TABLE 2.3-7
Crops Produced (Greater Than 200 Acres) in IID Service Area During 1999

Crop Description	Acres	Percentage
Alfalfa (all)	192,633	35.56
Sudan grass (all)	62,881	11.61
Bermuda grass (all)	55,179	10.19
Wheat	42,464	7.84
Sugar beets	33,997	6.28
Lettuce (all)	22,558	4.16
Carrots	16,995	3.14
Melons, spring (all)	14,293	2.64
Broccoli	12,305	2.27
Onions	11,526	2.13
Duck ponds (feed)	9,105	1.68
Cotton	7,131	1.32
Ear corn	6,790	1.25
Citrus (all)	6,169	1.14
Asparagus	6,166	1.14
Cauliflower	3,960	0.73
Onions (seed)	3,541	0.65
Potatoes	3,159	0.58
Klien grass	3,113	0.57
Rape	3,034	0.56
Rye grass	3,034	0.56
Vegetables, mixed	2,162	0.40
Watermelons	2,158	0.40
Tomatoes, spring	2,024	0.37
Melons, fall (all)	2,019	0.37
Rapini	1,323	0.24
Fish farms	1,293	0.24
Cabbage	1,284	0.24
Spinach	1,229	0.23
Garbanzo beans	1,057	0.20
Barley	868	0.16
Field corn	844	0.16
Pasture, permanent	701	0.13
Peppers, bell	429	0.08
Garlic	308	0.06
Flowers	279	0.05
Oats	212	0.04

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that occur in the Salton Sea include brine shrimp, brinefly larva, and some surface-dwelling insects. The remaining invertebrate species or life stages are primarily benthic. Organisms that need to attach permanently to a hard surface are limited to the few rocky areas, docks, debris, or inundated brush along the shore.

Fish species inhabiting the Salton Sea are adapted to living in high-salinity waters. Most of the fish are nonnative species (Walker 1961; Dritschilo and Pluym 1984; and Setmire et al. 1993) that have been introduced from the Gulf of California by CDFG. Fish found in the Salton Sea include the sport fish sargo (*Anisotremus davidsoni*), orangemouth corvina (*Cynoscion xanthulus*), Gulf croaker (*Bairdiella icistia*), and other fish species listed in Table 2.3-8.

TABLE 2.3-8
Fish Species Present in the Salton Sea

Sargo (*Anisotremus davidsoni*)	Mosquitofish (*Gambusia affinis*)
Gulf croaker (*Bairdiella icistia*)	Longjaw mudsucker (*Gillichthys mirabilis*)
Orangemouth corvina (*Cynoscion xanthulus*)	Sailfin molly (*Poecilia latapinna*)
Desert pupfish (*Cyprinodon macularis*)	Mozambique tilapia (*Oreochromis mossambicus*)
Common carp (*Cyprinus carpio*)	Zill's tilapia (*Tilapia zilli*)
Threadfin shad (*Dorosoma petenense*)	

Source: Black 1988

Gulf croaker, sargo, and corvina are marine species, while the remaining species are estuarine or freshwater fish with extreme salinity tolerances. Tilapia are the most abundant fish in the Salton Sea. Tilapia were introduced into drainage ditches to control aquatic weeds in the late 1960s and early 1970s. They were also produced on fish farms close to the Salton Sea. The Salton Sea was colonized by tilapia that escaped from the fish farm and from those stocked in the drainage system. Anglers first reported catching tilapia in the Salton Sea in 1967 (Costa-Pierce and Riedel 2000a). The highest densities were reported from areas around the New and Alamo rivers and nearshore areas extending about 1,970 feet (600 m) from the shoreline (Costa-Pierce and Riedel 2000a; Costa-Pierce, pers. comm.). Tilapia productivity of the nearshore area has been estimated at 3,600 kg/ha/yr, far exceeding productivity of tilapia in tropical lakes (Costa-Pierce and Riedel 2000a). The abundant fish population attracts and supports large numbers of piscivorous birds, particularly during winter.

The Salton Sea represents one of the centers for avian biodiversity in the American Southwest, with occurrence records for more than 400 species and an annual average abundance of waterbirds of 1.5 to 2 million (Reclamation and SSA 2000; Hart et al. 1998; and Shuford et al. 1999). Numbers of birds can exceed this average by several million during certain years; (e.g., the maximum number of wintering eared grebes alone has exceeded 3.5 million individuals [Jehl 1988], representing the majority of the population of eared grebes in western North America). Populations of some species that use the Salton Sea are similarly of regional, continental, or worldwide importance, representing significant

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portions of the total populations for those species. The Salton Sea is an integral part of the Pacific Flyway, providing an important migratory stopover for fall and spring shorebirds, and supporting large populations of wintering waterfowl. In surveys from 1978 to 1987, midwinter waterfowl numbers averaged more than 75,000 (Heitmeyer et al. 1989); species typically present in large numbers include snow and Ross's geese, ruddy ducks, pintail, white-faced ibis (*Plegadis chihi*), and others. The Salton Sea represents one of only four remaining interior sites along the Pacific Flyway that supports more than 100,000 shorebirds during migration (Page et al. 1992), with as many as 44 species represented (McCaskie 1970; and Shuford et al. 1999). The Salton Sea also supports large breeding populations of waterbirds.

The overall high productivity of the Salton Sea can be attributed to a number of factors, including relatively mild-warm year-round temperatures, ample nutrient input through agricultural runoff and wastewater discharges to the tributary rivers, and a generally high morpho-edaphic index in the Salton Sea. A high morpho-edaphic index reflects the high surface-to-volume ratio of the Salton Sea (i.e., it has a large area, but is relatively shallow), which results in a number of conditions that can generate higher productivity (e.g., with more of the water column within the zone of light penetration, there is greater production of phytoplankton and other photosynthetic organisms relative to the overall quantity of water). The higher productivity transfers steadily up the food chain, resulting in higher densities of prey species for birds.

Aquatic invertebrates are important as food resources for species of birds in the Salton Sea include brine shrimp (*Artemia salina*), brine fly larvae (*Ephydra sp.*), adult pileworm (*Neanthes succinea*), and the nauplia and cypris of the barnacle (*Balanus amphitrite saltonensis;* Reclamation and SSA 2000). These species are forage for a wide variety of species including diving ducks, grebes, phalaropes (*Phalaropus* spp.), and a number of piscivorous fish that supplement their diet with invertebrates. Dabbling ducks also may forage on aquatic invertebrates in shallow areas, and many shorebirds will forage for invertebrates in shallow flooded areas and mudflats. Other bird species forage on fish including cormorants, diving ducks, pelicans, black skimmer, terns, egrets, and herons. Species of fish in Salton Sea used as prey include tilapia, bairdiella, sargo, mosquito fish, and larval orange-mouthed corvina (Reclamation and SSA 2000).

Since the early 1990s, there has been an unprecedented series of fish and bird die-offs at the Salton Sea (USFWS 2000; and Kuperman and Matey 1999). Fish kills often are massive, averaging between 10,000 and 100,000 fish, but sometimes several million fish. Fish die-offs produce substantial amounts of carrion for piscivorous birds, but can have adverse effects on bird populations by contributing to disease outbreaks. Causes of the fish die-offs are not always clear, but a number of potential pathogens have been identified; low oxygen levels also could be responsible for some fish kills. Pathogens implicated in fish kills include infestations with a lethal parasitic dinoflagellate (*Amyloodinium ocellatum*) and acute bacterial infections from bacteria of the genus *Vibrio* (USFWS 2000).

Large fish kills have been associated with avian botulism die-offs. It is likely that septicemia in fish produces the conditions in the intestinal tract of sick fish that allow botulism spores to germinate and produce the toxin. Birds foraging on sick fish may ingest fatal doses of the botulism toxin (USFWS 2000). A large botulism die-off in birds occurred in 1996, when 8,538 white pelicans and 1,129 brown pelicans died along with large numbers of great egret, snowy egret, eared grebe, black-crowned night heron, and numerous other birds (Jehl 1996). The total bird mortality in this event was more than 14,000 birds (USFWS 1996b).

Since 1987, significant avian die-offs have been recorded on an almost annual basis. While avian disease has been present at the Salton Sea for many years, the recent increase of disease occurrence, the magnitude of losses, and the variety of diseases has increased concern for birds using the Salton Sea (Reclamation and SSA 2000). Significant events have included a die-off of 4,515 cattle egrets in 1989 from salmonellosis; a die-off of an estimated 150,000 eared grebes in 1992 from unknown causes; a loss of more than 14,000 birds, including nearly 10,000 pelicans, in 1996 from avian botulism; a die-off of 6,845 birds in 1997; and a loss of 18,140 birds in 1998 from various agents, including avian cholera, botulism, Newcastle disease, and salmonella (USFWS 1996b).

Habitat Features

Most of the bird activity at the Salton Sea is concentrated at three primary locations. These locations include along the north and south shores (particularly at the New and Alamo river deltas), and near the mouth of Salt Creek on the eastern shore (Reclamation and SSA 2000). In these areas, concentrations of breeding colonies for colonial breeding birds occur. Suitable habitat conditions for colonial birds include an easily accessible and abundant food source and nest and roost sites that are generally protected from predators, such as trees or islands.

Some natural islands are available for nesting at the Salton Sea; however, a number of sites consists of old levees now inundated in sections and separated from the mainland, or other man-made islands. With the exception of Mullet Island at the south end of the Salton Sea, most sites are less than 10,750 square feet in area. Fluctuations in the level of the Salton Sea can increase or decrease the available habitat for island nesting birds.

Nesting islands in the Salton Sea are described in Molina (1996). Mullet Island is located 1.6 miles from the Alamo River mouth and has relatively high relief and ample nesting areas. It has historically supported nesting black skimmers, double-crested cormorants, gull-billed terns, and Caspian terns; since 1992 gulls have also nested there. The site is subjected to some human disturbance, with the Red Hill Marina only 1.9 miles from the island. Other nesting sites in the south portion of the sea include Morton Bay, which consists of an eroded impoundment east of the mouth of the Alamo River. It has two low-lying nesting islets, protected from wave inundation by a nearly continuous perimeter levee. Near Rock Hill, a series of small flat earthen islets within a freshwater impoundment have been suitable for nesting since 1995; this site is located within Sonny Bono-Salton Sea NWR and is under active management, including water-level control and protection from disturbance. Adjacent to Obsidian Butte, a nesting site is located on a small, low islet, consisting of a rocky perimeter and an interior beach composed of crushed barnacle. At Ramer Lake, located along the Alamo River 3.1 miles southeast of the Salton Sea, small, man-made, compacted earth islets provide nesting habitat. However, heavy recreational use in this area results in a high potential for colony disturbance. A small nesting site is present at Elmore Ranch on the southwest shore of the Salton Sea; it lies on a single, earthen levee remnant and is susceptible to wave action, erosion, and inundation. On the north end of the Salton Sea, one site is present at Johnson Street near the mouth of the Whitewater River. This site consists of remnants of earthen levees isolated from the Salton Sea by rising water levels.

2.3.2.5 Desert Habitat

The HCP area supports little native desert habitat. The primary occurrence of native desert habitat in the HCP area is along the AAC within IID's right-of-way (Figure 2.3-8). The 82-mile AAC traverses desert habitat for 60 miles; the remaining 22 miles of the canal lie within agricultural areas of the Imperial Valley. Desert habitat also occurs adjacent to rights-of-ways of the East Highline, Thistle, Trifolium, and Westside Main canals, but not within the rights-of-way. Within Imperial Valley, desert plant species have colonized small areas that have not been under agricultural production for many years. These areas occur as inclusions within the predominantly agricultural landscape. Two principal desert habitats are supported in the HCP area: creosote bush scrub and dunes. The characteristics and distribution of each of these habitats are described below.

Creosote Bush Scrub

Creosote bush scrub is characterized by widely spaced shrubs, approximately 1.6 to 9.8 feet tall, usually with largely bare ground between. It is the basic creosote scrub community of the Colorado Desert, typically occurring on well-drained secondary soils of slopes, fans, and valleys. Characteristic species include creosote bush (*Larrea divaricata*), burro weed (*Ambrosia dumosa*), brittle brush (*Encelia farinosa*), and ocotilla (*Fouquieria splendens*). Succulents are common, and ephemeral annual herbs are present and generally bloom during late February and March. Mesquite thickets, an important wildlife habitat component, are present in creosote bush scrub habitat.

Creosote bush scrub is the predominant desert habitat in the HCP area and occurs along much of the AAC. It is also present adjacent to the HCP area along the East Highline and Westside Main Canals. Plant species comprising this habitat may occur in the Imperial Valley in areas that have been fallowed.

Desert Dunes

AAC traverses the Algodones Dunes. The dunes consist of both active desert dunes and stabilized or partially stabilized dunes. Active desert dune communities are characterized as essentially barren expanses of actively moving wind-deposited sand with little or no stabilizing vegetation. Dune size and shape are determined by abiotic site factors, including wind patterns, site topography, and source of sand deposits. Characteristic plant species may include bee plant (*Cleome sparsifolia*), *Dicoria canescens*, evening primrose (*Oenothera avita*), and *Tiquilia plicata*.

Some desert dunes have been stabilized or partially stabilized by shrubs, scattered low annuals, and perennial grasses in areas with less wind or higher water availability. These dunes typically occupy sites that are lower and more sheltered than active dunes, with soil moisture retained just below the sand surface, allowing perennial vegetation to survive long drought periods. Mesquite (*Prosopis glandulosa, P. pubescens*) scrub is often associated with this community. Other characteristic plant species include sand verbena (*Abronia villosa*), burro weed, ankle grass (*Astragalus* spp.), salt cedar (*Tamarix* spp.), saltbrush (*Atriplex canescens*), croton (*Croton californicus* var. *mojavensis*), dalea grass, wild buckwheat (*Eriogonum deserticola*), desert sunflower (*Geraea canescens*), and others. Plant cover increases as dunes are progressively stabilized. This community intergrades with sandier phases of creosote bush scrub.

2.3.2.6 Aquatic Habitat

Aquatic habitat occurs in the HCP area within IID's conveyance and drainage infrastructure as well as in the New and Alamo Rivers. Aquatic habitat conditions associated with these features are described in the following section. The Salton Sea also provides aquatic habitat, but was discussed previously (Section 2.3.2.4).

The IID diverts water from the Colorado River into the AAC at Imperial Dam. The AAC conveys water to three main canals in Imperial Valley: the East Highline Canal, Westside Main Canal, and Central Main Canal (Figure 2.3-5). Customers take water from the main canals or lateral canals that branch off of the main canals. To service customers in Imperial Valley, IID maintains 1,667 miles of canals (cited from IID Memorandum, dated October 4, 2000). Most of the canals (1,114 miles) are concrete lined. About 16 miles of the conveyance are pipelines, while the remaining 537 miles are earthen canals (cited from IID Memorandum, dated October 4, 2000). IID also operates the 82-mile AAC, which conveys water from Imperial Dam on the Colorado River to IID's conveyance system in the valley. The AAC is currently unlined, but 24 miles are planned to be concrete lined in the future (Reclamation and IID 1994).

Water levels in the AAC are maintained as high as possible to maximize power generation from the hydropower facilities. Although other canals do not contain hydroelectric power generation facilities, water levels also are tightly controlled. Lowest flows in the canal system occur in January and February when irrigation demand is lowest. Water velocity in the AAC ranges from about 0.5 to 1 foot per second (ft/s) during these months. The highest flows occur during March through August, which is the main irrigation season. During this period, water velocities in the AAC increase to about 2.5 to 3.5 ft/s (USACOE 1996).

Within the AAC and main canals in the Imperial Valley, aquatic habitat in the center of the canals is characterized by high water velocities and a lack of aquatic vegetation and aquatic invertebrates. This portion of the main canals provides poor conditions for fish and other aquatic organisms. Along the canal edges, lower water velocities and deposition of sediment allow limited development of submerged and emergent vegetation. The lower water velocities and cover provided by aquatic vegetation, in combination with vegetation on the canal banks (primarily the common reed), provide better habitat conditions for aquatic invertebrates and fish. Submerged vegetation consists primarily of Eurasian water-milfoil with some sago pondweed (*Potamogetou pectinatus;* Reclamation and IID 1994). The noxious aquatic weed hydrilla (*Hydrilla verticillata*) is common in the canal system within the Imperial Valley, but is rare in the AAC (Reclamation and IID 1994). The canals are routinely cleaned of vegetation, thus limiting aquatic habitat quality.

As a result of high water velocities, concrete substrates in many canals, and the lack of submerged and aquatic vegetation, the canals (with the exception of the AAC) support few invertebrates. In the AAC, mollusks, particularly the exotic Asiatic clam and aquatic snail, are common along the shoreline where sediment deposits and submerged and emergent vegetation develops (USACOE 1996). Crayfish are present in small numbers (USACOE 1996).

Drainage Network

A system of subsurface tile drains, surface drainage ditches, and river channels collect and convey agricultural drainwater in the IID service area. Currently, IID operates and

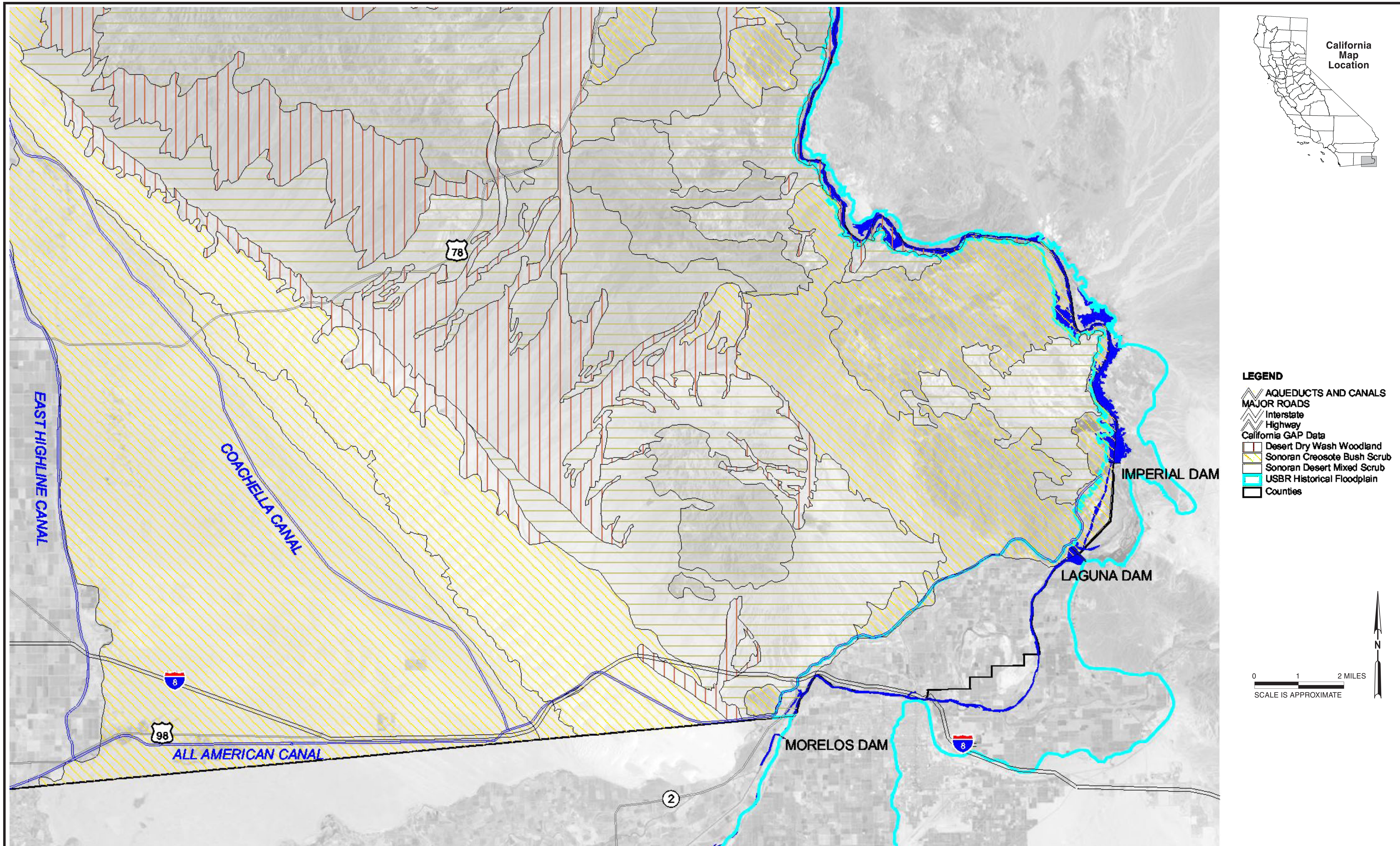

Figure 2.3-8
Desert Habitats Inland Adjacent to the HCP Area
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maintains 1,456 miles of drains (cited from IID Memorandum, dated October 4, 2000). These drains are primarily unlined earthen channels.

Aquatic habitat in the drains is of poor quality as a result of silty substrates, poor water quality, and shallow depth. Portions of the drains support rooted vegetation, such as cattails, common reed, or filamentous and mat-forming algae. These areas are more frequently found where canal (operational) discharge provides better water quality. However, vegetation is regularly cleared from the drains.

The availability of aquatic habitat in drains depends on drainwater from agricultural fields. This water comes from both surface and subsurface (tile) sources. As a result, the amount of water in the drains varies throughout the year in response to the level of irrigation. When the agricultural fields discharging into a drain are not being irrigated (i.e., little surface runoff), the drainwater flows are dominated by the highly saline subsurface (tile) water. In the upper portions of the drain watersheds, a lack of irrigation activity can result in drains experiencing a dry out condition and might not support aquatic habitat.

The drainage network supports abundant aquatic invertebrates, especially waterboatmen (*Corixa* sp.; Radke 1994). Analysis of benthic invertebrate communities in several of the irrigation drains indicates that the communities are composed of relatively few species and are dominated by one or two taxa. Of the 10 drains sampled, the mollusk family Thiaridae was the most abundant taxa in 8 of the drains, comprising between 50 and 95 percent of the sample (Setmire et al. 1996). Another taxon observed frequently, but with lesser abundance than Thiaridae, was the mollusk family Physidae. The pollution-sensitive mayflies, stoneflies, and caddisflies (Ephemeroptera, Plecoptera, and Trichoptera) were poorly represented. A single caddisfly larvae of the family Philopotamidae was the only pollution-sensitive taxon documented in the benthic samples (Setmire et al. 1996).

Invertebrate densities were found to be much lower in the water column than in the benthic samples (Setmire et al. 1996). The number of taxa ranged from a low of 4 to a high of 10. Chironomid larvae were the most abundant invertebrates found in 6 of the 10 drainwater column samples (Setmire et al. 1996). Other frequently observed taxa included mosquito larvae (*Culicidae*) and oligochaete worms. Larval chironomids are a food source for other invertebrates and fish, and adults are eaten by many kinds of birds.

New and Alamo Rivers

The New River was enlarged in the early 1900s when the Colorado River overflowed its banks and formed a new channel to the Salton Sea. When it crosses into the U.S., the New River is primarily composed of agricultural drainage water and wastewater from the Mexicali Valley in Mexico. In the Imperial Valley, agricultural drains discharge into the river. The Alamo River also enters the U.S. from Mexico and receives agricultural drainage water in the Imperial Valley. Aquatic habitat quality in the New and Alamo Rivers is poor because of poor water quality, as well as high turbidity and unstable substrates that inhibit production of benthic invertebrates and rooted vegetation.

2.3.3 Water Quality and Biological Resources

Water quality is a concern for biological resources in Imperial Valley and the Salton Sea. In the Imperial Valley, wildlife can be exposed to poor water quality conditions in the drains that carry agricultural drainage water. Much of the drain water empties into the Salton Sea where wildlife species also can be exposed to poor water quality conditions. The quality of water in drains and the Salton Sea can affect wildlife in a number of ways. Some contaminants (e.g., selenium) can bioaccumulate and have direct or indirect toxic effects. The concentrations of other constituents (e.g., salts) can affect survival or reproductive success of aquatic species inhabiting the Salton Sea. Finally, water quality can influence plant species composition of habitats supported along the Salton Sea or in agricultural drains, and thereby alter habitat suitability for species using these habitats. The constituents of greatest concern in the Imperial Valley and Salton Sea and potentially affected by the water conservation and transfer programs are salinity and selenium. These constituents are the focus of the following discussion. The IID Water Conservation and Transfer Project EIR/EIS provides information on other water quality constituents.

2.3.3.1 Salinity

The salinity of the Salton Sea has been increasing because of high evaporative water loss and continued input of salts from irrigation drainage water. The sea is currently hypersaline with a salinity greater than the ocean. The present salinity levels in the Salton Sea are 44 grams per liter (g/L; equivalent to parts per thousand). Tilapia are the most abundant fish in the Salton Sea and are the primary prey of piscivorous birds. Therefore, the salinity tolerance of tilapia is key to predicting the effects of the water conservation and transfer programs on covered species of piscivorous birds. The salinity tolerances of other fish species inhabiting the Salton Sea is provided in the IID Water Conservation and Transfer Project EIR/EIS.

Tilapia have been collected at a salinity level of 120 parts per thousand (ppt),[5] but reproduction has not been reported at this salinity level (Whitfield and Blaber 1979). Costa-Pierce and Riedel (2000a) provide a review of reported salinity tolerances of tilapia. Highest growth rates were reported at 14 parts per thousand (ppt), but growth was still good and tilapia reproduced at 30 ppt. At 69 ppt, tilapia grew poorly, but reproduced well. In the Salton Sea at about 44 ppt, tilapia also grew poorly, but reproduced well. Based on these studies, Costa-Pierce and Riedel (2000a) suggested that tilapia in the Salton Sea could successfully acclimate to and continue to reproduce at a salinity level of 60 ppt. In areas with higher salinity, growth, survival, and reproduction would be expected to decline (Costa-Pierce, pers. comm. January 12, 2001).

2.3.3.2 Selenium

Soil derived from parent rocks containing high amounts of selenium is found throughout much of the West (Seiler et al. 1999). Selenium enters soils, groundwater, and surface waters through irrigation of selenium-bearing soils, through selenium-bearing sediments brought in through local drainages, or through water imported for irrigation. Selenium enters the Imperial Valley through Colorado River water brought in for irrigation; its ultimate source is upstream from Parker Dam (Engberg 1992). Selenium is concentrated in irrigated soils through evapotranspiration and flushed into water sources through irrigation practices (Ohlendorf and Skorupa 1989; and Seiler et al. 1999). The primary source of selenium in

[5] Many of the studies regarding salinity tolerance of various species report the results in parts-per-thousand (ppt). Modeling conducted for this HCP utilized concentrations in mg/L (converted to g/L) which differs slightly from ppt as salinity increases due to the difference in the specific gravity of saltwater versus freshwater. Model results are reported in ppt for simplicity and to allow direct comparison with reported tolerances.

surface drains is from subsurface drainage discharges from sumps and tile drains (Setmire et al. 1996); subsequently it is discharged into rivers and the Salton Sea.

Selenium is essential in trace amounts for both plants and animals but toxic at higher concentrations (Rosenfeld and Beath 1946). At excessive levels, selenium can cause adverse effects in mammalian reproduction, but it is especially toxic to egg-laying organisms including birds and fish. Reproductive impairment is generally a more sensitive response variable than adult mortality. Selenium bioaccumulates readily in invertebrates (typically 1,000 times the waterborne concentration) and fish; hence, fish and birds that feed on aquatic organisms are most at risk for showing adverse effects (Ohlendorf 1989; and Eisler 2000).

Selenium concentrations were measured from Imperial Valley and Salton Sea in a number of different studies. These include broad-based studies of selenium in water, sediment, and biotic samples (Setmire et al. 1990; Setmire et al. 1993; and Rasmussen 1997) and more focused surveys looking at concentrations in tissues of specific fish or bird species (Ohlendorf and Marois 1990; Bruehler and de Peyster 1999; and Audet et al. 1997). These studies are reviewed below.

Early sampling (Rasmussen 1988) identified levels of selenium higher in Salton Sea fish than those occurring in the New and Alamo Rivers, reflecting the primary source of bioaccumulation of selenium from benthic food sources of the Salton Sea. More recent data show a similar pattern (Table 2.3-9).

TABLE 2.3-9
Selenium Concentrations in Freshwater and Marine Fish from Imperial Valley Rivers and the Salton Sea

Station No.	Station Name	Species	Tissue	Sample Date	Selenium (mg/kg WW)
719.47.00	Coachella Valley Stormwater Channel	Tilapia *Tilapia sp.*	Fillet	11/17/97	1.020
723.10.01	Alamo River / Calipatria	Channel Catfish *Ictalurus punctatus*	Fillet	11/20/97	1.060
723.10.02	New River / Westmorland	Channel Catfish *Ictalurus punctatus*	Fillet	11/20/97	0.360
723.10.02	New River / Westmorland	Channel Catfish *Ictalurus punctatus*	Liver	11/20/97	3.230
723.10.58	New River / Interboundary	Carp *Cyprinus carpio*	Fillet	12/10/97	0.460
728.00.90	Salton Sea / South	Tilapia *Tilapia sp.*	Fillet	11/20/97	1.310
728.00.90	Salton Sea / South	Tilapia *Tilapia sp.*	Liver	11/20/97	6.650
728.00.92	Salton Sea / North	Orangemouth Corvina *Cynoscion xanthulus*	Fillet	11/18/97	1.360
728.00.92	Salton Sea / North	Orangemouth Corvina *Cynoscion xanthulus*	Liver	11/18/97	2.040

Source: Rassmussen 1997
Notes:
WW Concentrations in wet weight
mg/kg milligrams per kilogram

Other early studies on selenium in tissues include the Selenium Verification Study (White et al. 1987), the reconnaissance investigation by the Department of Interior (DOI) in 1986 and 1987 (Setmire et al. 1990), and a follow-on detailed study by DOI from 1988 to 1990 (Setmire et al. 1993; and Schroeder et al. 1993). The Selenium Verification Study also identified higher selenium concentrations in samples from the Salton Sea fish than those reported in freshwater fish from the Alamo and New Rivers. In the reconnaissance investigation by DOI (Setmire et al. 1990), samples were taken of water, sediment, and biota in the Imperial Valley. Levels in fish and waterfowl in this study indicated bioaccumulation of selenium. Selenium concentrations in mollies and mosquitofish and in invertebrates are shown in Tables 2.3-10 and 2.3-11, respectively.

TABLE 2.3-10
Selenium Concentrations in Mosquitofish and Sailfin Molly from the New and Alamo Rivers and Irrigation Drains and San Felipe and Salt Creeks, Salton Sea, 1988-1990

	New and Alamo Rivers and Irrigation Drains			San Felipe and Salt Creeks		
Fish Species	**N/DV**	**GM (µg/g DW)**	**Range (µg/g DW)**	**N/DV**	**GM (µg/g DW)**	**Range (µg/g DW)**
Mosquitofish	3/3	3.5	2.6-4.7	2/2	6.9	6.4-7.4
Sailfin molly	4/4	3.9	2.5-5.8	2/2	6.4	5.5-7.4

Source: Setmire et al. 1993.
Notes:
DW Concentrations in dry weight
N/DV number of samples collected per number of samples with detectable values
GM Geometric mean; calculated using one-half detection limit when data set has more than 50 percent detectable values.

TABLE 2.3-11
Selenium Concentrations in Pelagic Invertebrates from the New and Alamo Rivers and Irrigation Drains and San Felipe and Salt Creeks, Salton Sea, 1988-1990

	New and Alamo Rivers and Irrigation Drains			San Felipe and Salt Creeks		
Pelagic Invertebrate Species	**N/DV**	**GM (µg/g DW)**	**Range (µg/g DW)**	**N/DV**	**GM (µg/g DW)**	**Range (µg/g DW)**
Amphipod, pileworm, waterboatman composite	-	-	-	2/2	2.8	2.6-3.1
Asiatic river clam	5/5	4.4	2.6-6.4	-	-	-
Crayfish	-	-	-	2/2	3.1	2.4-3.3
Pileworm	8/8	3.1	0.8-12.1	-	-	-
Waterboatman	3/3	2.1	1.4-3.3	-	-	-

Source: Setmire et al. 1993.
Notes:
DW Concentrations in dry weight
– no data
N/DV number of samples collected per number of samples with detectable values
GM Geometric mean; calculated using one-half detection limit when data set has more than 50 percent detectable values.

Selenium concentrations found in most invertebrates were generally below 5 µg/g dry weight (DW), which has been recommended as a dietary threshold to avoid adverse effects in fish and birds that prey on invertebrates (Setmire et al. 1993). This finding indicates that selenium in invertebrates at the Salton Sea are unlikely to cause toxicity to predators feeding on invertebrates. However, some of the pileworms analyzed did exceed 5 µg/g DW with concentrations ranging from 0.8 to 12.1 µg/g DW.

Several species of aquatic birds or eggs were also sampled (Table 2.3-12) (Setmire et al. 1993). Selenium exposure and potential effects in birds can be assessed most directly through the selenium concentrations in eggs (Skorupa and Ohlendorf 1991; and DOI 1998). In the detailed study, black-necked stilts were the only species for which eggs were sampled. Stilt eggs had geometric mean concentrations of 6.2 µg/g or less at all locations. Based on Lemly (1996), the geometric mean indicates that risks are low to none for reproductive impairment in black-necked stilts though the range of concentrations likely exceeds 6.2 µg/g and could result in some reproductive impairment. In fact, Bennett (1998) conducted a study that evaluated nesting proficiency in comparison to egg selenium concentrations, and the results indicated that the species is likely experiencing a low level of selenium-induced reproductive depression at the Salton Sea.

TABLE 2.3-12
Selenium Concentrations in Migratory Birds and Estimated Egg Concentrations from the New and Alamo Rivers, Agricultural Drains, San Felipe Creek, Salt Creek and the Salton Sea Collected During 1988-1990

	Salton Sea				New and Alamo Rivers and IID Drains			
Bird species	**N/DV**	**GM (µg/g DW)**	**Range (µg/g/DW)**	**Est. egg Conc. (µg/g DW)[a]**	**N/DV**	**GM (µg/g DW)**	**Range (µg/g DW)**	**Est. Egg Conc. (µg/g DW)[a]**
Migratory Birds								
Eared grebe (muscle)	5/5	12.7	2.7-35.1	-	-	-	-	-
Northern shoveler (liver)	-	-	-	-	19/19	19.1	9.1-47.0	6.3
Northern shoveler (muscle)	-	-	-	-	6/6	5.2	3.8-12.0	-
Ruddy duck (liver)	57/57	11.7	5.2-41.5	3.86	-	-	-	-
Ruddy duck (muscle)	17/17	4.8	2.7-7.2	-	-	-	-	-
White-faced ibis (carcass)	-	-	-	-	9/9	5.3	3.9-6.6	-
White faced ibis (liver)	-	-	-	-	9/9	7.4	5.0-13.2	2.44
Resident Birds								
American coot (liver)	-	-	-	-	3/3	10.3	7.9-16.3	3.4
Black-necked stilt (egg)	127/127	4.3	1.6-35.0	-	-	-	-	-
Black-necked stilt (carcass)	19/19	5.4	3.2-11.3	-	-	-	-	-

TABLE 2.3-12
Selenium Concentrations in Migratory Birds and Estimated Egg Concentrations from the New and Alamo Rivers, Agricultural Drains, San Felipe Creek, Salt Creek and the Salton Sea Collected During 1988-1990

	Salton Sea				New and Alamo Rivers and IID Drains			
Bird species	N/DV	GM (µg/g DW)	Range (µg/g/DW)	Est. egg Conc. (µg/g DW)[a]	N/DV	GM (µg/g DW)	Range (µg/g DW)	Est. Egg Conc. (µg/g DW)[a]
Listed Birds								
Yuma clapper rail (whole body)	-	-	-	-	1/1	-	4.8	-

Source: Setmire et al. 1993.
[a] Estimated from geometric mean using conversion factor from Lemly (1996)
Notes:
DW Concentrations in dry weight
\- No data
N/DV number of samples collected per number of samples with detectable values

A focused survey was conducted on selenium concentrations in subsurface drainwater, surface drainwater, bottom sediments, and transplanted Asiatic river clams at 48 irrigation drain sites in the Imperial Valley (Setmire et al. 1996; Roberts 1996; and Hurlbert 1997). Tilewater had the highest concentrations of selenium (median 28 µg/L). Drain samples showed considerable dilution of tilewater selenium (median 6 µg/L). Selenium in bottom sediments was correlated (r^2=0.55) with the percent material finer than 0.062 mm (median 0.5 µg/g).

In an attempt to evaluate concentrations of various compounds in colonial waterbirds, Audet et al. (1997) sampled eggs, bird livers, and fish from waterbird nesting colonies or adjacent areas at the Salton Sea. The results for selenium concentrations for bird egg and liver samples are presented in Table 2.3-13. Selenium concentrations found in eggs at the Salton Sea were below all teratogenesis thresholds indicating that selenium levels are below those found to cause teratogenesis. However, selenium concentrations in eggs were within the range at which reproductive performance could be affected. Fish samples were within the range of earlier studies (Saiki 1990; and Setmire et al. 1993).

TABLE 2.3-13
Selenium Concentrations in Bird Eggs and Livers Collected at the Salton Sea, 1991

	Egg Samples			Liver Samples		
Species	N	GM (µg/g DW)	Range (µg/g DW)	N	GM (µg/g DW)	Range (µg/g DW)
Double-crested cormorant	–	–	–	6	21.96	17-29
Great-blue heron	4	3.86	2.8-5	10	9.57	3.5-17
Black-crowned night-heron	3	5.27	4.6-6.5	4	12.24	4.8-20
White pelican	–	–	–	6	14.79	11-22
Black skimmer	12	4.65	2.2-8.2	–	–	–
Cattle egret	3	3.6	2.7-5.4	–	–	–

TABLE 2.3-13
Selenium Concentrations in Bird Eggs and Livers Collected at the Salton Sea, 1991

	Egg Samples			Liver Samples		
Species	**N**	**GM (µg/g DW)**	**Range (µg/g DW)**	**N**	**GM (µg/g DW)**	**Range (µg/g DW)**
Great egret	9	4.77	3.5-7.1	–	–	–
Gull-billed tern	6	4.1	3.4-5.3	–	–	–

Source: Audet et al. 1997.
Notes:
DW concentrations in dry weight;
– no data

Studies conducted on Yuma clapper rails (Roberts 1996; and USFWS 1994) involved analyses of sediment, crayfish, bird egg, kidney, liver, and whole body samples from salvaged birds for selenium and organochlorines. Egg and bird tissue samples were taken in the CDFG Wister Wildlife Management Unit when drainwater was being used as a water source for managed marshes. Concentrations of selenium from the study are presented in Table 2.3-14. The other samples (sediment and crayfish) were collected when most of the Wister Unit had been converted to the use of Colorado River water.

TABLE 2.3-14
Detection Frequency and Summary Statistics for Selenium in Yuma Clapper Rail Diet and Tissue Samples

Matrix	N/DV	Geometric Mean (µg/g DW)	Range (µg/g DW)
Sediments	19/19	1.43	0.55-9.57
Crayfish	19/19	2.16	0.92-4.67
Rail eggs	2/2	–	4.98-7.75
Rail liver	2/2	–	3.09-11.78
Rail kidney	1/1	–	3.69

Source: Roberts 1996.
Notes:
DW concentrations in dry weight
– no data
N/DV number of samples collected per number of samples with detected value

2.3.4 Covered Species and Habitat Associations

This HCP covers 96 species (Table 1.5-1). The covered species use one or more of the six general habitat types described below:

- Salton Sea
- Tamarisk scrub habitat
- Drain habitat
- Desert habitat
- Freshwater aquatic habitats
- Agricultural fields

The covered species can be grouped based on their habitat association and how they use the habitat. The following identifies the covered species associated with each of the habitat types in the HCP area, and describes how the habitat is used and the relative quality of the habitat for the covered species. Some species use more than one habitat in the HCP area and could be exposed to impacts in each of the habitats that they use. Such species are assigned to multiple habitats. More specific information on each of covered species' habitat requirements, status and distribution and life history traits is provided in Appendix A.

2.3.4.1 Salton Sea Habitat Associates

The Salton Sea is a large inland sea that attracts many species associated with large waterbodies as well as species that are more typically associated with coastal areas. Since its formation in the early 1900s the diversity and number of species using the Salton Sea has increased. The sea has become an important breeding location for several species. For example, the Salton Sea supports the largest inland breeding population of western snowy plovers. However, the Salton Sea is most well-known for the large populations of wintering birds. Located on the Pacific Flyway, many birds also pass through the Salton Sea area on migrations to and from Central and South America.

Table 2.3-15 identifies the covered species that are primarily associated with the Salton Sea. In the HCP area, some species (e.g., pelicans) only occur at the Salton Sea, while others use the Salton Sea in addition to other habitats within the HCP (e.g., western snowy plover).

TABLE 2.3-15
Covered Species Associated with the Salton Sea in the HCP Area

Resident Breeders[a]	Migratory Breeders[b]	Short-Term Residents[c]	Transient Species[d]
Desert pupfish	Van Rossem's gull-billed tern	Osprey	California least tern
Double-crested cormorant	Black skimmer	Black tern	Elegant tern
Western snowy plover		Laughing gull	Merlin
		American white pelican	Black swift
		Wood stork	Vaux's swift
		Long-billed curlew	Purple martin
		California brown pelican	Bank swallow
			Reddish egret
			Bald eagle
			Prairie falcon

[a] Resident breeders are species that occur at the Salton Sea year-round and breed in this habitat in the HCP area.
[b] Migratory breeders are species that breed at the Salton Sea, but migrate out of the HCP area or into other habitats for the non-breeding season.
[c] Short-term residents are species that do not breed in the HCP area, but migrate into the HCP area and use the Salton Sea for several months (e.g., during winter).
[d] Transient species are species that do not breed in the HCP area, but use the Salton Sea in the HCP area for short periods of time, typically during migration.

2.3.4.2 Tamarisk Scrub

The species associated with tamarisk scrub habitat are primarily riparian species that find optimal habitat in native riparian habitats consisting of cottonwoods, willows, and other native riparian plant species. As previously described, tamarisk invaded many areas and supplanted native riparian vegetation in the HCP area in most locations. Tamarisk also colonized non-riparian areas along drains or seepage areas. Tamarisk scrub habitat does not represent optimal habitat for the species that use this habitat in the HCP area. Rather, it constitutes the only available tree-dominated habitat in the HCP area. As such, it is used although not preferred. Table 2.3-16 identifies the covered species that use tamarisk scrub habitat in the HCP area.

2.3.4.3 Drain Habitat Associates

Covered species using drain habitat in the HCP area include species that use it exclusively (e.g., Yuma clapper rail) as well as species that will exploit the resources of the habitat, but are not dependent upon it (e.g., northern harrier; Table 2.3-17). The highest quality drain habitat within the HCP area occurs on the state and federal refuges where active management promotes development of emergent aquatic vegetation such as cattails and bulrushes. The drains themselves also provide habitat; however, much of the vegetation in the drains consists of common reed or salt cedar, and only a small proportion of the drains supports cattails or bulrushes. Thus, for species with an affinity for emergent vegetation, habitat quality and availability is limited outside of the state and federal refuges.

TABLE 2.3-16
Covered Species Associated with Tamarisk Scrub Habitat in the HCP Area

Resident Breeders	Migratory Breeders	Short-Term Residents	Transient Species
White-tailed kite	Elf owl[a]	Large-billed savannah sparrow	Merlin
Summer tanager	Brown-crested flycatcher	Sharp-shinned hawk	Black swift
Vermilion flycatcher	Yellow-breasted chat	Cooper's hawk	Vaux's swift
Gila woodpecker[a]	Yellow warbler		Long-eared owl
Gilded flicker[a]			Least Bell's vireo
Harris hawk			Purple martin
Crissal thrasher			Western yellow-billed cuckoo[a]
			Bank swallow
			Willow flycatcher
			Arizona Bell's vireo

[a] Species not known to use tamarisk, but could use native tree habitats.

TABLE 2.3-17
Covered Species Associated with Drain Habitats in the HCP Area

Resident Breeders	Migratory Breeders	Short-Term Residents	Transient Species
Yuma clapper rail	Fulvous whistling-duck	Short-eared owl	Golden eagle
California black rail		Northern harrier	Merlin
Desert pupfish[a]			Black swift
White-faced ibis			Vaux's swift
Least bittern			Purple martin
Lowland leopard frog[b]			Bank swallow
			Tricolored blackbird
			Bald eagle

[a] This species is addressed through a species-specific strategy.
[b] This species is addressed separately from the other species in this habitat group.

2.3.4.4 Desert Habitat Associates

Native desert habitat primarily occurs in the HCP area along the AAC. This portion of the HCP area consists of creosote bush scrub and desert dune habitats. This habitat has not been converted to another use, but is subject to disturbance from maintenance and recreational activities. Most of the covered species associated with desert habitat are limited to this habitat type (e.g., desert tortoise) and would not occur in other habitats in the HCP area. A few (e.g., loggerhead shrike) use desert habitats in addition to other habitats in the HCP area. Table 2.3-18 identifies the covered species associated with desert habitats.

TABLE 2.3-18
Covered Species Associated with Desert Habitat in the HCP Area

Resident Breeders	Migratory Breeders	Short-Term Residents	Transient Species
Cheeseweed moth lacewing[a]	Elf owl		Golden eagle
Andrew's scarab beetle[a]			Prairie falcon
Desert tortoise			
Colorado desert fringe-toed lizard			
Western chuckwalla			
Couch's spadefoot toad			
Colorado River toad[a]			
Flat-tailed horned lizard			
Banded gila monster[a]			
Harris' hawk			
Loggerhead shrike			
Le Conte's thrasher			

TABLE 2.3-18
Covered Species Associated with Desert Habitat in the HCP Area

Resident Breeders	Migratory Breeders	Short-Term Residents	Transient Species
Crissal thrasher			
Jacumba little pocket mouse[a]			
Nelson's bighorn sheep			
Peirson's milk-vetch			
Algodones Dunes sunflower			
Wiggin's croton			
Flat-seeded spurge[a]			
Foxtail cactus[a]			
Munz's cactus[a]			
Giant Spanish needle			
Sand food			
Orocopia sage[a]			
Orcutt's aster[a]			

[a] These species are addressed separately from the other species in this habitat group.

2.3.4.5 Aquatic Habitat Associates

The conveyance and drainage systems provide aquatic habitat. Most of the fish species present in these systems are foreign species. Razorback suckers are the only covered species that are residents in the canal system. Desert pupfish are the only covered species that are residents in drains.

2.3.4.6 Agricultural Field Habitat Associates

Agricultural fields make up most of the habitat in the Imperial Valley. While not a native habitat, many of the covered species have adapted to using agricultural fields in fulfilling one or more life requisites (Table 2.3-19). Often species show an association with certain crop types. Most of the covered species associated with agricultural fields use this habitat for foraging; only a few actually breed in agricultural habitats. Loggerhead shrike and Yuma cotton rat are the only species expected to breed in agricultural habitats. Actual nest locations of these species are on the margins of the fields. The remaining resident and migratory breeders breed in other habitats of the HCP area, but forage in agricultural fields during the breeding season. Agricultural habitats in the HCP area also provide foraging opportunities for wintering birds (i.e., short-term residents) and transient species.

TABLE 2.3-19
Covered Species Associated with Agricultural Fields in the HCP Area

Resident Breeders	Migratory Breeders	Short-Term Residents	Transient Species
Loggerhead shrike	Fulvous whistling-duck	Black tern	Prairie falcon
White-tailed kite		Mountain plover	Golden eagle
White-faced ibis		Ferruginous hawk	Swainson's hawk
Western snowy plover		Aleutian Canada goose	Merlin
Greater sandhill crane		Short-eared owl	Black swift
Yuma hispid cotton rat[a]		Northern harrier	Vaux's swift
Colorado River hispid cotton rat[a]		Long-billed curlew	Purple martin
			American peregrine falcon
			Bank swallow

[a]These species are addressed separately from the other species in this habitat group.

2.3.4.7 Other Species

Most of the covered species can be grouped according to their habitat associations. However, the occurrence of burrowing owls and the 12 bat species covered by the HCP are more a function of the occurrence of unique habitat features than the presence and quality of a general habitat type. Burrowing owls occur at high densities in the Imperial Valley and are associated with the general agricultural landscape. They are however, strongly associated with canals and drains where they inhabit burrows in the unlined banks of these structures. While the surrounding agricultural fields provide foraging opportunities, it is the presence of suitable burrows created by burrowing rodents that largely determine the occurrence of burrowing owls.

The HCP covers 12 bat species (Table 2.3-20). For foraging, it is likely that they use a wide range of habitats, exploiting localized areas of insect abundance. Habitats in the HCP area could be used for foraging. Whether any of the covered bat species roost in the HCP area and the types of structures that they use are unknown. Some bats probably roost outside of the HCP area but come into the HCP area to forage, while others can probably find suitable roosts within the HCP area in buildings, trees, bridges, or other structures. The location of suitable roosting sites is probably an important factor in the extent to which these species occur in the HCP area.

TABLE 2.3-20
Covered Bat Species in the HCP Area[a]

Spotted bat	Pale western big-eared bat
Western mastiff bat	Big free-tailed bat
California leaf-nosed bat	Mexican long-tongued bat
Occult little brown bat	Southwestern cave myotis
Western small-footed myotis	Pocketed free-tailed bat
Pallid bat	Yuma myotis

[a] The process for ensuring Federal Endangered Species Act and California Endangered Species Act coverage for these species is being developed.