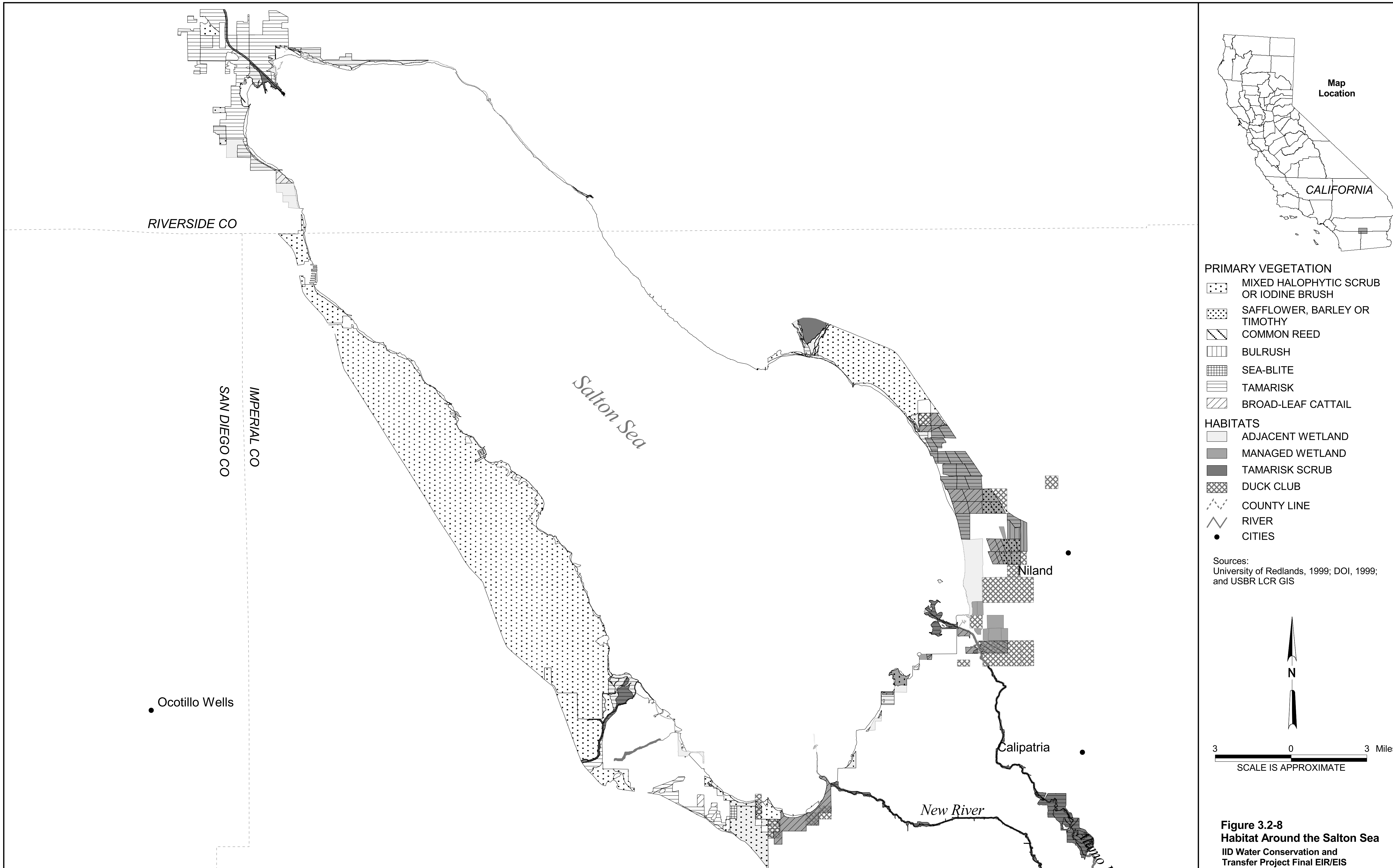

Figure 3.2-8
Habitat Around the Salton Sea
IID Water Conservation and Transfer Project Final EIR/EIS

The Imperial Wildlife Area (WA), managed by the CDFG, and the Sonny Bono Salton Sea NWR, managed by the USFWS lie within the Project area (Figure 3.2-9). Both refuges provide habitat for a wide diversity of resident and migratory waterfowl. The refuges provide marsh habitat and offer the highest quality, year-round marsh habitat value in the Project area.

The Project area also contains 17 private duck clubs, covering about 5,582 acres. Most of the duck clubs are near the Salton Sea. These clubs attract wintering waterfowl, although other wildlife use these marsh areas when available. Managed marsh units on the duck clubs are flooded in fall and winter when wintering waterfowl are in the valley. They are not flooded during other times of the year; therefore, they do not provide habitat for year-round resident wildlife associated with marsh habitat.

Wildlife Associated with Drain Habitat. A number of birds use the Imperial Valley agricultural drains, supply canals, and laterals. The Imperial Valley irrigation infrastructure offers wetland habitat and food, including snails, midge larvae, fish, and seeds and vegetative material from wetland plants. Wading birds using this habitat include green-backed heron (*Butorides striatus*), great blue heron (*Ardea herodias*), and great egret (*Ardea alba*). Other riparian and wetland birds species include the red-winged blackbird (*Agelaius phoeniceus*), common yellowthroat, Yuma clapper rail, and black phoebe (*Sayornis nigricans*). Canal embankments and levees provide open forage habitat for mourning dove, greater roadrunner, and killdeer (*Charadrius vociferus*). Channel embankments also provide burrow sites for burrowing owl (*Athene cunicularia*), kingfisher (*Ceryle alcyon*), and southern rough-winged swallows (*Stelgidopteryx ruficollis*). Species of waterfowl using the drains include American coots (*Fulica americana*) and mallards (*Anas platyrhynchos*). Refuges and duck clubs are managed to attract waterfowl.

Mammals associated with drain habitat include muskrat (*Ondatra zibethicus*), raccoon (*Procyon lotor*), and numerous species of bats, which often forage over wetlands. Round tailed ground squirrel, muskrat, and southern pocket gopher (*Thomomys bottae*) use the canal and drain embankments. Reptile and amphibian species associated with this habitat type include bullfrog, spiny softshell turtle (*Apalone spinifera*), and red-spotted toad (*Bufo punctatus*).

Tamarisk Scrub Habitat. Native riparian plant communities in the desert southwest are dominated by cottonwoods and willows, but palo verde and mesquite also occur. Much of the native riparian plant communities in the desert southwest were replaced by non-native plant species, particularly tamarisk. Tamarisk scrub communities supplant native vegetation following major disturbance, including alterations in stream and river hydrology, and form extensive stands in some places. Characteristic species include salt cedar (*Tamarix chinensis, T. ramosissima*), big saltbrush (*Atriplex lentiformis*), *Coldenia palmeri*, and saltgrass (*Distichlis spicata*); associated species include common reed (*Phragmites communis* var. *berlandieri*) and giant reed (*Arundo donax*).

In the Project area, tamarisk scrub is found along the New and Alamo Rivers. Areas along the New River are composed of a virtual monoculture of tamarisk, with only a few areas of native vegetation. Vegetation along the Alamo River is similarly dominated by tamarisk. Dredging has extended the river channels of both the New and Alamo Rivers into the Salton

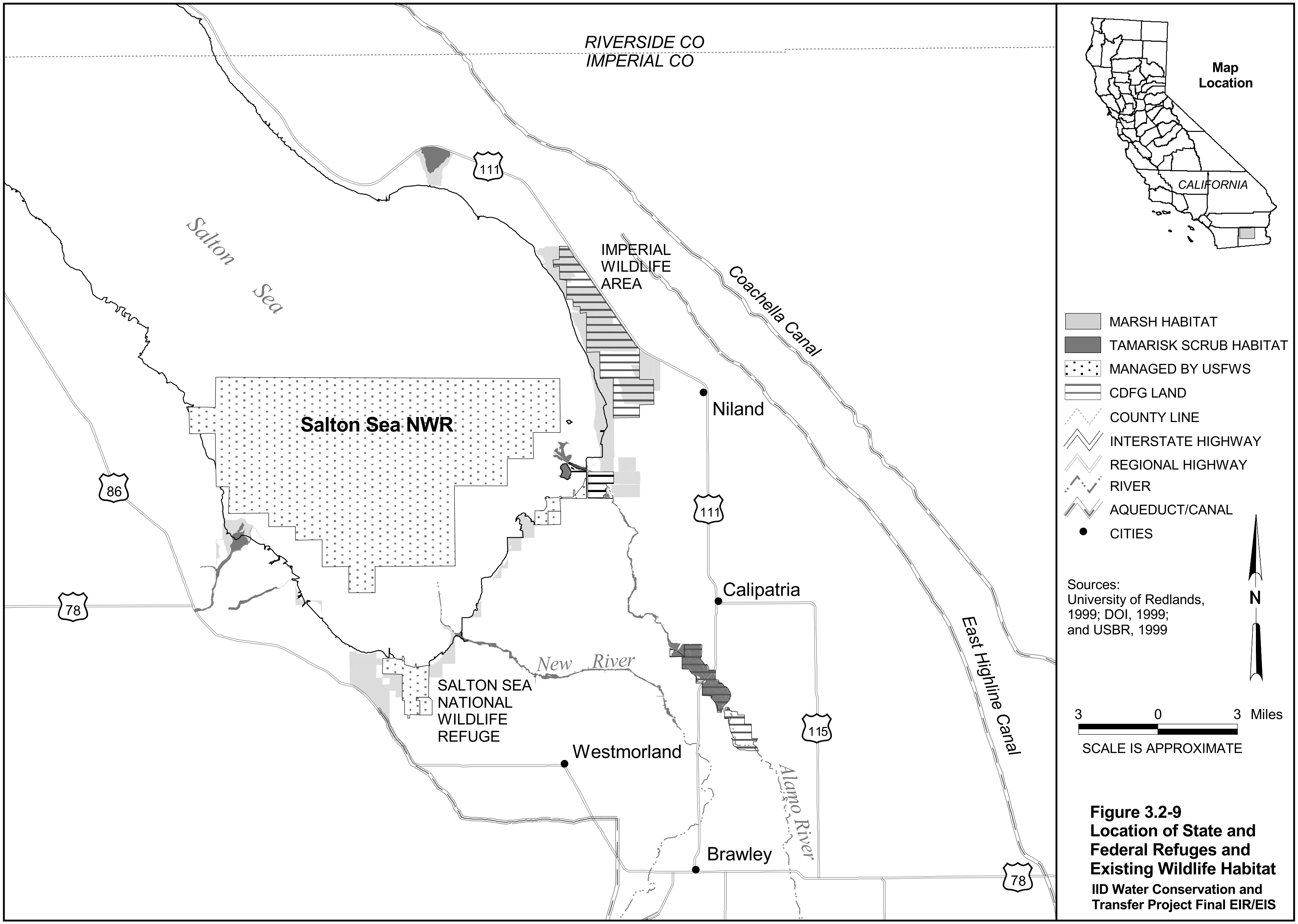

Figure 3.2-9
Location of State and Federal Refuges and Existing Wildlife Habitat
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Sea. The banks of the extended river channels support a thick stand of tamarisk and common reed.

The width of tamarisk scrub stands adjacent to the New and Alamo Rivers varies substantially along their lengths. Based on a review of DOQQs, much of the length of the rivers supports only a narrow band of tamarisk of less than 50 feet on both sides of the channels. In more limited portions of the rivers, larger stands of tamarisk have developed that may extend 500 feet or more from the river channel. To estimate the amount of tamarisk scrub habitat along the floodplains of the New and Alamo Rivers, vegetation along the rivers was digitized from the DOQQs. Vegetation along the rivers was assumed to consist of tamarisk scrub. Based on this work, the New and Alamo Rivers support about 2,568 acres and 962 acres of tamarisk scrub habitat, respectively, for a total of 3,530 acres.

Tamarisk scrub occurs in other portions of the Project area, wherever water is available, including the margins of the Salton Sea (Table 3.2-11). Tamarisk scrub is also one of the major plant species composing vegetation along the drains and is found in seepage areas adjacent to canals. The IID water service area contains about 438 acres of the tamarisk-dominated areas adjacent to the Salton Sea (University of Redlands 1999). The source of the water that supports tamarisk adjacent to the Salton Sea is uncertain, but is likely the result of shallow groundwater and seepage rising to the surface at its interface with the Sea. In addition to the adjacent wetlands, tamarisk is a primary component of areas designated as shoreline strand community in the Salton Sea database. The shoreline strand community occupies about 293 acres (University of Redlands 1999) immediately adjacent to the Salton Sea and consists of tamarisk and iodine bush. As with the tamarisk-dominated areas adjacent to the Salton Sea described, the source of water supporting this community is undetermined, but is likely the result of shallow groundwater and seepage rising to the surface at its interface with the Sea.

Along IID's drainage system, Hurlbert (1997) can be used to estimate the acreage of tamarisk scrub supported by the drains. Of the drains surveyed by Hurlbert (1997), the percentage of drain area composed of tamarisk varied from 0 to 29.6 percent (Table 3.2-8), yielding a weighted average percentage of 8.7. Assuming that tamarisk covers 8.7 percent of the drains, the drainage network in the HCP area supports about 215 acres of tamarisk scrub habitat.

Cottonwood-willow habitat is largely absent from the Project area. Cottonwoods and willows occur in seepage communities along the AAC. In addition, remnant cottonwoods occur in Imperial Valley 20 to 60 feet from the East Highline Canal (IID 1994). A few patches of willow also persist along the Alamo River.

Wildlife Associated with Tamarisk Scrub. Tamarisk is a non-native species that has invaded riparian areas of the southwest and readily colonizes non-riparian areas with adequate soil moisture. Tamarisk is considered poor quality habitat for native wildlife species, although some wildlife species have adapted to using tamarisk where it has displaced native vegetation. Tamarisk forms dense monocultures with little structural diversity. Bird species diversity and abundance are lower in tamarisk than in stands of native riparian vegetation. Bird species potentially using tamarisk scrub and other riparian habitat include yellow warbler (*Dendroica petechia*), southwestern willow flycatcher (*Empidonax traillii extimus*), mourning dove (*Zenaida macroura*), black-crowned night heron, cinnamon teal (*Anas cyanoptera)*, and phainopepla. Two groups, large raptors and cavity-nesting species, are not

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known to occur in tamarisk. Tamarisk's growth form is generally as a large shrub that does not possess the structural characteristics required by species, such as raptors or woodpeckers, that rely on trees as perch or nest sites.

Mammals associated with this habitat include deer mouse (*Peromyscus maniculatus*), cotton rat (*Sigmodon hispidus*), muskrat, raccoon, common gray fox (*Urocyon cinereoargenteus*), ringtail cat (*Bassariscus astutus*), and coyote (*Canis latrans*). Reptile and amphibian species that use this community type include the spiny softshell turtle, bullfrog, leopard frog, and Woodhouse's toad (*Bufo woodhousei*).

Desert Habitat. The Project area supports little native desert habitat. The primary occurrence of native desert habitat in the Project area is along the AAC within IID's right-of-way (Figure 3.2-10). 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 the East Highline Canal and portions of the Thistle, Trifolium, and Westside Main Canals. In the Imperial Valley, desert plant species have colonized small areas that have not been under agricultural production for many years. These areas occur as inclusions in the predominantly agricultural landscape. Two principal desert habitats are supported in the Project area: creosote bush scrub and dunes. The characteristics and distribution of each of these habitats are described subsequently.

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 tridentata*), burro weed (*Ambrosia dumosa*), brittle brush (*Encelia farinosa*), and ocotilla (*Fouquieria splendens*). Succulents are common, and ephemeral annual herbs generally bloom during late February and March. Mesquite thickets, an important wildlife habitat component, are in creosote bush scrub habitat.

Creosote bush scrub, the predominant desert habitat in the Project area, occurs along much of the AAC. It is also adjacent to the Project area along the East Highline and Westside Main Canals. Plant species composing this habitat may occur in the Imperial Valley in fallowed areas.

Desert Dunes. The 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 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 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

Figure 3.2-10
Desert Habitats in and Adjacent to the HCP Area
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weed, ankle grass (*Astragalus* spp.), salt cedar (*Tamarix* spp.), saltbrush (*Atriplex canescens*), croton (*Croton californicus* var. *mojavensis*), dalea grass, wild buckwheat (*Eriogonum deserticola*), and desert sunflower (*Geraea canescens*). Plant cover increases as dunes are progressively stabilized. This community intergrades with sandier phases of creosote bush scrub.

Wildlife Associated with Desert Habitat. Desert habitat areas support birds, mammals, and reptiles that are adapted to arid desert conditions. Resident bird species include the white-crowned sparrow (*Zonotrichia leucophrys*), greater roadrunner (*Geococcyx californianus*), great-horned owl (*Bubo virginianus*), and loggerhead shrike (*Lanius ludovicianus*). Mammals use this habitat, generally in low densities, including the Merriam's kangaroo rat (*Dipodomys merriami*), little pocket mouse (*Perognathus longimembris*), desert kangaroo rat (*Dipodomys deserti*), ground squirrels (*Spermophilus sp.*), striped skunk (*Mephitus mephitis*), and black-tailed hare (*Lepus californicus*). Reptile species include the zebra-tailed lizard (*Callisaurus draconoides*), side-blotched lizard (*Uta stansburiana*), and California whiptail (*Cnemidophorus tigris mundus*).

Plant species in this community, including mesquite, are important food resources to wildlife. Bird species that use this habitat include phainopepla (*Phainopepla nitens*), mockingbird (*Mimus polyglottos*), and ash-throated flycatcher. Mammals that use this habitat include black-tailed hare, desert cottontail (*Sylvilagus andubonii),* striped skunk, coyote, common gray fox (*Urocyon cinereoargenteus),* Merriam's kangaroo rat, and white-throated woodrat (*Neotoma albigula*). Reptiles include sidewinder (*Crotalus cerastes*), coachwhip (*Masticophis flagellum*), desert iguana (*Dipsosaurus dorsalis*), and side-blotched lizard.

Agricultural Fields. Irrigated agricultural land, the predominant land cover type in the Imperial Valley, composes most of the Proposed Project area. Agricultural fields attract a variety of wildlife species. The crops grown, the methods used, and the total acreage in production in the IID water service area are based on the decisions of individual farmers. Current and anticipated market prices have an important role in the crops that are economically beneficial for farmers to grow. As a result, the types and amount of crops grown fluctuate from year to year. The types of crops and the range of acreage of the major crops grown in the service area for 1999 are shown in Table 3.2-12. The cropping pattern is likely to be similar to Table 3.2-12 for the short term, but could change as markets for crops or other conditions change.

Wildlife Associated with Agricultural Fields. Agricultural fields are throughout the Imperial and Coachella Valleys adjacent to the Salton Sea. Agricultural fields are used by a large number and wide variety of species. They attract geese, ibis, gulls, blackbirds, long-billed curlews (*Numenius americanus*), and mountain plovers (*Charadrius montanus*) (Knopf 1998). Bird species use agricultural fields, ruderal communities along the edges of agricultural fields, fields that are inactive or fallow, or fields that are temporarily flooded during irrigations. Red-tailed hawk (*Buteo jamaicensis*), northern harrier, and wintering ferruginous hawks (*B. regalis*) forage on agricultural fields. Flooded fields are often used by foraging wading birds and waterfowl, such as egrets and geese, particularly during winter. Geese will also forage on crops when there is no standing water in the fields. Other species that forage in agricultural fields include a number of species of gulls, wintering mountain plovers, brown-headed cowbirds (*Molothrus ater*), and horned larks (*Eremophila alpestris*)

Common mammals in agricultural and ruderal habitats include western harvest mouse (*Reithrodontomys megalotis*) and southern pocket gopher.

TABLE 3.2-12
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
Total	**538,223**	**99.37**

Source: IID, unpublished data.

Special-Status Species. The Project area provides habitat for a large number of special-status plants and animals. Special-status species of plants include those listed by federal or state agencies as threatened or endangered or candidates for such listing, those listed as species of special concern by federal and state agencies, those listed by the state as rare, or those identified by the California Native Plant Society (CNPS) for inclusion on official lists. Special-status plant species with the potential to occur in the Project area are listed in Table 3.2-13. All special-status plant species in the Project vicinity are associated with desert habitat or forest / woodland habitat. No forest / woodland habitat occurs in the Project area, and species associated with this habitat do not occur. Desert habitat is limited to areas along the AAC and adjacent to the East Highline Canal, and portions of the Westside Main, Thistle, and Trifolium Extension Canals on the margins of the IID water service area. Special-status plants would not be expected elsewhere in the Project area.

TABLE 3.2-13
Special-Status Plants of Imperial and Riverside Counties

Name (Common/Scientific)	Status Federal	Status State	Other[a]	General Habitat
Harwood's milk-vetch/ *Astragalus insularis* var. *harwoodii*			CNPS: 2	D
Coachella Valley milk-vetch/ *Astragalus lentiginosus* var. *coachellae*	FE		CNPS: 1B	D
Peirson's milk-vetch/ *Astragalus magdalenae* var. *peirsonii*	FT	SE	CNPS: 1B	D
Triple-ribbed milk-vetch/ *Astragalus tricarinatus*	FE		CNPS: 1B	D
Ayenia/ *Ayenia compacta*			CNPS: 2	D
Arizona carlowrightia/ *Carlowrightia arizonica*			CNPS: 2	D
Crucifixion thorn/ *Castela emoryi*			CNPS: 2	D
Peirson's pincushion/ *Chaenactic carphodinia* var. *peirsonii*			CNPS: 1B	D
Arizona spurge/ *Chamaesyce arizonica*			CNPS: 2	D
Flat-seeded spurge/ *Chamaesyce platysperma*	SC		CNPS: 1B	D
Wiggin's croton/ *Croton wigginsii*		SR	CNPS: 2	D
Gander's cryptantha/ *Cryptantha ganderi*	SC		CNPS: 1B	D
California ditaxis/ *Ditaxis californica*	SC		CNPS: 1B	D
Glandular ditaxis/ *Ditaxis dariana*			CNPS: 2	D
Parish's daisy/ *Erigeron parishii*	FT		CNPS: 1B	D
Foxtail cactus/ *Escobaria vivipara* var. *alversonii*	SC		CNPS: 1B	D

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TABLE 3.2-13
Special-Status Plants of Imperial and Riverside Counties

Name (Common/Scientific)	Status			General Habitat
	Federal	State	Other[a]	
Little San Bernardino Mtns. Gilia/ *Gilia maculata*	SC		CNPS: 1B	D
Algodones Dunes sunflower/ *Helianthus niveus* spp. *tephrodes*	SC	SE	CNPS: 1B	D
Borrego Valley peppergrass/ *Lepidium flarum* var. *felipense*	SC		CNPS: 1B	D
Santa Rosa Mtns. Linanthus/ *Linanthus floribundus* spp. *halli*			CNPS: 1B	D
Parish's desert-thorn/ *Lycium parishii*			CNPS: 2	D
Spearleaf/ *Matelea paruifolia*			CNPS: 2	D
Munz's cholla (cactus)/ *Opuntia munzii*	SC		CNPS: 1B	D
Giant Spanish-needle/ *Palafoxia arida* var. *gigantea*	SC		CNPS: 1B	D
Slender-stem bean/ *Phaseolus filiformis*			CNPS: 2	D
Sand food/ *Pholisma sonorae*	SC		CNPS: 1B	D
Orocopia sage/ *Salvia greatae*	SC		CNPS: 1B	D
Desert spike-moss/ *Selaginella eremophila*			CNPS: 2	D
Mecca aster/ *Xylorhiza cognata*	SC		CNPS: 1B	D
Orcutt's aster/ *Xylorhiza orcuttii*	SC		CNPS: 1B	D

[a] Federal and state statuses have legal repercussions. CNPS statuses are assigned for information only.

Key:

FE: Federally endangered
FT: Federally threatened
FPE: Proposed endangered
FPT: Proposed threatened
SC: Species of concern

C: Candidate
SE: State endangered
ST: State threatened concern
SR: State rare
CSC: CDFG Species of Special Concern

Habitat Codes:

D: Desert dunes/ scrub

Sources: CNPS 1994; CDFG 1994; USFWS 1999b.

Special-status wildlife species potentially in the Salton Sea and Imperial Valley Project area and their general habitat usage are listed in Table 3.2-14. Status, life-history requirements, and occurrence in the Project area are described in Appendix A of the HCP.

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TABLE 3.2-14
Special-Status Wildlife Species Potentially Occurring in the Imperial Valley and Salton Sea and General Habitat Associations

Common Name/ Scientific Name	Federal	Status State	Other[a]	General Occurrence	General Habitat
Invertebrates					
Cheeseweed moth lacewing/ *Oliarces clara*	SC			R	D
Andrew's dune scarab beetle/ *Pseudocotalpa andrewsi*	SC			R	D
Amphibians					
Colorado River toad/ *Bufo alvariu*			CDFG: SC	R	W
Lowland leopard frog/ *Rana yavapaiensis*	SC			R	W
Couch’s spadefoot toad/ *Scaphiopus couchii*			CDFG: SC	R	D
Reptiles					
Desert tortoise/ *Gopherus agassizi*	FT	ST		R	D
Banded gila monster/ *Helodema sespectum cinctum*			CDFG: SC	R	D
Flat-tailed horned lizard/ *Phrynosoma mcallii*	FPT		CDFG: SC	R	D
Western chuckwalla/ *Sauromalus obesus obesus*	SC			R	D
Colorado Desert fringe-toed lizard/ *Uma notata notata*	SC		CDFG: SC	R	D
Birds					
Cooper's hawk/ *Accipiter cooperi*			CDFG:SC	W	R
Sharp-shinned hawk/ *Accipiter striatus*			CDFG: SC	W	R
Tri-colored blackbird/ *Agelaius tricolor*	SC		CDFG: SC	M	W
Golden eagle/ *Aquila chrysaetos*			CDFG: SC CDFG: FP	M	G
Short-eared owl/ *Asio flammeus*			CDFG: SC	M	Ag
Long-eared owl/ *Asio otus*			CDFG: SC	R	R
Burrowing owl/ *Athene cunicularia hypugea*	SC		CDFG: SC	R	Ag

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TABLE 3.2-14
Special-Status Wildlife Species Potentially Occurring in the Imperial Valley and Salton Sea and General Habitat Associations

Common Name/ Scientific Name	Federal	Status State	Other[a]	General Occurrence	General Habitat
Aleutian Canada goose/ *Branta canadensis leucopareia*	DM			W	Ag, W
Ferruginous hawk/ *Buteo regalis*	SC		CDFG: SC	W	Ag
Swainson's hawk/ *Buteo swainsoni*		ST		M	Ag
Western snowy plover/ *Charadrius alexandrinus nivosus*			CDFG: SC	R	A
Vaux's swift/ *Chaetura vauxi*			CDFG: SC	M	G
Mountain plover/ *Charadrius montanus*	FPT		CDFG: SC	W	Ag
Black tern/ *Chlidonias niger*	SC			S	Ag, A
Northern harrier/ *Circus cyaneus*			CDFG: SC	W	Ag, W
Western yellow-billed cuckoo/ *Coccyzus americanus occidentalis*	C	SE		M	R
Gilded flicker/ *Colaptes chrysoides*		SE		R	R
Black swift/ *Cypseeloides niger*			CDFG: SC		
Fulvous whistling-duck/ *Dendrocygna bicolor*	SC		CDFG: SC	R	Ag, W
Yellow warbler/ *Dendroica petechia*			CDFG: SC	M	R
Reddish egret/ *Egretta rufescens*	SC			W	A, W
White-tailed kite/ *Elanus leucurus*			CDFG: SC CDFG: FP	R	Ag
Little willow flycatcher/ *Empidonax trailii brewsteri*	SC	SE		M	R
Southwestern willow flycatcher/ *Empidonax trailii extimus*	FE	SE		S	R
Merlin/ *Falco columbarius*			CDFG: SC	W	G
Prairie falcon/ *Falco mexicanus*			CDFG: SC	W	Ag
Peregrine falcon/ *Falco peregrinus*	DM	E	CDFG: FP	M	G

TABLE 3.2-14
Special-Status Wildlife Species Potentially Occurring in the Imperial Valley and Salton Sea and General Habitat Associations

Common Name/ Scientific Name	Status Federal	State	Other[a]	General Occurrence	General Habitat
Greater sandhill crane/ *Grus canadensis tabida*		ST	CDFG: FP	W	Ag, W
Bald eagle/ *Haliaeetus leucocephalus*	FT	SE	CDFG: FP	W	W, A
Yellow-breasted chat/ *Icteria virens*			CDFG: SC	S	R
Least bittern/ *Ixobrychus exilis*	SC			R	W
Loggerhead shrike/ *Lanius ludovicianus*	SC			R	Ag, D
Laughing gull/ *Larus atricilla*			CDFG: SC	S	A
California black rail/ *Laterallus jamaicensis coturniculus*	SC	ST	CDFG: FP	R	W
Gila woodpecker/ *Melanerpes uropygialis*		SE		R	R
Elf owl/ *Micrathene whitneyi*		SE		S	D, R
Wood stork/ *Mycteria americana*			CDFG: SC	S	A, W
Brown-crested flycatcher/ *Myiarchus tyrannulus*			CDFG: SC	M	D, R
Long-billed curlew/ *Numenius americanus*			CDFG: SC	W	Ag
Osprey/ *Pandion haliaetus*			CDFG: SC	W	A
Harris' hawk/ *Parabuteo unicinctus*			CDFG: SC	R	D, R
Large-billed savannah sparrow/ *Passerculus sandwichensis rostratus*	SC			R	R
American white pelican/ *Pelecanus erythrorhynchos*			CDFG: SC	W	A
Brown pelican/ *Pelecanus occidentalis*	FE	SE	CDFG; FP	S	A
Double-crested cormorant/ *Phalacrocorax auritus*			CDFG: SC	R	A
Summer tanager/ *Piranga rubra*			CDFG: SC	S	R
White-faced ibis / *Plegadis chihi*	SC		CDFG: SC	R	Ag, W
Purple martin/ *Progne subis*			CDFG: SC	M	G
Vermilion flycatcher/ *Pyrocephalus rubinus*			CDFG: SC	R	R
Yuma clapper rail/ *Rallus longirostris yumanensis*	FE	ST	CDFG: FP	S	W

TABLE 3.2-14
Special-Status Wildlife Species Potentially Occurring in the Imperial Valley and Salton Sea and General Habitat Associations

Common Name/ Scientific Name	Federal	Status State	Other[a]	General Occurrence	General Habitat
Bank swallow/ *Riparia riparia*		ST		M	G
Black skimmer/ *Rynchops niger*			CDFG: SC	R	A
California least tern/ *Sterna antillarum browni*	FE	SE	CDFG: FP	S	A
Elegant tern/ *Sterna elegans*	SC			S	A
Van Rossem's gull-billed tern/ *Sterna nilotica vanrossemi*	SC		CDFG: SC	S	A
Crissal thrasher/ *Toxostoma crissale*			CDFG: SC	R	D
Leconte's thrasher/ *Toxostoma lecontei*			CDFG: SC	R	D
Arizona Bell's vireo/ Vireo bellii arizonae		SE		M	R
Least Bell's vireo/ *Vireo bellii pusillus*	FE	SE		M	R
Mammals					
Pallid bat/ *Antrozous pallidus*			CDFG: SC	R	G
Mexican long-tongued bat/ *Choeronycteris mexicana*	SC		CDFG: SC	M	G
Pale western big-eared bat/ *Corynorhinus townsendii pallescens*			CDFG: SC	R	G
Spotted bat/ *Euderma maculatum*	SC		CDFG: SC	R	G
Western mastiff bat/ *Eumops perotis californicus*	SC		CDFG: SC	R	G
Yuma puma/ *Felis concolor browni*	SC		CDFG: SC	R	G
California leaf-nosed bat/ *Macrotus californicus*	SC		CDFG: SC	R	G
Western small-footed myotis/ *Myotis ciliolabrum*	SC			R	G
Occult little brown bat/ *Myotis lucifugus occultus*	SC		CDFG: SC	R	G
Southwestern cave myotis/ *Myotis velifer brevis*	SC		CDFG: SC	R	D
Yuma myotis/ *Myotis yumanensis*	SC		CDFG: SC	R	G
Pocketed free-tailed bat/ *Nyctinomops femorosaccus*			CDFG: SC	R	D
Big free-tailed bat/ *Nyctinomops macrotis*			CDFG: SC	R	G
Nelson's bighorn sheep/ *Ovis canadensis nelsoni*	BLMSS			R	D

TABLE 3.2-14
Special-Status Wildlife Species Potentially Occurring in the Imperial Valley and Salton Sea and General Habitat Associations

Common Name/ Scientific Name	Federal	Status State	Other[a]	General Occurrence	General Habitat
Jacumba little pocket mouse/ *Perognathus longimembris internationalis*	SC		CDFG: SC	N	D
Yuma hispid cotton rat/ *Sigmodon hispidus eremicus*	SC		CDFG: SC	R	Ag
Colorado River hispid cotton rat/ *Sigmodon hispidus plenus*			CDFG: SC	R	R, Ag

[a] Federal and state status have legal consequence. CDFG: SC (California Department of Fish and Game, Species of Concern) is assigned for information only.

Key:
FE: Federally Endangered
FT: Federally Threatened
FPE: Proposed Endangered
FPT: Proposed Threatened
SC: Species of Concern
FP: State Fully Protected
BLMSS: Bureau of Land Management Sensitive Species
C: Candidate
SE: State Endangered
ST: State Threatened Concern
SR: State Rare
CSC: CDFG Species of Special Concern
DM: Federal Delisted – Monitored

Habitat Codes:
W: Wetland Habitat
A: Aquatic Habitat, predominantly Salton Sea
Ag: Agricultural fields
R: Riparian
G: Generalist at this level and/or requires presence of specific microhabitat features to persist in area
D: Desert dunes/ scrub

Occurrence Codes:
N: Does not occur in Project area
M: Migrates through Project area
S: Summer resident in Project area
W: Winter resident in Project area
R: Year-long resident in Project area

Sources:
CDFG 1999; USFWS 1999b.

FISH AND AQUATIC HABITAT

Aquatic habitat occurs in the Project area in the IID water service area's conveyance system and drainage infrastructure and in the New and Alamo Rivers. Aquatic habitat conditions of these areas are described subsequently. The Salton Sea also provides aquatic habitat, but is discussed separately.

Conveyance System. IID maintains 1,667 miles of canals in its service area, which distribute water diverted from the LCR to farms in the Imperial Valley. Most of the canals are concrete lined (1,114 miles). About 16 miles of the system are pipelines; the remaining 537 miles are earthen canals. IID also operates the 82-mile AAC, which conveys water from Imperial Dam to IID's conveyance system in the valley. The AAC is unlined, but portions are planned to be concrete lined in the future (Reclamation and IID 1994).

Water levels in the AAC are kept as high as possible to maximize power generation from hydropower facilities. Lowest flows in the canal system occur in January and February. 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 (Corps 1996).

In the AAC and Imperial Valley main canals, aquatic habitat in the center of the canals is characterized by high water velocities and a lack of aquatic vegetation and aquatic invertebrates. The central portions of the main canals provide 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), offer better habitat conditions for aquatic invertebrates and fish. Submerged vegetation consists primarily of Eurasian water-milfoil (*Myriophylum spicatum*) with some sago pondweed (*Potamogeton pectinatus*) (Reclamation and IID 1994). The noxious aquatic weed hydrilla (*Hydrila verticulata*) is common in the Imperial Valley canal system, but is rare in the AAC (Reclamation and IID 1994). Vegetation is routinely cleaned from the canals.

Because of high velocities, concrete substrates, and lack of submerged and aquatic vegetation, many canals (except for 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. Crayfish are present in small numbers (Corps 1996).

The IID conveyance system, including the AAC, supports populations of game and non-game fish from three sources: the Colorado River, IID water service area canals, and fish stocking (Corps 1996). The CDFG previously stocked channel catfish, and IID stocks sterile grass carp (*Ctengoharyngodon idella*) in the canal system. The AAC fishery is dominated by channel catfish introduced by CDFG. Threadfin shad (*Dorosoma Petense*) are the next most abundant fish (Table 3.2-15). Gamefish, including largemouth bass, sunfish (*Lepomis cyanellus*), and flathead catfish (*Pylodictis olivaris*), represent a minor component of the AAC fish community. Common carp and striped bass are also typical of the AAC's population (Corps 1996). Small numbers of razorback suckers have been found during canal and reservoir dewaterings in the Imperial Valley over the years. Between the Pilot Knob and Drop 4 hydroelectric facilities on the AAC, an estimated 284,738 fish yield an average density of 430 fish per acre. Although no surveys have been conducted of the fish community of the main IID canal system (East Highline Canal, Westside Main Canal, and Central Main Canal), the fish community is believed to be similar in composition to that in the AAC.

Drainage System. A system of subsurface tile drains, surface drainage ditches, and stream channels collects and conveys agricultural drainwater in the IID water service area. Currently, IID operates and maintains 1,456 miles of drains. These drains are primarily unlined earthen channels.

Aquatic habitat in the drains is of poor quality because of silty substrates, poor water quality, and shallow depth. Portions of the drains support rooted vegetation, such as cattails, common reed (*Phragmites* sp.), 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.

TABLE 3.2-15
AAC Fish Community between Pilot Knob and Drop 4

Species	Estimated Numbers	Percentage of Total Species
Channel catfish	258,464	90
Threadfin shad	10,706	4
Shoreline gamefish[a]	10,851	4
Common carp	4,575	2
Striped bass	142	Trace
Total	**284,738**	**Approximately 100%**

[a] Largemouth bass, sunfish, and flathead catfish.
Source: Reclamation and IID 1994.

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 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, no irrigation activity can dry out drains and might not support aquatic habitat.

During irrigation, the drainage network supports abundant aquatic invertebrates, especially waterboatman (*Corixa* sp) (Radke 1994). Analysis of benthic invertebrate communities in several of the irrigation drains indicates the communities are composed of relatively few species and are dominated by one or two taxa. In the 10 drains sampled, the mollusk family Thiaridae was the most abundant taxon in 8 of the drains, composing between 50 and 95 percent of the sample. Another taxon observed frequently (but with lesser abundance than Thiaridae) was the mollusk family Physidae. 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 have been found to be much lower in the water column than in the benthic samples. Taxa richness ranged from 4 to 10. Chironomid larvae were the most abundant invertebrates in 6 of the 10 drainwater column samples. Other frequently observed taxa include mosquito larvae (*Culicidae*) and oligochaete worms. Larval chironomids are a food source for fish and other invertebrates and are eaten by many kinds of birds. Five pollution-sensitive taxa of the orders Ephemeroptera and Trichoptera were observed in the water column samples (Setmire et al. 1996).

At least 13 species of fish are known to inhabit the surface drains that discharge directly to the Salton Sea (Table 3.2-16). Sport fish, such as green sunfish (*Lepomis cyanellus*), tilapia (*Tilapia mossambica* and *T. zilli*), livebearer species (*mollies*), and mosquitofish, are common in the drains adjacent to the southern Salton Sea. The state and federally endangered desert pupfish (*Cyprinodon macularius*) is also known to inhabit the terminus of irrigation drains that discharge directly into the Salton Sea, in addition to tributary streams, washes, and near-shore pools.

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TABLE 3.2-16
Fish Species Known to Inhabit Irrigation Drains Adjacent to the Salton Sea

Species Name	
Desert pupfish (*Cyprinodon macularius*)	Common carp (*Cyprinus carpio*)
Sailfin molly (*Poecilia latipinna*)	Shortfin molly (*P. mexicana*)
Mozambique mouthbrooder (*Tilapia mossambica*)	Zill's cichlid (*T. zilli*)
Longjaw mudsucker (*Gillichthys mirabilis*)	Mosquitofish (*Gambusia affinis*)
Red shiner (*Cyprinella lutrensis*)	Porthole livebearer (*Poeciliopsis gracilis*)
Variable platyfish (*Xiphophorus variatus*)	Green sunfish (*Lepomis cyanellus*)
Corvina (*Cynoscion* sp.)	Yellow bullhead (*Ameiurus natalis*)
Gulf croaker (*Bairdeilla icistia*)	

Source: Corps 1996.

Fish populations in drain habitat vary greatly because of seasonal and operational changes. Species composition is derived from migrants and juveniles from the Alamo River, New River, supply canals, and the Salton Sea. The presence and abundance of fish in specific drains are affected by irrigation flows, operational discharges, pesticide and herbicide usage by farmers, water quality, and other factors. Water quality conditions and the effects of water quality on fish and aquatic invertebrates are addressed more thoroughly in the Water Quality and Biological Resources discussion in this section.

New and Alamo Rivers. The New River enters the U.S. from Mexico, and, when it crosses the border, it is primarily composed of agricultural drainage water and wastewater from the Mexicali Valley. In the Imperial Valley, agricultural drains discharge into the river. The Alamo River also enters the U.S. from Mexico and receives Imperial Valley agricultural drainage water.

Aquatic habitat quality in the New and Alamo Rivers is poor because of poor water quality, high turbidity, and unstable substrates, which inhibit production of benthic invertebrates and rooted vegetation. Although comprehensive fish distribution and abundance surveys have not been conducted in the New and Alamo Rivers, qualitative information is available. Fish populations are probably limited by food availability and water quality, not by flow. Channel catfish, common carp, tilapia, largemouth bass, red shiner, mosquitofish, sailfin molly, Zill's cichlid, yellow bullhead, and flathead catfish are found in the New and Alamo Rivers (Corps 1996). Desert pupfish are not known to occur, nor are they expected, in the New or Alamo Rivers because of high sediment loads, excessive velocities, and predators.

Special-Status Species. Two special-status fish species occur in the aquatic habitats of the Imperial Valley. These species are the desert pupfish and razorback sucker, both of which are listed as federally and state endangered. The razorback sucker is also a California fully protected species. Life history traits, habitat requirements, and occurrence in the Project area for these species are described in Appendix A of the HCP.

Desert pupfish populations inhabit drains that discharge directly into the Salton Sea, shoreline pools of the Salton Sea, and desert washes at San Felipe Wash and Salt Creek.

Pupfish movement between the Salton Sea and nearby drains has been observed (Sutton 1999). Because pupfish prefer shallow, slow-moving waters with some vegetation for feeding and spawning habitat, the shallow Salton Sea pools probably do not provide an optimal habitat (UCLA 1983).

Razorback suckers historically occupied the major river systems of the Colorado River Basin between southwestern Wyoming and northern Mexico (Minckley et al 1991). Some individuals are believed to inhabit the canal system in Imperial County, but the population s is believed to be made up of old members of a dwindling, non-reproductive stock (Tyus 1991; Minckley et al. 1991); no recruitment of wild-spawned fish occurs, probably because of predation by introduced fish (Tyus 1991). Razorback suckers, also known to occur in the AAC, are likely to occur elsewhere in the canal system.

SALTON SEA

The Salton Sea was created in the early 1900s, when the course of the Colorado River changed and flowed north. The Salton Sea is relatively shallow, with a maximum depth of about 49 feet (Radke 1994). Since the Salton Sea's creation, its primary inflow has been agricultural drainage water from the Coachella, Mexicalli, and Imperial Valleys. This agricultural drainage water carries high levels of phosphorous, nitrogen, and salinity; thus, Salton Sea salinity has increased and evaporative losses have contributed to the creation of a hypersaline lake. Salinity of greater than 44 g/L of TDS and summer temperatures in excess of 30 °C limit fish species diversity in the Sea. The saline condition is due to the Salton Sea having no outlet.

Phosphorous and nitrogen inputs to the Salton Sea result in eutrophic conditions that stimulate high primary productivity of phytoplankton and phytobenthic algae. These primary producers, in turn, support high concentrations of zooplankton and benthic worms (i.e., pileworms) that feed on the phytoplankton and algae. Fish species that can tolerate the high temperatures and salinity and low dissolved oxygen concentrations find favorable conditions in the Salton Sea.

Lower Trophic Level Resources. The Salton Sea is considered eutrophic with plentiful phytoplankton, a condition that often results in algal blooms (Hurlbert 1999a). The dominant primary producers are phytoplankton and phytobenthos; plant life in the Salton Sea predominantly is single-celled algae. Major groups of algae include diatoms (*Chrysophyta*), dinoflagellates (*Pyrrophyta*), and green algae (*Chlorophyta*) (Carpelan 1961). Blue-green algae (*Cyanophyta*) are also on the seafloor in shallow water and on buoys and pilings in the Salton Sea. During recent sampling, several new species of diatoms were observed (Hurlbert 1999b). Many of the previously observed species are still in the Salton Sea. The phytoplankton composition changes may be caused by an increase in the salinity of the Salton Sea and from the introduction of tilapia (Hurlbert 1999b).

In the Salton Sea, five phyla of invertebrates are represented: Protozoa, Rotifera, Nematoda, Annelida, and Arthropoda. Common invertebrates in the Salton Sea include ciliate protozoans, foraminifera, rotifers, copepods, barnacle, pileworm, amphipod, and the water boatman (a corixid). The rotifer *Brachionus plicatilis* is the dominant rotifer species, is completely planktonic, and has great value as food for larval fish. The pileworm *Neanthes*, a major food source for fish and birds, is a significant species in the benthos of the Salton Sea.

Pileworms, abundant since their introduction to the Salton Sea during the 1930s, are the principal detritus-feeding benthic organisms in the Salton Sea.

Major zooplanktonic organisms in the Salton Sea include *Brachionus*, copepods (*Apocyclops dengizicus, Cletocamptus dietersi*), the egg and larval stages of the pileworm, and the larval stages of the barnacle (*Balanus amphitrite saltonensis*). Other zooplanktonic species in the Salton Sea include brinefly larva and surface-dwelling insects. The remaining invertebrate species or life stages are primarily benthic. Organisms that attach permanently to a hard surface are limited to the few rocky areas, docks, debris, or inundated brush along the shore.

Fish Resources. Fish species inhabiting the Salton Sea are adapted to living in high-salinity waters. Most of the fish are non-native species (Walker 1961; Dritschilo and Pluym 1984; Setmire et al. 1993) that have been introduced from the Gulf of California by CDFG. Fish in the Salton Sea include the sport fish sargo (*Anisotremus davidsoni*), orangemouth corvina (*Cynoscion xanthulus*), Gulf croaker (*Bairdiella icistia*), tilapia (*Tilapia mossambica*), and other fish species listed in Table 3.2-17. 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.

TABLE 3.2-17
Fish Species in the Salton Sea

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

Source: Black 1988.

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 reported are from areas around the New and Alamo Rivers and nearshore areas extending about 6,458 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 kilograms per hectare per year (kg/ha/yr), far exceeding productivity of tilapia in tropical lakes (Costa-Pierce and Riedel 2000a).

The fish community experiences periodic large-scale die-offs. Fish kills can be massive, averaging between 10,000 and 100,000 fish, but sometimes reaching upwards of several million fish. A fish die-off estimated at 7.6 million fish was reported in August 1999. Causes are not always clear, but many die-offs are caused by rapid declines in dissolved oxygen levels resulting from seasonal algal blooms (Salton Sea Science Subcommittee 1999). Potential pathogens have also been identified. Pathogens implicated in fish kills include infestations of a lethal parasitic dinoflagellate (*Amyloodinium ocellatum*) and acute bacterial infections from bacteria of the genus *Vibrio* (USFWS 1997a). Fish deaths can happen at any time of the year, but the largest die-offs occur during the summer in association with high water temperatures.

Food-Chain Relationships. The aquatic food web of the Salton Sea is unusual because it lacks an adult fish that is exclusively planktivorous. Corvina are the top predators, feeding on tilapia, longjaw mudsuckers, Gulf croaker, sargo, and threadfin shad. Adults of these fish forage on macroinvertebrates, of which the pileworm is important. The invertebrate herbivores, rotifers, and copepods provide food for larval fish (Thiery 1994).

A food habit study of tilapia in the Salton Sea showed that in pelagic areas, tilapia feed on zooplankton, particularly copepods and rotifers, whereas in the nearshore and deltaic areas, their diet was much more diverse and included sediment and detrital matter (Costa-Pierce and Riedel 2000b). The high concentration of tilapia in the river deltas and nearshore areas may be related to the high levels of organic matter in river and drain discharges to the Sea.

Avian Resources. The Salton Sea represents a major center for avian biodiversity in the southwest U.S., with occurrence records for more than 400 species and an annual average abundance of 1.5 million to 2 million waterbirds (SSA and Reclamation 2000; Hart et al. 1998; Shuford et al. 1999). The Salton Sea is an integral part of the Pacific Flyway, providing a migratory stopover for fall and spring shorebirds and supporting large populations of wintering waterfowl. The Salton Sea represents 1 of only 4 interior sites along the Pacific Flyway, which supports more than 100,000 shorebirds during migration (Page et al. 1992), consisting of as many as 44 species (McCaskie 1970; Shuford et al. 1999). The Salton Sea also supports large or unique breeding populations of some species.

The overall high productivity of the Salton Sea can be attributed to a number of factors, including relatively mild 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 conditions that generate higher productivity (e.g., with more of the water column in 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, important as food for birds in the Salton Sea, include brine fly larvae (*Ephydra sp.*), adult pileworm (*Neanthes succinea*), and the nauplia and cypris of the barnacle (*Balanus amphitrite saltonensis*) (Reclamation and SSA 2000). Aquatic invertebrates are forage for a variety of species, including diving ducks, grebes, phalaropes (*Phalaropus* spp.), and 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 birds forage on fish, including cormorants, diving ducks, pelicans, black skimmer, terns, egrets, and herons. Fish in the Salton Sea used as prey include tilapia, bairdiella, sargo, mosquito fish, and larval orange-mouthed corvina (Reclamation and SSA 2000).

Colonial Nesting Populations. Most bird activity at the Salton Sea is concentrated in three primary locations: along the north shore, along the south shore, and near the mouth of

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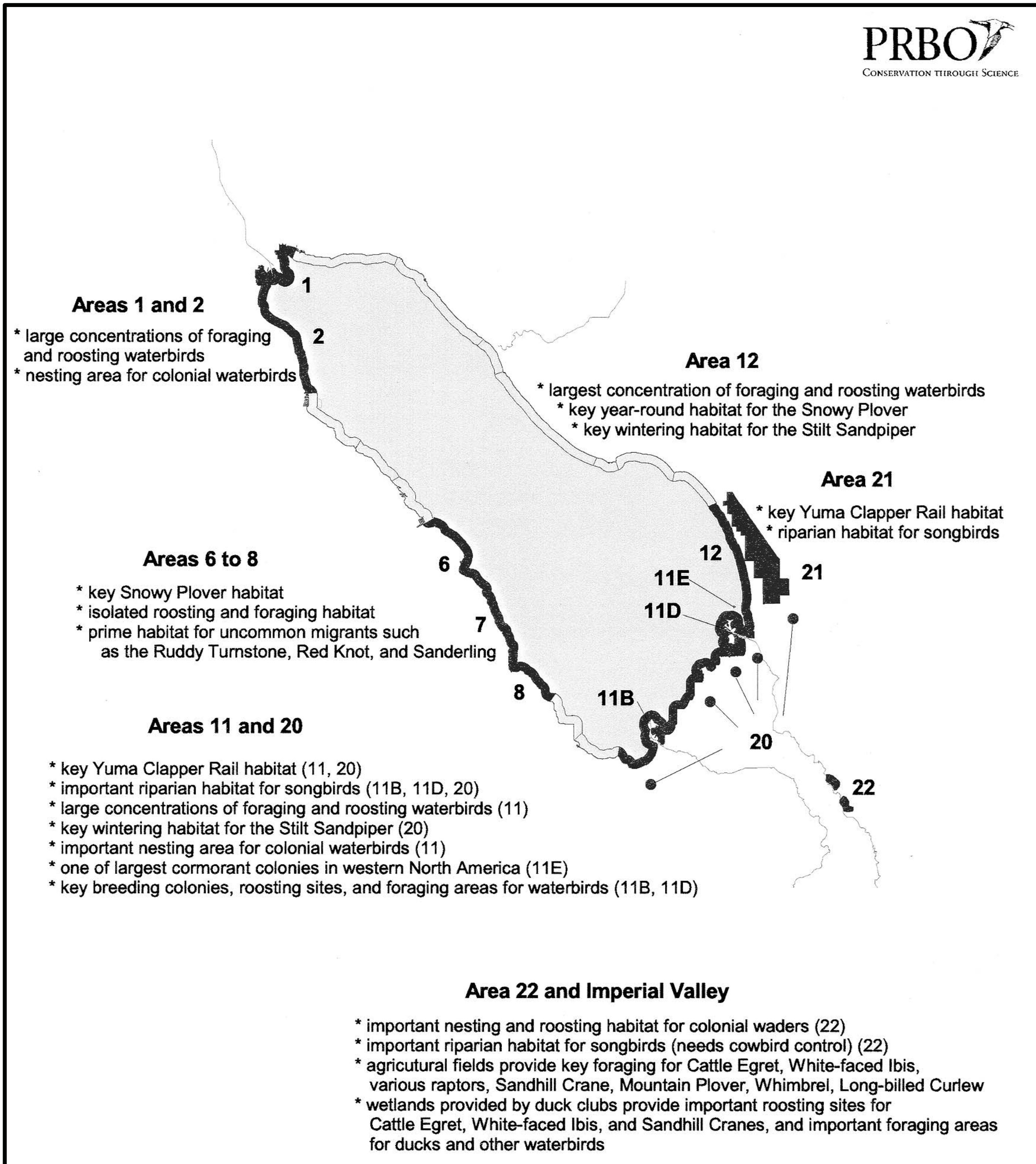
Salt Creek on the eastern shore (Figure 3.2-11) (SSA and Reclamation 2000). In these areas, populations of colonial breeding birds occur (Table 3.2-18). Suitable habitat conditions for colonial birds include an easily accessible and abundant food source and nest sites, such as tree nests or islands protected from predators. Some natural islands are available for nesting at the Salton Sea; however, a number of sites consist of old levees now inundated in sections and separated from the mainland and other manmade islands. Except for Mullet Island at the south end of the Sea, most sites are less than 11,000 square feet in area. Fluctuations in the Sea's level increase or decrease habitat for island nesting birds. Island suitability as nesting habitat for some species is also determined by competition for nest sites.

TABLE 3.2-18
1998 Estimate of Salton Sea Nesting Birds

Common Name	Scientific Name	Number of Pairs
Great egret	*Ardea alba*	227
Great blue heron	*Ardea herodias*	364
Cattle egret	*Bubulcus ibis*	11,138
Snowy egret	*Egretta thula*	337
Laughing gull	*Larus atricilla*	a
California gull	*Larus californicus*	37
Black-crowned night heron	*Nycticorax nycticorax*	282
Brown pelican	*Pelecanus occidentalis*	b
Double-crested cormorant	*Phalacrocorax auritus*	3,584
White-faced ibis	*Plegadis chihi*	a
Black skimmer	*Rynchops niger*	450
Caspian tern	*Sterna caspia*	800
Forster's tern	*Sterna forsteri*	a
Gull-billed tern	*Sterna nilotica*	160

[a] Not known to nest in 1998.
[b] Nesting attempts only.
Source: Shuford et al 1999.

Mullet Island is 1.6 miles from the Alamo River mouth and has relatively high relief and ample nesting areas. It has historically supported nesting black skimmers, cormorants, gull-billed terns, and Caspian terns; since 1992, gulls have also nested there (Molina 1996). The site is subjected to human disturbance, with the Red Hill Marina only 1.9 miles away. Other nesting sites in the south portion of Salton Sea include Morton Bay, which consists of an eroded impoundment east of the Alamo River mouth. It has two low-lying nesting islets, protected from wave inundation by a nearly continuous perimeter levee. Near Rock Hill, small flat earthen islets in a freshwater impoundment have been suitable for nesting since 1995. This site is in the Sonny Bono Salton Sea NWR and is actively managed, including water-level controls and protection from disturbances.



Source: Shuford et al., 2000

Figure 3.2-11
Areas of Particular Importance to Birds at the Salton Sea

Adjacent to Obsidian Butte, a nesting site is on a small, low islet, consisting of a rocky perimeter and an interior beach composed of crushed barnacle. A small nesting site is 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 at Johnson Street near the mouth of the Whitewater River; this site consists of remnants of earthen levees isolated from the shore by rising water levels.

Gulls, terns, skimmers, and pelicans nest communally on isolated islands free from predators. Sites are typically open, lack high vegetation, and are above the level of inundation from wind-generated wave action (Molina 1996). In recent years, black skimmer nesting colonies have been reduced from six to only two, probably as a result of competition with larger, more gregarious ground-nesting species, such as cormorants or gulls (Shuford et al. 1999). Current population estimates include about 40 pairs of California gull at the south end of the Salton Sea in 1997. Black skimmers maintain a population of about 300 pairs at the north and south ends of the Salton Sea, despite reduced numbers of colonies (Molina 1996). Gull-billed terns form nesting colonies of about 160 pairs annually (Shuford et al. 1999). Little information on the population size of Forster's tern is available, although colonies were reported at the Salton Sea as early as 1978 (Garrett and Dunn 1981). Caspian terns have large nesting colonies, with total numbers of up to 3,000 pairs. Cormorants also nest on isolated islands, preferring sites that contain rock ledges; they might also nest in trees inside heron and egret rookeries (Shuford et al. 1999). Small nesting colonies were documented at the north end of the Sea in 1995 (USFWS 1996a), but recently (1999) more than 7,000 double-crested cormorants and 4,500 nests were counted on Mullet Island. Mullet Island now represents the largest breeding colony of double-crested cormorants in California (Shuford et al. 1999).

Most herons and egrets nest colonially, generally in large trees that support substantial nest platforms, but sometimes in smaller trees and shrubs or in emergent wetland vegetation (Zeiner et al. 1990). Near the Salton Sea, herons and egrets typically nest in lower trees, including stands of tamarisk trees and mesquite snags (Shuford et al. 1999). A colony is in snags on the north side of the Salton Sea, near the mouth of the Whitewater River.

Wintering Populations. Large numbers of wintering waterfowl use the Salton Sea and adjacent agricultural areas. Eared grebes are the most numerous waterbirds on the Salton Sea, with 65,000 to 700,000 individuals annually on average (SSA and Reclamation 2000; USFWS 1996a). As many as 1 million eared grebes might winter at the Salton Sea (Jehl 1996), and as many as 3.5 million were estimated during March 1988 (Jehl 1988; Shuford et al. 1999). By some estimates, 90 percent of the North American population of eared grebes might pass through the Salton Sea in some years. Other waterfowl using the Salton Sea in large numbers include northern shovelers, northern pintail, green-winged teal, American wigeon, ruddy ducks, Snow geese, and Ross's geese. The maximum number of waterfowl reported during aerial surveys conducted in 1999 was 55,062 recorded in January. By March, numbers had declined to about 39,539 birds (Shuford et al. 2000).

In addition to large fall and spring migrant populations of shorebirds (see below), the Salton Sea hosts a large wintering population. Along with the Central Valley of California, the Sea represents one of only two interior sites in the west that hosts more than 10,000 wintering shorebirds (Page et al. 1992). Wintering shorebird populations at the Salton Sea number up to 30,000 birds. Table 3.2-19 summarizes counts conducted in 1999 (Shuford et al. 1999).

Numbers of individuals per species from earlier counts include about 9,500 dowitcher (*Limnodromus* spp.), 4,700 western sandpiper (*Calidris mauri*), 5,800 American avocet (*Recurvirostra americana*), 4,300 black-necked stilt (*Himantopus mexicanus*), 1,800 willet (*Cataptrophorus semipalmatus*), 1,400 marbled godwit (*Limosa fedoai*), and 1,000 black-bellied plover (*Pluvialis squatarola*) (Shuford et al. 1999).

TABLE 3.2-19
1999 Winter Shorebird Populations at the Salton Sea (January and February)

Species	Number of Individuals
Black-bellied plover	1,310
Snowy plover	275
Semi-palmated plover	73
Killdeer	277
Black-necked stilt	3,941
American avocet	7,318
Greater yellowlegs	81
Lesser yellowlegs	62
Willet	1,162
Spotted sandpiper	7
Long-billed curlew	737
Marbled godwit	1,297
Ruddy turnstone	17
Sanderling	52
Western sandpiper	1,573
Least sandpiper	2006
Dunlin	799
Stilt sandpiper	164
Ruff	1
Dowitcher spp.	6,356
Common snipe	24
Wilson's phalarope	1
Total	**27,533**

Source: Shuford et al. 2000.

Large numbers of white pelicans use the Salton Sea as a migratory stopover and wintering area. Some birds probably remain at the Salton Sea throughout the winter rather than continuing on to Mexico. The number of pelicans using the Salton Sea at any time varies substantially. According to counts reported by USFWS and aerial surveys conducted by Point Reyes Bird Observatory (Shuford et al. 2000), the Salton Sea at times supports one of the largest concentrations of white pelicans in the Pacific Flyway. McKay reported maximum counts of white pelicans at the Salton Sea during 1984 to 1990 of 2,000 to 17,000. More recently, Shuford et al. (2000) reported 19,197 pelicans at the Salton Sea. The USFWS recorded numbers of white pelicans at the Salton Sea for a 21-month period between December 1999 and August 2001. White pelican numbers were highest (24,110) in February 2000 and lowest (770) in June 2001.

The largest populations of gulls at the Salton Sea occur in winter, with a total population of many tens of thousands. In 1998, tens of thousands of ring-billed gulls (*Larus delawarensis*) and California gulls (*Larus californicus*), as well 1,000 to 2,000 herring gulls were present along with other rarer species (McCaskie 1998). These estimates suggest the Salton Sea supports wintering gull populations that are among the largest for any inland site in North America (Shuford et al. 1999).

Migratory and Post-Breeding Populations. The Salton Sea and surrounding environments support transient species during post-breeding periods and during spring and fall migrations. More than 100,000 shorebirds use the Sea during migrations from wintering grounds in Central or South America to breeding grounds in the Arctic, or on their return trips in the fall. Other common migrants include black tern (*Chlidonias niger*) and American white pelicans, some of which winter at the Salton Sea, but many more of which migrate to wintering grounds along the west coast of Mexico (Shuford et al. 1999).

In terms of overall numbers, the Salton Sea is the most used spring stopover area in the intermountain and desert regions of the west and the second most important, after the Great Salt Lake, in the fall. Shorebird populations at the Salton Sea averaged about 85,000 in August, 24,000 in December, and 90,000 in April (Shuford et al. 1999). Eleven taxa had populations of more than 1,000 in at least one season, with more than 44 total species of shorebirds recorded (McCaskie 1970, Shuford et al. 1999). General numbers of migrating shorebirds are summarized in Table 3.2-20. They have included up to 10,200 black-necked stilts, 15,700 American avocets, 50,000 western sandpipers, 15,800 dowitchers, 7,000 whimbrels (*Numenius phaeopus*), 4,500 red-necked phalaropes (P*halaropus lobatus*), 3,000 Wilson's phalaropes (*Steganopus tricolor*), 2,100 long-billed curlews, and 1,700 marbled godwits (*Limosa fedoai*).

TABLE 3.2-20
Migratory Shorebirds at the Salton Sea

Species Name (Scientific/Common)	**Mean Number of Individuals**	
	August	**April**
Calidris mauri (western sandpiper)	33,600	50,000
Cataptrophorus semipalmatus (willet)	900	200
Erolia minutilla (least sandpiper)	2,300	1,800
Himantopus mexicanus (black-necked stilt)	10,200	4,500
Limnodromus spp. (dowitcher)	10,400	15,800
Limosa fedoai (marbled godwit)	1,700	1,200
Numenius americanus (long-billed curlew)	2,100	50
Numenius phaeopus (whimbrel)	30	7,000
Phalaropus lobatus (red-necked phalarope)	4,500	700
Recurvirostra americana (American avocet)	15,700	7,600
Steganopus tricolor (Wilson's phalarope)	3,000	250
Total Shorebirds	**85,430**	**89,100**

Note: Mean figures are based on Pacific Flyaway Project (1989-1995) Comprehensive Surveys.
Source: Schuford et al. 1999.

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Several species use the Sea during the post-breeding season in summer and early fall. The wood stork (*Mycteria americana*) breeds in Florida and Mexico, but it is a common post-breeding visitor to the Salton Sea, with as many as 275 individuals recorded during the post-breeding season. Some gulls, such as laughing gulls, breed elsewhere in California, but visit the Salton Sea later in the summer. Brown pelicans maintain a year-round presence at the Salton Sea, but are most common as post-breeding visitors. These post-breeding visitors could be from the nearest nesting colony in the Gulf of California on San Luis Island, about 220 miles from the Salton Sea (IID 1994). As many as 5,000 individuals have been observed at the Salton Sea.

Avian Die-Offs and Diseases. Since the early 1990s, there has been an unprecedented series of fish and bird die-offs at the Salton Sea (USFWS 2000; Kuperman and Matey 1999). A number of diseases have been implicated, but some causes of mortality remain unknown. Fish kills directly affect birds and can be massive, averaging between 10,000 and 100,000 fish and sometimes reaching upwards of a million fish. Causes are not always clear, but potential pathogens have been identified, and low oxygen levels might also be responsible. 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. Fish septicemia produce conditions in the intestinal tracts of sick fish that allow botulism spores to germinate. Birds foraging on sick fish could ingest fatal doses of the botulism toxin (USFWS 2000). In 1996, a large avian botulism (Type C) outbreak killed 8,538 white pelicans and 1,129 brown pelicans and many great egret, snowy egret, eared grebe, black-crowned night heron, and other birds (Jehl 1996). More than 14,000 birds died in this event (USFWS 1996b).

Other major diseases causing significant bird die-offs include avian cholera, which killed up to 5,000 birds in 1992; salmonellosis, which killed more than 4,500 cattle egrets in 1989; and Newcastle disease. In 1992, a die-off of an estimated 150,000 eared grebes occurred (USFWS 1996c); the causes are still unknown. These deaths represented close to 7 percent of the world's eared grebe population (Jehl 1996). In 1997, 6,845 species died, and in 1998, 18,140 birds died from such agents as avian cholera, botulism, Newcastle disease, and salmonella. Since 1987, significant die-offs have been recorded almost annually.

WATER QUALITY AND BIOLOGICAL RESOURCES

This section presents information regarding the association of water quality and biological resources in the IID water service area and Salton Sea geographic subregions.

Constituents of Concern. Water quality COCs for biological resources in the IID water service area and Salton Sea are:

- Salinity
- Selenium
- Nitrogen and phosphorus
- Organochlorine insecticides
- Organophosphorus insecticides
- Organochlorine herbicide
- Boron

Salinity. Salinity is primarily a concern for biological resources at the Salton Sea. The current salinity level of the Salton Sea is about 46 grams per liter (g/L). Studies have indicated that many fish and invertebrates in the Sea are at risk from this high level. The Salton Sea Science Subcommittee summarizes the latest information on salinity tolerances of invertebrates and fish from the Salton Sea. Salinity occurrence and tolerance data are presented in Table 3.2-21.

TABLE 3.2-21
Salinity Occurrence and Tolerance Data for Species Inhabiting the Salton Sea

Invertebrates (Scientific/Common Name)	Collection	Life-Stage Survival	Life-Cycle Completion	Population Maintenance
Brachionus plicatilis (rotifer)	76	50	48-50	40
Apocyclops dengizicus (copepod)	75	79	68	51
Cletocamptus deitersi (copepod)	44 [a]	107	80	80
Balanus amphitrite (barnacle)	44 [a]	60	60	50
Nereis succinea (pileworm)	44 [a]	67.5	50	–
Gammarus micronatus (amphipod)	50	57	–	–
Trichlcorixa reticulata (waterboatman)	200	100	–	–
Fish (Scientific/Common Name)				
Cynoscion xanthulus (orangemouth corvina)	44 [a]	57.5	40 [b]	–
Bairdiella icistia (Gulf croaker)	44 [a]	55	55	–
Anisotremus davidsonii (sargo)	44 [a]	52.5	50	–
Oreochromis mossambica (tilapia)	120	70	60 [c]	–
Cyprinodon macularius (desert pupfish)	90	70	70	–
Mugil cephalus (mullet)	80	126	–	–
Poecilia latipinna (sailfin molly)	87	80	–	–
Gillichthys mirabilis (longjaw mudsucker)	82.5	–	75	–

Explanation of columns:
Collection. Refers to the salinity at a site where an organism was collected in nature.
Life-Stage Survival. The maximum salinity, in experimental work, at which one or more life stages of a species can survive for an extended time, but where completion of the entire life cycle has not been established.
Life-Cycle Completion. The maximum salinity, in experimental work, at which completion of a species' entire life cycle has been demonstrated. This salinity theoretically should always be lower than the life stage survival salinity.
Population Maintenance. The maximum salinity, in experimental work, at which population growth has been demonstrated and theoretically should be lower than the life cycle and life stage salinity values.

Notes:
Salinity concentrations in g/L = no data
a: Based on current conditions of Salton Sea.
b: Juvenile corvina have been observed under current conditions 44 g/L. This may indicate either a higher salinity tolerance than previously recorded or successful reproduction is occurring in areas with lower salinity levels.
c: Costa-Pierce and Riedel (2000a)

Source: Salton Sea Science Subcommittee (1999).

The actual response of the organisms to salinity levels in the Salton Sea above the levels shown in Table 3.2-21 is somewhat uncertain for several reasons, including:

- Toxicity studies might not have been conducted on actual Salton Sea fish populations or on fish acclimated to current Salton Sea salinity.
- Temperature, dissolved oxygen, parasitism, toxic substances, and other factors could affect the salinity tolerances of fish.
- The importance and limits of selective forces and genetic adaptation are unknown.
- Laboratory studies on salinity tolerance might not prove applicable to natural conditions.
- Portions of fish life stages could take place in less saline environments outside the Salton Sea (i.e., in drainage canals).

Further, little is known about the interaction of other factors with increased salinity. For example, evidence shows that certain fish die-offs caused by pathogens could be a result of or aggravated by increased salinity (USFWS 1997a and b). Thus, some species could be at risk from other factors at salinities lower than suggested by those presented in Table 3.2-21.

Current salinity levels in the Salton Sea are 46 g/L. Studies have indicated that many fish and invertebrates in the Sea are at risk from this high level. Bairdiella and sargo larvae die at salinity levels starting at 40 g/L (Lasker et al. 1972); adult orangemouth corvina and sargo die at 62.5 g/L (Hanson 1970). Reproductive failure of bairdiella, sargo, and tilapia at 40 g/L is moderately probable, along with declining productivity of pileworms, which reduces food available for bairdiella and young corvina.

Tilapia have a high salinity tolerance. They adapt to high salinity levels, particularly if the increase in salinity is gradual (Phillipart and Ruwet 1982, cited in Costa-Pierce and Riedel 2000a). Tilapia have been collected at a salinity level of 120 g/L, but reproduction has not been reported at this salinity level (Whitfield and Blaber 1979). Costa-Pierce and Riedel (2000a) reviewed reported salinity tolerances of tilapia. Highest growth rates were reported at 14 g/L, but growth was still good and tilapia reproduced at 30 g/L. At 69 g/L, tilapia grew poorly, but reproduced well. In the Salton Sea at about 44 g/L, 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 reproduce at a salinity level of 60 g/L. Above a salinity level of 60 to 70 g/L, growth, survival, and reproduction would decline (Costa-Pierce, pers. comm. January 12, 2001).

In the drains, salinity levels influence the distribution of freshwater emergent plants, such as cattails. Cattails grow best in water with a salinity of less than 3 g/L. Between 3 and 5 g/L, growth of cattails can be stunted; cattails are rare at salinity levels above 5 g/L.

Selenium. Soil derived from parent rocks containing high amounts of selenium is found throughout the west (Seiler et al. 1999). Selenium enters soils, groundwater, and surface waters through irrigation of selenium-bearing soils, selenium-bearing sediments brought in through local drainages, or 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

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through evapotranspiration and flushed into water sources through irrigation practices (Ohlendorf and Skorupa 1989; Seiler et al. 1999). The primary source of selenium in 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 adversely affect reproduction in mammals, 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; Eisler 2000).

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

Early sampling (Rasmussen 1988; Rasmussen and Starrett 1988) identified levels of selenium higher in Salton Sea fish than those 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 3.2-22).

TABLE 3.2-22
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

Notes: Concentrations in wet weight; mg/kg – milligrams per kilogram.
Source: Rasmussen 1997b.

Other early studies on selenium in tissues include the Selenium Verification Study (White et al. 1987), the reconnaissance investigation by the DOI in 1986 and 1987 (Setmire et al. 1990), and a follow-up detailed study by DOI from 1988 to 1990 (Setmire et al. 1993; 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 fish and invertebrates are shown in Tables 3.2-23 and 3.2-24, respectively.

TABLE 3.2-23
Selenium Concentrations in Mosquitofish and Sailfin Molly from the Salton Sea, New and Alamo Rivers and Irrigation Drains, and San Felipe and Salt Creeks, 1988-1990

	Salton Sea			New and Alamo Rivers and Irrigation Drains			San Felipe and Salt Creeks		
	N/DV	GM (µg/g dw)	Range (µg/g dw)	N/DV	GM (µg/g dw)	Range (µg/g dw)	N/DV	GM (µg/g dw)	Range (µg/g dw)
Fish Species									
Bairdiella	5/5	12.9	12.0-16.0	-	-	-	-	-	-
Longjaw mudsucker	1/1	-	6.1	-	-	-	-	-	-
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

Notes: N/DV = number of samples collected per number of samples with detectable values.
Geometric mean (GM) calculated using one-half detection limit when data set has more than 50 percent detectable values.
µg/g dw = microgram per gram dry weight.

Source: Setmire et al. 1993.

Selenium concentrations in most invertebrates were generally below 5 micrograms per gram (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 (Tables 3.2-25 and 3.2-26). Selenium exposure and potential effects in birds can be assessed most directly through the selenium concentrations in eggs (Skorupa and Ohlendorf 1991; DOI 1998). In the detailed study, black-necked stilts were the only species for which eggs were sampled. Stilt eggs had a geometric mean concentration of 4.3 µg/g. Based on Lemly (1996), the geometric mean indicates that risks are low to none for reproductive impairment in black-necked stilts; however, the range of selenium concentrations observed in stilt eggs exceeds 6 µg/g and could impair reproduction. In fact, Bennett (1998) conducted a study that evaluated nesting proficiency in comparison to egg selenium concentrations, and results indicated the species is likely experiencing a low level of selenium-induced reproductive depression at the Salton Sea.

TABLE 3.2-24
Selenium Concentrations in Invertebrates from the Salton Sea, New and Alamo Rivers and Irrigation Drains. 1988-1990

Pelagic Invertebrate Species	Salton Sea			New and Alamo Rivers and Irrigation Drains		
	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	-	-	-

Notes:
–: no data
N/DV" number of samples collected per number of samples with detectable values
Geometric mean (GM) calculated using one-half detection limit when data set has more than 50 percent detectable values
μg/g dw: microgram per gram dry weight

Source: Setmire et al. 1993.

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; 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 millimeter (mm) (median 0.5 μg/g).

To evaluate concentrations of 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 Tables 3.2-25 and 3.2-26. Selenium concentrations in eggs at the Salton Sea were below teratogenesis thresholds (DOI 1998), 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; Setmire et al. 1993).

Studies conducted on Yuma clapper rails (Roberts 1996; USFWS 1994) involved analyses of sediment, crayfish, bird egg, kidney, liver, and whole body samples from salvaged birds for selenium and organochlorines. Samples were taken in the CDFG Wister Wildlife Management Unit when drainwater was used as a water source for managed marshes. Concentrations of selenium from the study are presented in Table 3.2-27.

TABLE 3.2-25
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 Irrigation Drains			
Bird species	**N/DV**	**GM (µg/g dw)**	**Range (µg/g/dw)**	**Estimated egg Concentration (µg/g dw)[1]**	**N/DV**	**GM (µg/g dw)**	**Range (µg/g dw)**	**Estimated Egg Concentration (µg/g dw)[a]**
Migratory Birds								
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	-	-	-	-	-
Listed Birds								
Yuma clapper rail (whole body)	-	-	-	-	1/1	-	4.8	-

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

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TABLE 3.2-26
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	–	–	–
Great egret	9	4.77	3.5-7.1	–	–	–
Gull-billed tern	6	4.1	3.4-5.3	–	–	–

Notes:
–: no data.

Source: Audet et al. 1997.

TABLE 3.2-27
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

Notes:
–: no data
N/DV: number of samples collected per number of samples with detected value.

Source: Roberts 1996.

Nitrogen and Phosphorus. Nitrogen and phosphorus concentrations are high in the Imperial Valley; these elements are the primary components of fertilizers applied to agricultural fields. Although nitrogen and phosphorus are essential for plant growth, an excess of these nutrients can lead to algal blooms and eutrophication (Thiery 1994). Blooms of these organisms are common in the Salton Sea. Excess algal growth can lead to oxygen depletion, which occurs after excessive plant growth, subsequent senescence, and decomposition by bacteria. High-standing stock of algae and enhanced levels of decomposition consume oxygen and produce oxygen deficiencies, particularly in deeper regions of the lake. This lack of oxygen can adversely affect plant and animal communities, including causing large fish die-offs. Studies of the Salton Sea have identified high nutrient levels, high photosynthetic capacity and oxygen production in surface waters, and high decomposition rates with oxygen depletion at depths (Thiery 1994; Setmire 1984; Anderson and Amrhein 1999; Holdren 1999; Reclamation 1970).

Concerns about these nutrients relate to eutrophication and its relation to potentially toxic species of algae in the Sea, disease outbreaks, and dissolved oxygen depletion in the Sea. Nutrient stimulation has been implicated in causing blooms of green and blue-green algae in the Sea (Thiery 1994). Both may be added to the river and drain systems (and eventually to the Sea) through agricultural drainage.

Organochlorine Insecticides. DDT and its metabolites persist in the environment and, although banned in the U.S. in the 1970s, remain in the environment on agricultural land. They are in the Imperial Valley and, through mobilization by irrigation water, are carried into surface drainage systems (Setmire et al. 1993). DDT and its metabolites, DDD and DDE, are also in sediments in drains and rivers and mobilize during turbulent flows. DDT also enters the Imperial Valley through irrigation drainwater from Mexico via the New and Alamo Rivers. Agricultural fields, irrigation drains, the New and Alamo Rivers, and the Salton Sea are sources of biological uptake of DDT and its metabolites, primarily DDE (IID 1994). Studies show high concentrations of DDT-related compounds in the Imperial Valley and Salton Sea (Audet et al. 1997; Setmire et al. 1993; Rasmussen 1997a, 1997b).

The toxicity and accumulation of DDT and its metabolites are of primary concern for birds. DDT has long been identified to cause reproductive failure in many species. DDT and DDE have been associated with eggshell thinning and reduced reproductive success (Mendenhall et al. 1983; Henny et al. 1984; Gress 1973; Ohlendorf and Marois 1990). DDT and its metabolites are especially problematic for birds that forage high on the food chain and are subject to bioaccumulation and biomagnification (Blus 1996). Birds that feed on fish or other birds have higher tissue residues than birds that feed on vegetation or seeds, and DDE is more common than DDT or DDD in bird tissues (DOI 1998). Toxic effects of DDT poisoning in birds include reproductive impairment, reduced fledgling success, eggshell thinning, and death when levels are high.

Toxaphene is toxic to some aquatic organisms, particularly fish. It can impair reproduction and reduce embryo vitality in fish at low concentrations and produce debilitating diseases at higher levels. It is less harmful to birds than it is to fish (Eisler 2000; TOXNET 2000).

Organochlorine concentrations in biota in the IID water service area, AAC, and Salton Sea were measured in many of the same studies that evaluated selenium concentrations. The most recent toxaphene and DDT data from five sites sampled along the New and Alamo Rivers and at the Salton Sea are presented in Table 3.2-28.

In a detailed water quality study of the drains (Setmire et al. 1993; Schroeder et al. 1993), organochlorine concentrations were generally below detection limits (0.01 μg/g ww for most chemicals; 0.05 μg/g ww for PCBs and toxaphene), except for DDE. Aquatic invertebrates from rivers and drains had higher concentrations of p-p'-DDE than invertebrates in the Salton Sea. In general, DDT metabolite concentrations in clams from rivers and drains ranged from 0.16 to 0.47 μg/g dw. Bioaccumulation tests of clams in Imperial Valley drains showed that DDE exposure corresponded to increased drainwater flows during late winter to early spring peak irrigation periods. Exposure occurs as sediment-borne DDT metabolites are transported with tailwater runoff or resuspended from sediment in drains and rivers. Rivers were observed to have higher potential for DDT metabolite exposure than drains, and rivers also have higher suspended sediment loads and higher sediment DDE concentration than drains.

TABLE 3.2-28
Organochlorine Insecticide Concentrations in Freshwater and Marine Fish

Station No.	Station Name	Species (Common/ Scientific Name)	Tissue	Sample Date	p-p' DDE ppb	Total DDT ppb	Diazinon ppb	Toxaphene ppb
723.10.01	Alamo River, Calipatria	Channel catfish *Ictalurus punctatus*	Fillet	11/20/97	2,500	2,621	<50.0	340.0
723.10.02	New River, Westmorland	Channel catfish *Ictalurus punctatus*	Fillet	11/20/97	450.0	482.0	<50.0	340.0
723.10.58	New River, International Boundary	Carp *Cyprinus carpio*	Fillet	12/10/97	60.0	80.0	<50.0	<100.0
728.00.90	Salton Sea, South	Tilapia *Tilapia* sp.	Fillet	11/20/97	31.0	31.0	<50.0	<100.0
728.00.92	Salton Sea, North	Orangemouth corvina *Cynoscion xanthulus*	Fillet	11/18/97	<10.0	190.0	<50.0	<100.0

Source: Rasmussen 1997b.

Concentrations of DDE in mosquitofish in IID water service area river and drain sites were higher than concentrations in fish collected from other locations in California and nationwide, but they were still below levels known to adversely affect fish. Concentrations of DDE in fish from the Salton Sea were generally low. Concentrations of p-p'-DDE suggested that waterfowl and other aquatic species using drains and rivers could be exposed to higher levels of DDT metabolites than birds that primarily forage at Salton Sea (Table 3.2-29). Birds foraging in agricultural fields had some of the highest detected DDE concentrations in liver and fat tissue of the birds studied. White-faced ibis that winter in the Imperial Valley and forage in agricultural fields had DDE liver concentrations of 5.93 μg/g ww and fat concentrations of 5.57 μg/g ww (Setmire et al. 1993).

Audet et al. (1997) determined the p-p'-DDE concentrations in bird eggs and livers from waterbird nesting colonies or adjacent areas at the Salton Sea (Table 3.2-30). Eggshell samples were in the range known to cause thinning (0.26 to 66 mg/kg ww in piscivores and 0.25 to 20 mg/kg ww in omnivores). Fish samples were within the range of earlier studies, and higher concentrations were found in fish from rivers and drains than in those from the Salton Sea (Setmire et al. 1993).

Ohlendorf and Marois (1990) measured organochlorine concentrations in black-crowned night heron and great egret eggs collected at the Salton Sea from 1982 to 1985. Most (70 percent) of those eggs contained DDE concentrations exceeding 8 μg/g ww. The level of thinning for night-heron eggshells approached levels that have been associated with reduced reproductive success, but no significant eggshell thinning was reported for egret eggs (snowy and great combined).

TABLE 3.2-29
1986-1990 p-p'-DDE Concentrations in Aquatic Birds

	Salton Sea			New and Alamo Rivers and IID Drains		
	N/DV	GM (µg/g ww)	Range (µg/g ww)	N/DV	GM (µg/g ww)	Range (µg/g ww)
Migratory Birds						
Eared grebe (muscle)	5/5	0.28	0.17-1.10	–	–	–
Northern shoveler (muscle)	–	–	–	6/6	0.55	0.17-2.10
Ruddy duck (muscle)	30/30	0.26	0.096-1.50	–	–	–
White-faced ibis (fat)	–	–	–	9/9	5.57	3.70-11.0
White-faced ibis (liver)	–	–	–	9/9	5.93	3.10-9.60
Resident Birds						
American coot (liver)	–	–	–	3/3	0.014	0.01-0.03
American coot (muscle)	–	–	–	4/4	0.22	0.09-0.45
Barn owl (muscle)	–	–	–	1/1	–	2.7
Black-necked stilt (egg)	84/84	2.54	0.05-12.0	–	–	–
Black-necked stilt (carcass)	38/38	0.69	0.02-2.76	–	–	–
Cattle egret	–	–	–	2/2	2.3	2.20-2.40
Double-crested cormorant (muscle)	3/3	1.13	0.38-4.90	–	–	–
Great blue heron (muscle)	–	–	–	1/1	–	13.0
Herring gull	1/1	–	2.80	–	–	–

Notes:

ww: wet weight.
N/DV: number of collected samples per samples with detectable values.
GM: geometric mean (calculated using one-half detection limit when data set had more than 50 percent detectable values).
-: no data.

Source: Setmire et al. 1993.

Embryo malformations were observed in 5 of the 17 embryos that were examined for malformations, and signs of embryo toxicity were observed in an additional. This indicates a malformation rate of 29 percent, which exceeds the typical incidence of embryo

malformations (Bennett 1998). The causative agents for this elevated incidence of teratogenesis could not be identified, but were consistent with DDE contamination.

Organophosphorus Insecticides. Like DDT, diazinon and chlorpyrifos were first introduced to the Imperial Valley as agricultural insecticides. Although organophosphorus insecticides are less persistent than organochlorines, sediments could retain these toxic compounds. Chlorpyrifos has a large molecular weight and density and is likely to settle in sediments and persist in the soil. The organophosphates are transported to the Salton Sea through irrigation drain channels.

TABLE 3.2-30
1991 p-p'-DDE Concentrations in Salton Sea Bird Eggs and Livers

	Egg Samples			Liver Samples		
Species	**N**	**GM (μg/g)**	**Range (μg/g)**	**N**	**GM (μg/g)**	**Range (μg/g)**
Double-crested cormorant	–	–	–	6	2.47	0.49-11
Great blue heron	4	5.78	2.6-10	10	1.89	0.28-25
Black-crowned night heron	3	2.34	1.7-3.6	4	14.02	7.8-33
White pelican	–	–	–	6	5.43	1.3-35
Black skimmer	12	4.9	1.8-16.4	–	–	–
Cattle egret	3	2.81	1.6-4.8	–	–	–
Great egret	9	8.36	0.86-31	–	–	–
Gull-billed tern	6	1.32	0.54-2.8	–	–	–

Notes: concentrations in wet weight
-: no data
N=4 where 4 represents the number of organisms sampled.

Source: Audet et al. 1997.

Diazinon is acutely toxic to terrestrial invertebrates and is used widely as an insecticide; effects on aquatic invertebrates are less known, but many toxicity thresholds have been demonstrated (TOXNET 2000). Diazinon can be toxic to birds. Data on teratogenic effects from chronic exposure are less conclusive, but studies have identified effects (TOXNET 2000). Chronic and acute toxicity to aquatic organisms, including aquatic invertebrates, is the primary concern related to organophosphorus compounds in the Project area (De Vlaming et al. 2000).

Diazinon and chlorpyrifos are used by farmers in the IID water service area and could appear in the drains, in rivers, or at the Sea. Although recent studies have not found these compounds in Salton Sea and river sediments (Levine-Fricke 1999b; Vogle et al. 1999), chlorphyrifos has been found in fish tissue from the New and Alamo Rivers as part of the Toxic Substances Monitoring Program (TSMP).

Organochlorine Herbicides. Organochlorine herbicides are typically used to limit the growth of annual grasses and broadleaf weed species in vegetable crops. Irrigation can mobilize organochlorine herbicides, depositing them in surface drainage systems. Organochlorine herbicides are often found in fish from the Imperial Valley (Rasmussen 1997a, 1997b).

Dacthal is used as a herbicide in the IID water service area. Dacthal has been detected in fish tissue from the New and Alamo Rivers; the Peach Drain, Barbara Worth Drain, Greeson Drain, and Reservoir Main South Drain; and the south end of the Salton Sea (Table 3.2-31). Recent studies have not found Dacthal in Salton Sea and river sediments (Levine-Fricke 1999b; Vogle et al. 1999). Dacthal toxicity to animals is considered low by the EPA. However, toxicological concerns do arise for mammals exposed to high levels. Chronic exposure has been shown to alter adrenal weights of female rats and kidney weights in male rats, but it did not pose a threat to reproductive ability (TOXNET 2000).

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TABLE 3.2-31
1992-1995 Chlorpyrifos and Dacthal Concentrations in Fish Tissue from IID Drains, New and Alamo Rivers, and the Salton Sea

Water Body	Chlorpyrifos (ppb, ww)	Dacthal (ppb, ww)
Peach Drain	ND	5,500
Barbara Worth Drain	ND	5
Greeson Drain	ND	27,740
Reservoir Main Drain	ND	6.2
Alamo River	27-230	9.7-4,000
New River	28-130	7.6-4,100
Salton Sea	ND	5.2-7.6

Note: ND: not detected
Source: Rasmussen 1995, 1997a

Boron. Boron is an essential micronutrient for higher plants. Though beneficial in small quantities, boron in elevated concentrations can adversely affect organisms. At increased levels, boron can affect reproduction and fish survival. In waterbirds, high concentrations of boron lead to abnormal growth rates and can act as a potent teratogen if an embryo is exposed during its first 96 hours of development (Eisler 2000).

Results from the investigations on boron in tissue samples from invertebrates in the Project area are presented in Table 3.2-32. The highest levels of boron in aquatic invertebrates were detected in pileworms in the Salton Sea (up to 160 μg/g dw). Waterboatmen concentrations were comparable to background concentrations detected elsewhere (10 μg/g dw) (Setmire et al. 1993). A typical waterbird diet sample, consisting of pileworms, amphipods, and waterboatmen, had a concentration of 20 μg/g dw (IID 1994). This is less than the level of concern for waterfowl diet (greater than 30 μg/g dw) (Reclamation 1998). The highest dissolved boron concentration detected in Imperial Valley surface water was 11 mg /L. This level is lower than concentrations shown to cause chronic effects in invertebrates but is higher than the no-effect level reported for invertebrates and fish.

Boron concentrations in fish from the Salton Sea, such as bairdiella, were 5.0 to 8.3 μg/g dw; freshwater fish from rivers and drains had boron concentrations in the same range as Salton Sea species. Effects levels for boron in fish are unknown (Setmire et al. 1993; Reclamation 1998). Boron concentrations in birds were reported up to 52 μg/g dw for livers of resident waterbirds (Setmire et al. 1990). Liver samples in brown pelicans had a geometric mean of 1.41 μg/g dw, with a maximum of 5.92 μg/g dw. Liver samples in white pelicans had a geometric mean of 2.16 μg/g dw, with a maximum of 3.63 μg/g dw (Roberts 1997). These levels are below known thresholds for adverse or toxic effects (Reclamation 1998).

Overall, little evidence indicates that boron concentrations reach levels that would adversely affect IID aquatic habitats outside the Salton Sea. Studies have identified concentrations that could cause sublethal effects, but these concentrations appeared to be temporary (Setmire et al. 1990), and no adverse effects have been documented in birds from IID water service area agricultural areas (Schroeder et al. 1993; Setmire et al. 1993).

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TABLE 3.2-32
Boron Concentrations in Invertebrates from the Salton Sea, New and Alamo Rivers, and Irrigation Drains, 1986-1990

	Salton Sea			New and Alamo Rivers and IID Drains		
Species	**N/DV**	**GM (µg/g dw)**	**Range (µg/g dw)**	**N/DV**	**GM (µg/g dw)**	**Range (µg/g dw)**
Asiatic river clam	–	–	–	5/0	–	<29.2
Crayfish	–	–	–	2/0	–	<23.9
Waterboatman and amphipod composite	1/1	–	21.0	–	–	–
Waterboatman, amphipod, and pileworm composite	1/1	–	20.0	–	–	–
Pileworm	8/7	70.2	22-160	–	–	–
Waterboatman	3/1	–	10	–	–	–

Notes:

dw: dry weight
N/DV: number of collected samples per samples with detectable values
GM: geometric mean (calculated using one-half detection limit when data set had more than 50 percent detectable values)
-: no data

Source: Setmire et al. 1993.

Food-Chain Pathways of Toxic Compounds. Waterborne constituents are of concern mainly because they bioaccumulate in organisms. This occurs through either bioconcentration (the direct uptake of dissolved compounds across respiratory and epithelial membranes by passive or active mechanisms) or bioaccumulation (a more general term that also includes uptake through food). Biomagnification occurs when higher trophic-level organisms

accumulate progressively higher concentrations of compounds by ingesting and assimilating them through lower-trophic-level organisms (Maier et al. 1988). Tissue concentrations for some compounds (such as DDT) increase with each higher food-chain level, and high trophic-level consumers have concentrations of toxic compounds many times higher than those of primary producers. Consequently, high trophic-level consumers are more likely to show deleterious effects. Top predators, such as herons, egrets, or birds of prey, are most at risk.

Selenium, boron, and organochlorine insecticides, including DDT and its metabolites, bioaccumulate. Food-chain relationships and toxic contaminants in the Imperial Valley vary, according to habitat and contaminant. In general, the potential for accumulation of selenium is great in the Salton Sea and in IID water service area drains, rivers, and wetlands. The potential for elevated boron is low in IID water service area aquatic habitats but higher in the Salton Sea.

Trophic relationships for species using rivers and drains in IID water service area are presented in Figure 3.2-12. Selenium and other toxic compounds enter the food chain through the water, and they are first incorporated into lower trophic levels, such as plants and invertebrates, including phytoplankton and zooplankton. Larger invertebrates, such as waterboatman, forage on plankton. Filter-feeding invertebrates, such as clams, feed on

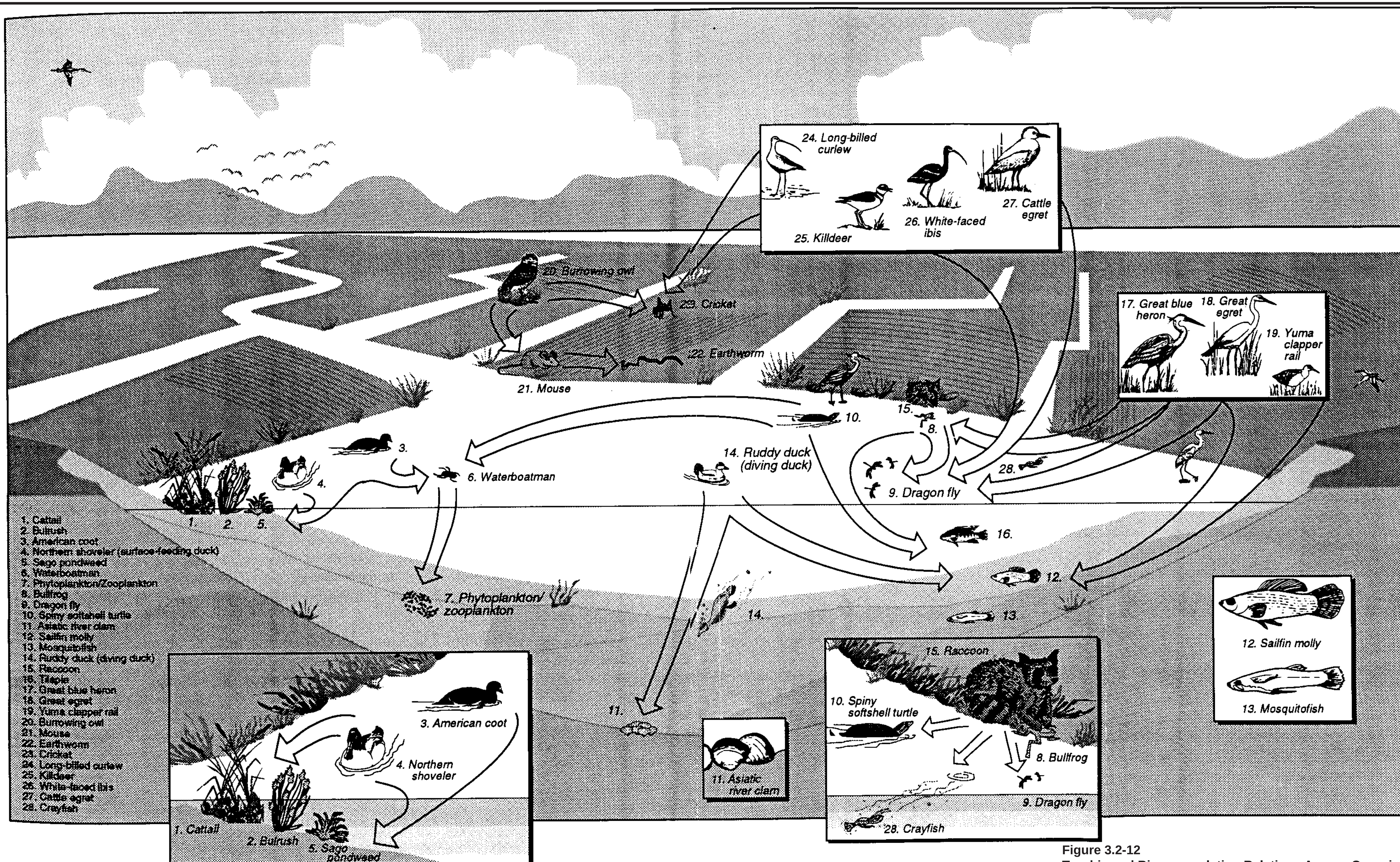

Figure 3.2-12
Trophic and Bioaccumulation Relations Among Organisms of Rivers and Drains in the Imperial Valley
(Source: Setmire et al, 1993)
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155202.08.02•Figure 3.2-12• 10-9-02•SFO•ccc plankton and likely concentrate selenium. Amphibians and fish that forage on aquatic invertebrates represent the next step along the biological pathway. Ducks, egrets, herons, grebes, and other species foraging on fish and amphibians represent the following step and have the greatest exposure to bioaccumulated compounds.

Trophic relationships for the Salton Sea are presented on Figure 3.2-13. Toxic compounds enter the food chain through the water and are incorporated into plants and invertebrates, including phytoplankton and zooplankton. Although larval tilapia and bairdiella forage on zooplankton, the lack of an effective planktivorous fish in the Salton Sea means that most energy must flow through the benthos. Pileworms are the primary detritivores and represent the next major step in bioaccumulation of toxic compounds. Adult fish and waterbirds forage on pileworms; piscivorous birds, generally highest on the food chain, are susceptible to risks from toxic compounds. Another food-chain pathway with bioaccumulation risks consists of phytoplankton, zooplankton, and other invertebrates, which are then eaten by ducks, shorebirds, and other waders. These species, in turn, could be eaten by birds of prey, such as peregrine falcon.

Potential Role of Water Quality in Fish and Avian Disease. Disease outbreaks in fish and birds at the Salton Sea have focused attention on the condition of this ecosystem, with special attention to the role of water quality in disease outbreaks (Bruehler and de Peyster 1999; Rocke 1999; Roberts 1997; Carmichael 1999). High selenium levels, high concentrations of nutrients resulting in eutrophication and algal blooms, and increasing salinity have been suggested as possible contributors to epizootic events at the Salton Sea. Research is ongoing, and many causes of disease outbreaks at the Salton Sea remain unknown. This section summarizes recent research and suspected causes.

Fish kills are common at the Salton Sea, often involving hundreds of thousands of fish. Fish kills of tilapia, Gulf croakers, and corvina have been recorded in conditions of large algal blooms, low dissolved oxygen, and high ammonia readings (USFWS 1998A, 1999b, 1997b). These conditions are characteristic of a eutrophic system, with high nitrogen and phosphorus loading (Thiery 1994; Setmire 1984; Anderson and Amrhein 1999; Holdren 1999).

Diseases can also cause fish kills. During a September 1997 fish kill involving more than 1 million tilapia, sick and freshly killed fish were infested with a lethal parasite. The parasite, known as *Amyloodinium ocellatum*, is found worldwide and infects marine fish. In wild fish, the numbers of parasites per fish are typically low, and infections are not lethal. When present in high levels, the parasite impairs respiratory function and can suffocate fish. High temperatures and high salinities, such as those present at the Salton Sea in summer months, are optimal for this parasite. Under these conditions, the parasite can reach high levels rapidly (USFWS 1997a).

In 1996, a severe avian botulism (Type C) outbreak killed more than 14,000 pelicans and other fish-eating birds (USFWS 1996b). Large fish kills coincided with this event, and both live and dead tilapia collected during the event tested positive for avian botulism. Fish collected during this event and additional events in 1997 also had gross external and internal signs of bacterial septicemia; tissue cultures indicated infections with one or more of the following bacteria: *Vibrio alginolyticus, V. Vulnificus, V. Damsela*, *Pseudomonas putrefaciens*, and a *Bacillus* species (USFWS 1997a, 1997b). Bacteria of the genus *Vibrio* are common marine fish pathogens

(USFWS 1997b) and are potential avian or human pathogens (Rocke 1999). At least one of these fish kills was associated with a large algal bloom; pollution, overcrowding, high temperatures, and high salinity could have contributed (USFWS 1996b).

Selenium has been investigated as a contributor in the pelican die-off of 1996. Chronic contaminant exposure can result in immune suppression and increase susceptibility to disease (Fairbrother and Fowles 1990; Peterle 1991; Bobker 1993). Birds and fish suffering from selenium-induced immune dysfunction are hypersensitive to pathogen challenges (USFWS unpublished data; Larsen et al. 1997). Bruehler and de Peyster (1999) and Roberts (1997) evaluated levels of selenium and other contaminants in pelicans collected during the 1996 die-off event. In both studies, selenium concentrations in livers were elevated, and Bruehler and de Peyster found concentrations significantly higher than levels in control birds from Sea World. Selenium also could have contributed to immune suppression in

Salton Sea fish, leaving them hypersensitive to the *Vibrio* bacterial attacks and facilitating the fish-mediated pathway for the avian botulism outbreak (USFWS unpublished data).

Between January and March 1992, an estimated 145,000 eared grebes died from an undetermined cause at the Salton Sea, representing the largest documented epizootic event in eared grebes and killing about 10 percent of the North American population (Jehl 1996; Rocke 1999). In 1994, 1995, and 1997, similar but smaller-scale mortality events were reported. Despite efforts to identify a responsible agent, the cause of this event remains unknown. Present research focuses on algal biotoxins. Preliminary results from eared grebe tissues collected during the events identified microcystins produced by cyanobacteria; additional information suggests that a toxin produced from a nannoplankton could also be present. Increased nutrient loading and consequent algal blooms have been suggested as a possible contributor (Carmichael 1999). Several algal species are abundant during the winter when grebe mortality takes place. This includes organisms from at least four genera (*Heterocapsa*, *Gyrodinium*, *Gonyaulax*, and *Gymnodinium*) that are toxic to other microorganisms, bivalves, birds, or marine mammals (Dexter et al. 1999). In 1994, a large plankton bloom occurred at the south end of the Salton Sea; species of *Gonyaulax* and possibly *Gyrodinium* or *Gymnodinium* were present, and extracts of the mixture were toxic in a mouse bioassay. The rapidophyte *Chattonella marina* has also been identified in the Salton Sea and was determined to be associated with a conspicuous “green tide.” This species has caused major fish kills in Japan, and studies indicate that it produces neurotoxins and other compounds potentially lethal to fish (Dexter et al. 1999). Selenium levels could play a role in toxic algal blooms (Imai et al. 1996).

3.2.3.3 SDCWA Service Area

The following narrative summarizes biological resources found in the SDCWA water service area. The information is based on data compiled from four City and County of San Diego habitat conservation programs (SANDAG 1998). Data were compiled in support of the Multiple Habitat Conservation Program (MHCP), MSCP, MSCP North County Subarea, and the Multiple Habitat Conservation and Open Space Program (MHOCSP). Areas covered by the programs include all of San Diego County (except for the Marine Corps Air Station at Miramar and the Marine Corps Base Camp at Pendleton). Biological resources information compiled for the MHCP is current as of 1998 and covered 78 percent of San Diego County. Areas not mapped primarily consist of desert habitats in the eastern third of

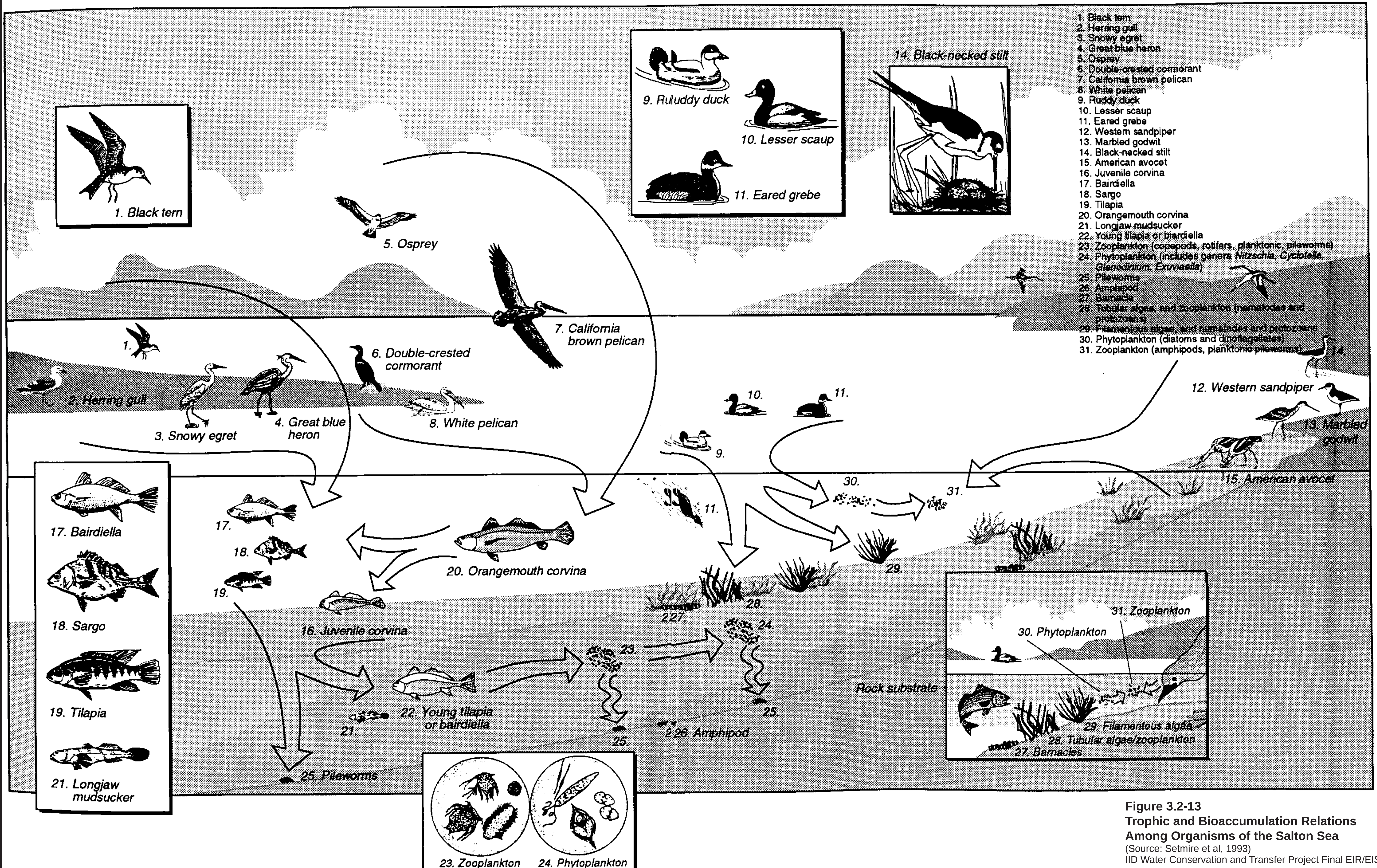

Figure 3.2-13
Trophic and Bioaccumulation Relations Among Organisms of the Salton Sea
(Source: Setmire et al, 1993)
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the county. The SDCWA service area covers San Diego County; therefore, the information correlates to the SDCWA service area and is used for this analysis.

San Diego County encompasses biologically diverse environments, attributable to the variety of regional soil types, topography, and climates. Of the approximately 2.1 million acres of land mapped for the MHCP, approximately 1.6 million acres are natural habitat. Although the majority of San Diego County remains in natural habitat, development has led to habitat loss, primarily in the western portion of the County. In addition to habitat loss, development patterns have fragmented natural areas in the County. The effects of development on habitat are addressed as part of the habitat conservation programs.

Habitats within San Diego County support numerous federal- and state-listed (and proposed) endangered / threatened species.

General habitat types include desert communities, montane and riparian forests, foothill chaparral and scrub communities, coastal scrub communities, lagoons, estuaries, and beaches. Lands in agricultural production are considered non-natural habitat for this analysis. General vegetation in the natural habitats is shown in Table 3.2-33.

The majority of the natural vegetation in the County is chaparral (approximately 50 percent), consisting mostly of southern and northern mixed chaparral communities. Chaparral communities serve as secondary and foraging habitats for species associated with coastal sage scrub communities.

Other major habitat types in the habitat conservation area include coastal sage scrub (approximately 15 percent), grasslands (approximately 9 percent), desert scrub (approximately 8 percent, but likely to be underestimated because of incomplete mapping in 1998), and woodlands (approximately 8 percent). Coastal sage scrub communities provide habitat for many of the endangered and threatened species in the County, including the federally listed California gnatcatcher (*Polioptila californica*). It is estimated that 90 percent of the coastal sage scrub habitat in San Diego County has been removed by development. County grassland communities are mostly non-native (44 percent), but approximately 39 percent are native, with the remainder being unidentified or mixed habitats. Grasslands provide foraging areas for raptors. Woodland habitats consist mostly of coast live oak and Engelmann oak woodlands.

Other habitat types making up 5 percent or less each of the natural habitats include forests, riparian forests, meadows and seeps, and riparian scrub. A small amount (less than 1 percent each) of the natural habitats in the County are coastal and desert dunes, marshes, riparian woodland, marine and bay vegetation, estuaries and beaches, and freshwater and wetland vegetation.

Land ownership in San Diego County is primarily private and federal ownership. For all ownership categories, the majority of lands are natural habitats. The land ownership mix might contribute to the majority of lands remaining in natural habitat within the County. The majority of state and federal agencies owning land have a conservation function and will likely preserve natural habitat. Private lands might be subject to future development. Except for beach and other marine-related habitats, generalized vegetation types are roughly equally divided between public and private ownership.

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TABLE 3.2-33
Generalized San Diego Region Vegetation

Generalized Vegetation Type	Acres	Percent of Total	Percent of Natural Habitats
Coastal and Desert Dunes	1,517	0.1	0.1
Coastal Sage Scrub	234,070	11.0	14.6
Desert Scrub	122,655	5.8	7.7
Chaparral	795,354	37.4	49.7
Grasslands	148,623	7.0	9.3
Meadows and Seeps	17,259	0.8	1.1
Marshes	6,870	0.3	0.4
Riparian Forest	32,548	1.5	2.0
Riparian Woodland	8,285	0.4	0.5
Riparian Scrub	16,748	0.8	1.0
Woodlands	123,122	5.8	7.7
Forests	77,636	3.7	4.8
Marine and Bay	199	<0.1	<0.01
Estuaries and Beaches	2,484	0.1	0.2
Freshwater and Wetlands	14,130	0.7	0.9
Natural Habitats	1,601,501	75.3	100.0
Non-Natural Habitats [a]	524,814	24.7	N/A
Total	**2,126,315**	**100.0**	**N/A**

[a] Includes developed, agricultural, and disturbed land.
Note: Figures pertain only to the 2.1 million acres of the San Diego region mapped to date.
Source: SANDAG 1998.

From 1990 to 1995, a decrease of 0.5 percent of natural habitats and an increase of 1.5 percent of non-natural habitats were estimated. Of the generalized habitat types, the greatest decrease occurred for riparian forest and riparian woodland communities (approximately 3 percent each of the vegetation community types). The greatest increase occurred in freshwater and wetland habitats (approximately 6 percent of the total vegetation community type). Indicated by the varied vegetation types in private ownership, it is likely that losses might occur for a range of communities. However, as discussed previously, the purpose of the habitat conservation programs is to minimize loss of natural habitats for developable land ownership categories.

3.2.4 Impacts and Mitigation

This section describes the methodology for assessing project impacts and addresses the impacts associated with the Proposed Project and Alternatives for the four geographic areas (the LCR, the IID water service area and the AAC, the Salton Sea, and the SDCWA service area). Mitigation is identified for impacts determined to be significant.

3.2.4.1 Methodology

LOWER COLORADO RIVER

The environmental baseline for this LCR assessment includes the effects of past and ongoing human and natural factors leading to the current status of biological resources in the LCR. This baseline also includes existing facilities, ongoing operations and maintenance activities, the existing extent of land cover types, and the existing species abundance and distribution.

Under the IID water conservation and transfer agreement, water now diverted from the LCR at Imperial Dam by IID would be reduced. MWD would continue to divert an equivalent volume of water at the Whitsett intake behind Parker Dam. The intake is an existing structure, and the volume of water to be diverted to account for the transfer is within the range of diversion volumes at this point over the past several decades. Therefore, no additional water will be transported to the Coastal Plain of Southern California through the CRA.

Operations of the Whitsett Intake and CRA will continue at historic levels or slightly less as they have since the 1960s with implementation of the transfer project, and therefore would be unchanged from baseline conditions. For CEQA, the baseline is defined as the physical conditions at the time the Notice of Preparation is published. Therefore, these physical structures and diversion volume represent baseline conditions, and this assessment focuses on potential biological effects on the LCR between Parker Dam and Imperial Dam in which physical changes from Baseline conditions could occur. Analysis of these potential changes is based on predicting possible changes in water surface elevations that could occur with implementation of the transfer. This approach to the baseline also is consistent with Reclamation's Baseline definition for the Interim Surplus Criteria, Biological Assessment, and the resulting USFWS Biological Opinion.

Historically, the CRA has transported up to 1.3 MAF of Colorado River water each year into Southern California. Implementation of the transfer would change only the source from which the Colorado River water is derived. Historically, the water in the CRA has consisted of some combination of MWD's basic apportionment, water from a conservation agreement with IID, any unused higher priority agricultural water in California, unused apportionment from Arizona and Nevada, and surplus water. Under the water conservation transfer program (and related lining actions), the CRA will continue to transport the same amount of Colorado River water each year, with a greater proportion of that water coming from conservation.

Reclamation evaluated impacts to biological resources along the LCR in its Biological Assessment for the Interim Surplus Criteria, Secretarial Implementation Agreements, Water Administration, and Conservation Measures on the LCR, Lake Mead to the Southerly International Boundary (Reclamation 2000). This analysis and the resultant Biological Opinion for that project issued by the USFWS (2001) are the basis for the impact evaluation for biological resources along the LCR for this project.

Potential impacts to the biological resources in the LCR relate to the change in the point of diversion of water that would reduce flows in the River between Parker and Imperial Dams. A hydrologic model (the Colorado River Simulation System [CRSS]) developed by Reclamation for the LCR was used to assess impacts to biological resources in the Project area. Reclamation's model addressed the potential transfer of 1.574 MAFY (one of the covered actions to be included in the LCR Multi-Species Conservation Program [MSCP]), of which 400 KAFY was included in the IA analysis. The IA would change the point of diversion from Imperial Dam to Parker Dam for up to 400 KAFY. Additional projects covered under the MSCP change the point of diversion for 1.574 MAFY, including the 400 KAFY under the IA.

The assessment of potential effects on biological resources covers a wide variety of habitat types and the species that rely on that habitat for feeding, cover, nesting, breeding, and rearing young. Federal and state special-status species are addressed using this habitat-based approach as well, under the premise that if the underlying habitat is protected or mitigated for sensitive species, potential impacts on more common species and general habitat conditions will be avoided and mitigated as well. Exhaustive evaluation of water surface elevation effects on every individual species encountered in the LCR subregion has therefore not been performed, and is not needed to reach meaningful conclusions regarding potential impacts.

Wildlife and Wildlife Habitat

Riparian Habitat. Using the model described previously, Reclamation modeled the effect of a change in the point of diversion for 1.574 MAFY. Under the IA, up to 400 KAFY of water would be transferred. Reclamation (2000) estimated the changes in cottonwood-willow vegetation for a change in the point of diversion for 400 KAFY, 300 KAFY, and 200 KAFY. To estimate the effects of these increments from the model that considered a change in point of diversion for 1.574 MAFY, the changes in river surface elevation, groundwater elevation, and vegetation responses were assumed to be proportional to the amount of water transferred. For Alternatives 2 and 3, under which 130 KAFY and 230 KAFY, respectively, would be conserved by the IID water service area, changes in cottonwood-willow vegetation were estimated by assuming a linear relationship between the acreage affected and amount of water transferred.

Backwaters and Marshes. A reduction in river flow can directly and indirectly affect the quantity and quality of available aquatic and terrestrial habitat associated with backwaters. For backwaters connected to the River by open water, a drop in water surface elevation in the River will drop the water surface elevation of the backwater and subsequently reduce the acreage of aquatic habitat. Perimeter vegetation supported by the inundated feature also could be affected. For backwaters without an open connection to the River, the drop in River water surface elevation can drop groundwater elevation that is assumed to supply the water source to the isolated backwater.

Reclamation estimated potential impacts to backwater and marsh (i.e., acreage loss and impact to vegetation) for a change in the point of diversion for 400 KAFY, 300 KAFY, and 200 KAFY by assuming that the amount of backwater habitat affected was linearly related to the amount of water transferred, based on the results for transfer of 1.574 MAFY. For Alternatives 2 and 3, under which 130 KAFY and 230 KAFY, respectively, would be conserved by IID, changes in backwater and marsh habitat were estimated by assuming a linear relationship between acreage affected and amount of water transferred.

Special-status Wildlife Species. As part of its Biological Assessment, Reclamation (2000) evaluated the potential impact to special-status wildlife species from the habitat losses predicted by the model. The analysis was based on recorded occurrence data for the species and known habitat associations. For the Proposed Project and Alternatives, the magnitude of the response of wildlife populations was assumed to be directly proportional to the changes in vegetation communities. Reclamation's analysis focused on federally-listed species. For this Project, impacts to state-listed species and species of concern also are considered. Impacts to species not addressed in Reclamation's analysis were evaluated, based on the habitat associations for these species (Table 3.2-34).

TABLE 3.2-34

Primary Association and Use of Vegetation Communities by Selected Wildlife Species in the Study Area

Common Name	Habitat Association	Habitat Use	Federal Status	California Status	Arizona Wildlife of Concern
Arizona Bell's vireo	Cottonwood-willow/early successional	Nesting		CE	
Yuma hispid cotton rat	Cottonwood-willow/early successional	Year-round		SC	
Colorado River hispid cotton rat	Cottonwood-willow/early successional	Year-round		SC	
Southwestern willow flycatcher	Cottonwood-willow/mid-successional, salt cedar	Nesting	FE	CE	
willow flycatcher	Cottonwood-willow/mid-successional	Nesting		CE	
brown crested flycatcher	Cottonwood-willow/mature	Nesting		SC	
Common black-hawk	Cottonwood-willow/mature	Nesting			X
Harris hawk	Cottonwood-willow	Nesting		CSC	
Cooper's hawk	Cottonwood-willow/mature	Nesting		SC	
elf owl	Cottonwood-willow/mature	Nesting		CE	
Gila woodpecker	Cottonwood-willow/mature	Nesting		CE	
Gilded northern flicker	Cottonwood-willow/mature	Nesting		CE	
Long-eared owl	Cottonwood-willow/mature or salt cedar (*Athel* spp)/tall	Nesting		SC	

TABLE 3.2-34

Primary Association and Use of Vegetation Communities by Selected Wildlife Species in the Study Area

Common Name	Habitat Association	Habitat Use	Federal Status	California Status	Arizona Wildlife of Concern
Mississippi kite	Cottonwood-willow/mature or salt cedar(*Athel* spp)/tall	Summer migrant and visitor			X
Summer tanager	Cottonwood-willow	Nesting		SC	
Yellow warbler	Cottonwood-willow/early to mid-successional	Nesting		SC	
Vermilion flycatcher	Cottonwood-willow/mature	Nesting		SC	
Western yellow-billed cuckoo	Cottonwood-willow/mature	Nesting	C	CE	
Red bat	Cottonwood-willow	Breeding			X
Belted kingfisher	Backwaters	Nesting/ winter foraging			X
California brown pelican	Backwaters	Migration and winter	FE	CE; Fully protected	
Bald eagle	Backwaters	Breeding, wintering	FT	CE; Fully protected (Southern Bald Eagle)	
Bonytail chub	Backwaters	All life stages	FE	CE	
Flannelmouth sucker	Backwaters	All life stages			X
Razorback sucker	Backwaters	All life stages	FE, CH desig-nated	CE; Fully protected	
Colorado River pupfish	Springs and marshes	All life stages	FE		
Allen’s big-eared bat	Backwaters	Breeding			X
California leaf-nosed bat	Backwaters	Breeding/ Wintering		SC	
Greater western mastiff	Backwaters	Breeding			X
Pallid bat	Backwaters	Breeding		SC	
Pale big-eared bat	Backwaters	Breeding		SC	
Spotted bat	Backwaters	Breeding			X
Big free-tailed bat	Backwaters	Breeding		SC	
Cave myotis	Backwaters	Breeding		SC	

TABLE 3.2-34

Primary Association and Use of Vegetation Communities by Selected Wildlife Species in the Study Area

Common Name	Habitat Association	Habitat Use	Federal Status	California Status	Arizona Wildlife of Concern
Mexican long-tongued bat	Backwaters	Breeding	SC	SC	
Occult little brown bat	Backwaters	Breeding	SC	SC	
Ringtail	Cottonwood-willow	Breeding		FP	
American bittern	Marsh	Breeding			X
California black rail	Marsh	Nesting, foraging, and wintering		CT; Fully protected	
Clark's grebe	Marsh	Breeding			X
Western least bittern	Marsh	Breeding			X
Yuma clapper rail	Marsh	Nesting	FE	CT; Fully protected	
American peregrine falcon	Backwaters and marshes	Winter foraging		CE; CA Fully protected	
Colorado river toad	Backwaters and marshes	All life stages		SC	
Lowland leopard frog	Backwaters and marshes	All life stages			X
Northern leopard frog	Backwaters and marshes	All life stages		SC	X
Sonoran mud turtle	Backwaters	All life stages		SC	
Desert tortoise (Mojave population)	Floodplain, uplands	All life stages	FT		

CE: California Endangered
SC: Species of Special Concern in California or Federal Species of Concern
CT: California Threatened
FE: Federally Endangered
FT: Federally Threatened
C: Candidate
FP: Fully Protected

Fish and Aquatic Resources. Reclamation's model predicted changes in the acreage of open water habitat in the main river channel and in backwater habitats. As described for riparian habitat and backwaters, Reclamation (2000) predicted changes in backwaters and open water in the main river channel for a change in the point of diversion for 400 KAFY, 300 KAFY, and 200 KAFY. This information was used to predict changes in backwaters and open water in the main river channel for the transfer for 130 KAFY and 230 KAFY to capture the range of transfer amounts potentially resulting under the Proposed Project and Alternatives.

IID WATER SERVICE AREA AND ACC

Wildlife and Wildlife Habitat

Drain Habitat. Drain habitat could be affected by the Proposed Project and Alternatives through changes in the amount or the quality of water in the drains. The IID Water Conservation Model (described in Appendix E as the Imperial Irrigation Decision Support System) predicted average annual flows in the drains under the Proposed Project and Alternatives. Potential responses of vegetation (both amount and species composition) to flow changes were predicted by considering the magnitude of flow changes; the drought-tolerance of plant species composing drain habitat; and other factors affecting the amount, distribution, and composition of drain habitat (e.g., drain maintenance activities).

Effects of salinity changes on vegetation in the drains were predicted using results from the IID Water Conservation Model. Cattails were the focus of this assessment because of their sensitivity to salinity and their importance as wildlife habitat. Cattails have a low salinity tolerance and provide habitat for some species using the drains. At a salinity below 3 g/L, cattails are not adversely affected. At a salinity of 3 to 5 g/L, growth of cattails is stunted. Cattails are typically absent in water with a salinity greater than 5 g/L.

To estimate the potential effects of water quality on drain habitat under the Proposed Project and Alternatives, the number of miles of drains with an average salinity of less than 3 g/L, between 3 and 5 g/L, and above 5 g/L were predicted with the IID Water Conservation Model. The acreage of cattails in the drains was estimated based on Hurlbert (1997) as described in the Existing Environment section. Based on drain mileage, cattails were assumed to be proportionately distributed in drains with salinity less than 3 g/L and between 3 and 5 g/L. Loss of cattail acreage was predicted from the reduction in miles of drains with a salinity of less than 5 g/L relative to existing conditions under the Proposed Project and Alternatives. The total acreage of cattails remaining under each Alternative was then assumed to be proportionately distributed in drains with salinity less than 3 g/L and between 3 and 5 g/L.

Tamarisk Scrub Habitat. The Proposed Project and Alternatives could reduce flows in the New and Alamo Rivers. Potential changes in tamarisk scrub adjacent to the New and Alamo Rivers were evaluated, based on changes in flows in these two rivers under the Proposed Project and Alternatives. The IID Water Conservation Model predicted average annual flows in the New and Alamo Rivers under the Proposed Project and Alternatives. Potential responses of tamarisk scrub to flow changes were predicted by considering the magnitude of flow changes and the drought tolerance of tamarisk.

Other potential effects of the Proposed Project and Alternatives to tamarisk scrub include removal of tamarisk during construction to install water conservation measures. These potential effects were determined by identifying whether water delivery system improvements would be in areas known or likely to support tamarisk scrub habitat.

Wildlife Resources. Under the Proposed Project and Alternatives, wildlife resources could be affected by changes in the amount or quality of habitat, changes in water quality, or disturbance during construction to install water conservation measures. Special-status species were the focus of the evaluation of potential impacts to wildlife resources. By focusing on special-status species, it was assumed that the most sensitive species and those potentially experiencing the greatest impact would be addressed. Other species using the same habitats were assumed to respond similarly. The special-status species potentially occurring in the IID water service area and AAC were assigned to one or more of the following groups based on their primary habitat association:

- Drain habitat associates
- Tamarisk scrub habitat associates
- Agricultural field habitat associates
- Desert habitat associates

Species associated with wetland habitat were classified as drain habitat associates and species associated with riparian habitat were classified as tamarisk scrub habitat associates (Table 3.2-14). Desert and agricultural field habitat associates were as indicated in Table 3.2-14. Potential impacts to special-status species were evaluated for these habitat groups, based on predicted changes in the amount or quality of habitat and the occurrence of construction or operation of water conservation practices in each habitat. When necessary to fully evaluate and disclose potential impacts of the Proposed Project and Alternatives, individual species were addressed. Species associated with aquatic habitat were those typically found at the Salton Sea or other relatively large water bodies in the Imperial Valley (e.g., Finney and Ramer Lakes). Impacts to these special-status species are evaluated under the Salton Sea section.

Fish and Aquatic Resources. Fish and aquatic habitat could be affected by the Proposed Project and Alternatives from reductions in flows in the rivers or drains, changes in vegetation that affect aquatic habitat quality, or changes in water quality. Water quality and flows in the drains and rivers were predicted for the Proposed Project and Alternatives using the IID Water Conservation Model. The products of the model include predictions of average flow in the drains and rivers, and average concentrations of several constituents of concern. Impacts to aquatic habitat were assessed, based on changes in flow under the Proposed Project and Alternatives.

Water Quality Effects on Biological Resources. Changes in water quality in the drains and rivers were predicted using the IID Water Conservation Model. This model predicts average monthly water quality for eight categories of constituents of concern. Estimates of water quality conditions under existing conditions, represented by the historic Baseline, and the Proposed Project and Alternatives are presented in Section 3.1, Hydrology and Water Quality. Output from the model is summarized as average monthly concentrations and as the miles of drains with certain constituent concentrations. Water quality impacts were evaluated relative to the significance criteria in Section 3.1.4.2.

Although eight water quality categories, including individual classes of pesticides and nutrients, were available as model output, the water quality impacts presented here and in Section 3.1 (Hydrology and Water Quality) are limited to model results for TSS, TDS, and selenium. The limited number of field samples available for the pesticides precludes their usefulness as model output presentations and interpretations. As discussed in Section 3.1, the model output for those parameters is not precise enough to predict water quality exceedances. Nitrogen and phosphorus predictions are more precise, but water quality standards for those parameters are not available and their impacts to downstream nutrient enrichment are extremely difficult to predict. Boron concentrations do not exceed water quality concentrations of concern under the Proposed Project and Alternatives.

The three constituents with the greatest degree of accuracy of model results and greatest importance in predicting project impacts are selenium, TSS, and TDS. Selenium is of particular concern because of its prevalence in the supply water, concentration effects through agricultural practices, and potential for food chain accumulation and toxicity in aquatic environments. TDS is a direct measure of salinity loading to the Salton Sea and a useful surrogate for all dissolved water constituents. It also is a direct measure of suspended sediment concentrations for those constants where results are not presented increases or decreases relative to Baseline can be assumed based on their tendency to be mobilized as dissolved constituents (boron, nitrogen) or with the particulate fractions of runoff (phosphorus, organochlorine and organophosphorus compounds) and sediment loadings, and a surrogate for all particulate-associated compounds.

Water delivery system improvements and on-farm irrigation system improvements, in combination, could contribute to increased selenium concentrations in drainwater and affect reproductive success of some Proposed Project covered species associated with drain habitat. The potential effect of the water conservation activities on selenium concentrations in drainwater and the subsequent potential effects on reproductive success were predicted using results from the IID Water Conservation Model and mathematical equations that relate selenium concentrations in water-to-egg concentrations and hatchability as described below.

Prediction of Selenium Concentrations. The IID Water Conservation Model predicted selenium concentrations (parts per billion [ppb]) in drainwater at specific locations (nodes)[5] in the drainage system over a 12-year period for the following scenarios:

- Capped Baseline conditions (No Project Alternative)
- Conservation of 300 KAFY consisting of 130 KAFY from on-farm irrigation water delivery system improvements and 170 KAFY from on-farm irrigation system improvements, system improvements, or fallowing (Proposed Project)
- Conservation of 130 KAFY from on-farm irrigation system improvements (Alternative 2)
- Conservation of 230 KAFY consisting of 130 KAFY from on-farm irrigation system improvements and 100 KAFY from water delivery system improvements (Alternative 3)
- Conservation of 300 KAFY through fallowing (Alternative 4)

On-farm irrigation system improvements of 130 KAFY (Alternative 2) are the lowest level of conservation under the IID / SDCWA water conservation and transfer agreement. Under the Quantification Settlement Agreement (QSA), a minimum of 230 KAFY is to be conserved. The maximum amount of water that can be conserved using water delivery system improvements is 100 KAFY. The maximum amount of conservation and transfer is 300 KAFY under both agreements. Thus, the scenarios reflect the range of water

[5] In the IID Water Conservation Model, nodes were located at the end of each drain where the drain empties into the New or Alamo River or the Salton Sea.

conservation levels (130 KAFY to 300 KAFY) and techniques (up to 100 KAFY water delivery system improvements).

Implementation of on-farm irrigation system improvements will vary from year to year and cannot be predicted with certainty for each node. Therefore, a number of model runs for each level of conservation were completed, and the average selenium concentration at each node over the runs was computed for use in the analysis of potential toxic effects. The number of miles of drain associated with each node was used to compute summary statistics that express the overall number of miles of drain with waterborne selenium concentrations in the following categories:

0-5 ppb	5-6 ppb	6-7 ppb	7-8 ppb	8-9 ppb
9-10 ppb	10-11 ppb	11-12 ppb	12-13 ppb	>13 ppb

For both the conversion from waterborne selenium to egg selenium concentrations and the probability of effects on hatchability (following discussion), the upper end of each concentration category was used (e.g., 5, 6, 7… ppb). For the category representing greater than 13 ppb of waterborne selenium, the maximum selenium concentration predicted by the model under each conservation level was used.

Conversion of Waterborne Selenium to Egg Selenium Concentration. Based on samples of eggs from 18 pond systems and 3 non-drainwater reference sites in the San Joaquin Valley (Skorupa et al. unpublished data), there is a strong correlation between mean waterborne selenium and mean egg concentrations ($r=0.901$, $N=36$, $P<0.01$), with the following regression equation for the relationship as reported by Ohlendorf et al. (1993) for black-necked stilt:

$$\log \text{egg Se } (\mu g/g) = 0.44 + 0.434 \log \text{water Se } (\mu g/l)$$

Based on this relationship, the predicted selenium concentrations in drainwater were converted to selenium concentrations in eggs for black-necked stilt. Black-necked stilt was used because of the extensive data available on this species and because it displays an intermediate level of sensitivity to selenium (Skorupa 1998). The “stilt standard” is considered the appropriate standard for generalized assessments of toxic impacts (Skorupa 1998).

Probability of Toxic Effects from Selenium. Based on the predicted concentration of selenium in eggs for black-necked stilt, the probability of effects on the hatchability of eggs was computed from the following logistic equation reported in Skorupa (1998):

$$P(>1 \text{ inviable egg}) = EXP(-2.327 + 0.0503[\text{selenium conc.}]) / \{1 + EXP(-2.327 + 0.0503[\text{selenium conc.}])\}$$

Although the probability of teratogenic effects (e.g., embryonic deformities) could have been used as a measure of potential impact, egg hatchability was chosen as the response variable for assessing the potential impact of selenium toxicity because of the relative insensitivity of teratogenesis as a response variable. Egg hatchability effects were expressed as the probability of a hen producing a clutch in which at least one egg was inviable (did not hatch). Hatchability effects were corrected for background rates of inviability as described in Skorupa (1998).

Computation of Habitat by Increased Selenium. The number of drain miles at each selenium concentration and the probability of hatchability effects at that concentration were used to predict the potential effect at each level of water conservation. The probability of hatchability effects in each category of waterborne selenium concentration was multiplied by the number of miles in each category as predicted with the IID Water Conservation Model and summed over all categories to estimate the number of miles of drain habitat affected by waterborne selenium. This estimate is not the total number of miles of drain habitat that would be affected (even minimally) by waterborne selenium, but rather, is an estimate of the "equivalent" number of miles that would be fully (i.e., 100 percent) affected by waterborne selenium. For example, 100 miles of drain habitat with a 10 percent (i.e., 0.10) probability of hatchability effects is "equivalent" to 10 miles of fully affected habitat (100 x 0.10). The hatchability effects were presented at the level of the clutch (or hen) rather than at the level of an individual egg.

SALTON SEA

Adjacent Wetlands and Shoreline Strand. Tamarisk scrub is supported in areas adjacent to the Salton Sea and along its immediate margins. Where freshwater is available, cattails and bulrush vegetation can develop. Changes in the surface water elevation can affect the amount and distribution of these plant communities adjacent to the Salton Sea. The potential response of tamarisk scrub and cattail/bulrush areas adjacent to the Salton Sea were evaluated to consider likely sources of water supporting these communities, the magnitude of reductions in water surface elevation, and ability of tamarisk to colonize new areas. The surface water elevation of the Salton Sea was predicted for the Proposed Project and Alternatives using a model developed by Reclamation. This model is described in Section 3.1.4.1.

Aquatic Resources. Potential impacts to aquatic resources under the Proposed Project and Alternatives relate to changes in the rate of salinization of the Salton Sea resulting from reduced inflows. Reclamation developed a model Sea that predicts the average salinity of the main body of the Salton Sea at inflow levels expected under the Proposed Project and Alternatives over a 75-year period. Changes in fish and invertebrate resources were evaluated, based on predicted changes in salinity and species-specific salinity tolerances (Table 3.2-35). The long-term persistence of fish and invertebrate species in the Salton Sea depends on their ability to complete their life cycles. Therefore, the salinity threshold for life-cycle completion was used to evaluate changes in the invertebrate and fish resources. Even though adults of some species, particularly long-lived fish species, could persist at higher salinity levels, their populations would eventually decline as the older fish died.

Avian Resources. Potential impacts to birds at the Salton Sea relate to changes in the fish and invertebrates on which birds forage, in the amount of shallow water and mudflat habitat, and in the suitability of nesting and roosting sites for colonial species. Increases in the salinity of the Salton Sea could change the abundance and composition of fish and invertebrate resources. Reductions in the surface water elevation could change the amount of shallow water and mudflat habitat. Snags and islands used for nesting also could be affected by reductions in the surface water elevation that result in these areas becoming accessible from the mainland.