used two strategies to avoid predation by historical predators such as the Colorado squawfish. They hid during the day, and they grew quickly.

<u>Distribution and Abundance</u>

The razorback sucker was formerly the most widespread and abundant of the big-river fishes in the Colorado River. It ranged from Wyoming to northwestern Mexico and occurred in most of the major tributaries (Minckley et al., 1991). Early explorers report the fish as extremely abundant (Gilbert and Scofield, 1898). In central Arizona it was abundant enough to be commercially harvested for human and animal food and for fertilizer in the late 1800s. Similar abundances have been noted for the upper basin (Bestgen, 1990). Today the species occupies only a small portion of its historical range, and most occupied areas have very low numbers of fish. The razorback sucker was listed as an endangered species in October 1991 (FR Vol.56 No. 205, 1991).

Distribution along the lower Colorado River is briefly summarized as follows. In Lake Mead the fish were abundant for many years after the reservoir filled but greatly declined during the 1960s and 1970s. The current population in Lake Mead is estimated to be less than 300 fish. Of interest is a small number of juvenile adults have been captured since 1997, indicating some successful recruitment is taking place. Larval razorback sucker were captured at the upper end of Lake Mead in the Spring of 2000 (Holden, pers. Comm). An occasional fish is captured in the upper reaches of the Overton Arm near the Moapa and Virgin River inflows (Sjoberg, 1995). There are two populations of razorback sucker in Lake Mead, one in Las Vegas Bay and the other at Echo Bay. Currently a study is underway to determine population size and movements of these fish. As part of this study, an attempt is being made to determine why there is a small number of fish able to recruit to the population thus enabling some small number of razorback sucker to persist in Lake Mead.

Lake Mohave has the largest single population, currently estimated to contain less than 12,000 razorbacks. Of those, 75 percent are wild adults and 25 percent are repatriated juveniles (Pacey and Marsh, 1999). This population was estimated to be 60,000 fish as recently as 1987 (Marsh, 1994). The rapid decline for the Lake Mohave population was predicted by McCarthy and Minckley (1987). They aged a large sample of adult fish taken from Lake Mohave. Of the fish they aged, the youngest was 24 years with the oldest 44. Eighty-eight percent of the fish they aged hatched prior to or around the time Lake Mohave was constructed and filled. They reported that in other reservoirs in the Colorado River basin, razorback suckers had drastically declined around 40 years after closure of the dam and filling of the reservoir. They predicted that a similar event would occur on Lake Mohave by the turn of the century. In an effort to replace this aging population before it underwent complete collapse, an interagency team of biologists began rearing fish in protected lakeside ponds in 1992. Between 1992 and the present, this group, NFWG, has reared and released over 38,000 juvenile razorback suckers in Lake Mohave .

For the entire reach of the Colorado River downstream of Lake Mohave, including associated backwaters and side channel habitats (except Senator Wash Reservoir), confirmed records exist for capture of only 42 adult razorback suckers between 1962 and 1988 (Marsh and Minckley, 1989). Numerous reintroductions of larvae, juvenile and adult razorback suckers have taken place during this same period. Observations on adults and reintroductions are discussed below for each reach of the lower Colorado River.

Immediately below Davis Dam, a few adult fish are seen (and sometimes captured) almost every year, but no estimate of the population size can be made (Burrell, pers. comm.). Between Davis Dam and Lake Havasu observations of razorback suckers are extremely rare. CFG conducted a fishery survey of 15 backwaters between Davis Dam and Lake Havasu in 1976 and captured 3 adult razorback suckers (Marshall, 1976). These areas were surveyed by CFG and Reclamation personnel in 1983, and no razorback suckers were captured or observed. CFG stocked approximately 400,000 larval razorback suckers into this reach of the river during 1985 (Ulmer, 1987). In 1999 12 razorback suckers were captured between Davis Dam and Lake Havasu. These 12, plus 8 more were radio tagged and released as part of an ongoing study.

In Lake Havasu, observations on adults are again, extremely rare, with only 16 adults captured or observed since 1962. Open water sampling for fish eggs and larvae as part of a striped bass study by CFG resulted in the capture of 37 larval razorback suckers in 1985-86 (Marsh and Papoulias, 1989). Flow data for Lake Havasu suggest that the larvae hatched out either within the upper end of Lake Havasu or in the Colorado River inflow area to the lake. Two larval and three adult razorback suckers were entrained into and captured within the CAP canal between 1987 and 1989 (Mueller, 1989a). An interagency native fish rearing and stocking program has been initiated on Lake Havasu as part of an ongoing Lake Havasu Fishery Improvement Project. Patterned after the NFWG's program on Lake Mohave, the project has reared and/or stocked over 18,000 razorback suckers into Lake Havasu since 1992. Enough fingerling razorback suckers are being reared at present to meet the goal of reintroducing 25,000 juveniles.

Below Lake Havasu, adult razorback suckers are again, very rare. Dill (1944) reported the largest single capture of adults within the lower river since closure of Hoover Dam, when he captured 13 fish below Headgate Rock Dam in 1942. Larval razorback suckers have been stocked by CFG in 1986 into backwater areas connected to the main channel below Headgate

Rock Dam. Two larval razorback suckers were captured during a fish passage study at Headgate Rock Dam in 1988 (USBR, file data). Thirty eight juvenile razorback suckers were captured in 1987 in the CRIT canal system, which diverts Colorado River water at Headgate Rock Dam. These fish were most likely a result of fish stocked in 1986. Three adult fish were captured in 1988 in the same canal and aged by ASU as 3, 4, and 7 years old. They did not coincide with any stocking and were concluded to have been naturally produced within the system (Marsh and Minckley, 1989). Four adults were captured in 1993 (Marsh, pers. comm.).

Over 250,000 juvenile razorback suckers were stocked into the river and into backwater areas between Headgate Rock Dam and Imperial Dam by CFG in 1987-88 (Langhorst, 1988; Langhorst, 1989), and nearly 500,000 larval razorback suckers were stocked into the river and backwaters (Ulmer, 1987). Razorback suckers are being reared in the old river channel impoundment known as "High Levee Pond" on Cibola National Wildlife Refuge downstream of Blythe, California. Over 100 fish have been reared to ten or more inches in length and released into the river during 1996 (C.O. Minckley, pers. comm.).

Since 1999, five thousand juvenile razorback suckers have been released to the Colorado River below Parker Dam. There are an additional 12,000 razorback suckers being reared for release in later years. These are a portion of a 50,000 razorback sucker reintroduction requirement Reclamation is implementing as a result of the Biological Opinion on the routine operations and maintenance on the lower Colorado River.

Razorback suckers were reported at Senator Wash Reservoir, a pump-back storage facility, during the 1970s. Exactly when these fish accessed the reservoir, and at what size, is not known. The reservoir was filled in 1966, but the earliest record of a razorback sucker in Senator Wash Reservoir was seven adults captured in a gill net in 1973. The population in the reservoir was estimated to be about 55 adults. No fish from this population were aged. Fish did annually spawn and produced larvae, but there was never any indication of recruitment into the adult population (Ulmer and Anderson, 1985). Attempts to locate these fish in 1988 and 1989 were unsuccessful, and it is believed this small population had died off (Paul Marsh, pers. comm.) Adult razorback suckers from Niland State Fish Hatchery ponds were transferred to Senator Wash Reservoir in 1990 after the hatchery was closed. CFG netted these fish during monitoring activities in the of spring 1996, capturing 100 of these fish, all of which were in excellent condition (CFG, file data.). Razorback suckers are occasionally captured or observed in the All-American and Coachella Canals, laterals and sumps during outages for maintenance.

The pattern of decline for the razorback sucker in lower basin reservoirs has been as follows. Upon initial impoundment, razorback suckers expand their population into the newly flooded reservoir basin. Over the next 30 or so years fish are observed spawning along gravel shorelines in late winter and early spring. Fishery managers believe there is recruitment to adulthood because of the abundance of fish, despite the lack of observations of juvenile fish. However, recruitment to the adult life stage does not occur due to predation from nonnative fishes, and the population gets older and eventually collapses as fish die of old age and natural causes.

This scenario was played out in Lake Roosevelt and Saguaro Lake on the Salt River and in Lakes Mead and Havasu on the Colorado River. In all cases, 40 to 50 years after dam completion, the reservoir populations completed a boom-and-bust cycle and were left with small remnant populations. This scenario is being played out today at Lake Mohave.

No single introduced species is responsible for the lack of recruitment. On Lake Mohave for example, razorback suckers spawn from January through April, which is the earliest of all the fish species in the reservoir. Adult razorback suckers are passive and provide no protection of the fertilized eggs. Upon release of gametes, the adults swim away and carp can be observed moving to the site of the released eggs. Carp have been captured and sacrificed at the site, showing their stomachs to contain gravel and fish eggs (file data, USBR). Those eggs that survive and incubate to hatching yield prolarvae that only have pectoral fins and are relatively poor swimmers. The preceding year's crop of young sunfish, only a few centimeters long themselves, can be observed feeding on the emerging larvae.

After observing spawning razorback suckers on Lake Mohave in 1954, Jonez and Sumner (1954) make the following report:

> "Very small fish (about ¾ of an inch long, threadlike, and translucent) which appeared to have been humpback suckers, were observed in the areas where the above described spawning took place. It is doubtful whether very many of those tiny humpback suckers survived because they were mingling with predaceous small bass and sunfish."

Juvenile suckers that survive past the larval stage take on a nocturnal behavior pattern, hiding during the day in weeds, brush, and rock crevices and caverns. Unlike historical times, they now must share these hiding places with nonnative, nocturnal predators, such as channel catfish. During dawn and dusk, when young fish emerge from their hideouts, they are preyed upon by ambush predators such as largemouth bass. Occasionally, some fish do survive and individuals are still caught in some of these impoundments. Regardless of what percentage of fish do make it to adult life-stage, the numbers have not been sufficient to sustain the populations.

Today, razorback suckers are only infrequently encountered in the Colorado River below Lake Mohave, and nothing is really known of the current population status although it is thought to be extremely low, consisting of releases to the river either for research purposes in the Imperial Division or as a result of recent releases below Parker Dam mentioned earlier.

As stated in Minckley et al. (1991):

> "The only substantial numbers of juveniles resulting from natural spawning in the 1980s were caught from irrigation canals and ponds downriver from Parker Dam."

Why and how this occurs is not known for sure; however, one hypothesis is that the off-season shut down, and periodic drawdowns for maintenance actions on the irrigation systems, provides windows of opportunity wherein the nonnative fishes are reduced or eliminated long enough for a few native fish to grow large enough to avoid most predators. As a side note, this may be the mechanism which is allowing for limited recruitment in Lake Mead. Aging studies are being conducted on the razorbacks currently encountered, and these ages will be compared to times when Lake Mead has had considerable drawdown.

Numerous attempts to stock razorback suckers in the lower river have met with limited success. Langhorst (1988, 1989) reports on several stockings in the lower Colorado River, all of which have met with almost no success. Several million larvae have been introduced with no noted survival. Larger fish raised in some backwaters appeared to do better, but predation rates remain high. Similarly, of the tens of thousands of young razorback suckers stocked into the Gila River the overwhelming majority were lost due to predation by catfish (Marsh and Brooks, 1989).

Minckley et al. (1991) concluded that lack of recruitment to adulthood was the primary limiting factor for razorback suckers today, and that predation by nonnative fishes was the single most likely factor precluding recruitment of razorback suckers in nature. The authors stated:

> "The strongest evidence that predation is the major factor in loss of larval razorback suckers is simply that larvae persist and grow, to maturity if given adequate time in habitats from which predators are excluded."