Chapter 3F. Environmental Setting, Impacts, and Mitigation Measures - Wildlife

INTRODUCTION

This chapter describes wildlife resources in Mono Basin and Upper Owens River Basin and the potential effects on these resources that could result from changes in LADWP's water rights to the diverted tributaries of Mono Lake. Although water rights changes could affect streamflows throughout the Owens River system, the potential changes downstream of Lake Crowley reservoir would be insufficient to induce significant changes in wildlife populations.

For the environmental setting, information is presented about the status of wildlife habitats and populations before streamflow diversions, at the 1989 point of reference, and through 1992 when data were available. Although prediversion status is presented first, a more thorough description of these resources is found in the "Environmental Setting" section.

Common and scientific names of all wildlife species mentioned in the text are listed in Appendix B. Technical discussions of long-term population trends and factors affecting the survival and reproductive success of California gulls at Mono Lake are contained in Appendix C. A report on 1991 wildlife use of Mono Basin and Upper Owens River habitats is contained in Appendix D. Appendix E comprises an assessment of special-status wildlife species in Mono Basin and along the Upper Owens River. All of these appendices should be considered as key elements of this assessment.

PREDIVERSION CONDITIONS

This section describes wildlife resources in Mono Basin and along the Upper Owens River in the years preceding the start of stream diversions in 1941.

Sources of Information

Most pre-1900 accounts of the wildlife inhabiting Mono Basin were anecdotal and qualitative, and some accounts were based on secondhand information (Jehl et al. 1988). SWRCB consultants did not conduct detailed reviews of pre-1900 information sources on wildlife of Mono Basin, but instead consulted the summary references, such as Gaines (1981, 1988), Jehl (1988a), Jehl et al. (1984, 1988), and Winkler and Shuford (1988).

In the early 1900s, expert naturalists such as Dixon (1915 and 1916) and Dawson (1923) made detailed wildlife observations in the Mono Lake region. SWRCB consultants reviewed these references and selected field notes from Joseph Grinnell, Tracy Storer, Walter Taylor, and their associates. In addition to reviewing these sources, they reviewed other relevant literature published since 1900 and solicited information about historical wildlife populations from several individuals who resided or worked in the Mono Lake area before 1940, including Don Banta, Kent DeChambeau, Wallis McPherson, and Eldon Vestal (retired from DFG). SWRCB consultants also reviewed the transcripts of court testimony from the Mono Lake hearings (Superior Court of the State of California for the County of El Dorado 1990) and reviewed interviews with long-term Mono Basin residents (Jerry Andrews, Don Banta, Katherine Clover, Jessie Durant, August Hess, Wallis McPherson, and Jack Preston pers. comms.). Unfortunately, few quantitative data are available in these sources that describe the wildlife inhabiting prediversion freshwater wetlands and riparian forests of Mono Basin.

SWRCB consultants also reviewed all prediversion records of special-status wildlife species, plant species, and natural communities contained in the California Department of Fish and Game's (DFG's) Natural Diversity Data Base (NDDB). They also reviewed maps and photographs of Mono Lake and its tributary streams that were made in prediversion times.

General Conditions

Mono Lake is more than 700,000 years old, making it one of the most ancient lakes in North America (Lajoie 1968). It lies in a closed basin and has no natural outlets; through the millennia, its waters fluctuated widely in response to changes in climate and became increasingly saline and alkaline (Lajoie 1968, Stine 1990). This hypersaline lake reached its highest historical elevation of 6,428 feet in 1919. However, when diversions of its primary tributary streams began in 1940, its level had already naturally declined by 11 feet to a surface elevation of 6,417 feet (Vorster 1985, Stine 1990).

At prediversion and early diversion lake elevations (i.e., greater than about 6,402 feet), Mono Lake supported a diversity of ponds, lagoons, and other freshwater and brackish water habitats that were fed by creeks and springs (Chapter 3C, "Vegetation") (Stine pers. comm.). Similarly, dense, continuous stands of riparian forest dominated by cottonwoods and willows grew along the major tributary streams to the lakeshore (Chapter 3C, "Vegetation").

Wildlife on Mono Lake's Islands and Islets

General

Mono Lake has two major islands, Negit and Paoha (Figure 3F-1); both islands have volcanic origins and are quite young geologically (Stine 1987a, 1990). Negit Island, in the northwestern part of the lake, is composed of a series of volcanic flows that formed between about 1,700 and 300 years ago. By 1940, it consisted of about 162 acres of mostly unvegetated, rough volcanic rock. An older platform of explosion debris lying near the center of the island and blanketed by volcanic ash was colonized by a relatively dense shrub cover dominated by greasewood. The island was separated from the mainland by 2.5 miles of deep, open water (Figure 3F-1). Nine small volcanic islets, totaling about 0.7 acre, flanked Negit Island to the north and northeast (Stine 1990a).

Paoha Island, near the center of the lake, is a large mass of lakebed sediment that was uplifted in a single volcanic event about 300 years ago (Stine 1987b). In 1940, the island was 1,236 acres in size lying about two-thirds of a mile southeast of Negit Island and not flanked by any islets.

Both Negit and Paoha Islands offered nesting habitat for California gulls because their isolation provided protection from mainland predators (see "California Gull" below). Other bird species recorded at Negit Island included the peregrine falcon, common poorwill, Say's phoebe, rock wren, violet-green swallow, white-crowned sparrow, Brewer's sparrow, sage sparrow, and house finch (Dixon 1916, Nichols 1938). However, Negit Island's isolation, lack of fresh water, and extremely rocky terrain made it inaccessible and inhospitable to terrestrial species such as small mammals, reptiles, and amphibians.

Compared to Negit Island, Paoha Island offered a greater diversity of wildlife habitats, including a freshwater marsh, greasewood and sage scrub communities, and alkali meadows (Dixon 1916, DeDecker 1975). Heart and Dollar Lakes were located on Paoha Island, and their salty waters provided abundant brine shrimp and a protected feeding area for gulls and other water birds (McPherson pers. comm.). An operating goat farm was located on Paoha Island in the 1920s and 1930s (Dawson 1923, Moore 1991, McPherson pers. comm.), which undoubtedly affected the island's natural vegetation.

During field surveys of Paoha Island, Dixon (1916) observed a variety of bird species, including the California gull, Say's phoebe, violet-green swallow, sage thrasher, orange-crowned warbler, Wilson's warbler, song sparrow, white-crowned sparrow, Brewer's sparrow, and western meadowlark. The freshwater marsh attracted a variety of ducks, shorebirds, and wading birds (McPherson pers. comm.). Because the island was isolated, however, reptiles and amphibians were absent, and bats were the only native mammals to visit it (Harris pers. comm.).

California Gull

California gull populations since 1900 are described in detail in Appendix C, "California Gulls at Mono Lake since 1900: Population Trends, Survivorship, and Reproductive Success". In the discussion of this species to follow here and in the "Environmental Setting" section, the detailed information in the appendix is summarized.

Nineteenth-Century Populations. Jehl et al. (1984, 1988) and Winkler and Shuford (1988) summarized the available historical sources describing Mono Lake's nesting California gulls, including published literature, unpublished field notes, newspaper articles, books on regional human history, and egg collection records in major western museums.

Several 19th-century visitors described "clouds" and "immense swarms" of California gulls nesting at Mono Lake (Winkler and Shuford 1988), but most of these accounts were qualitative and sometimes based on secondhand information (Jehl et al. 1988). Despite the lack of reliable information about the size and distribution of Mono Lake's California gull colony during the 19th century, historical records suggest that the colony was large enough to provide a reliable food source for resident Paiutes in Mono Basin (Winkler and Shuford 1988).

Commercial egg collectors began to exploit the Mono Lake gull colony in the 1860s (Winkler and Shuford 1988), and by the 1880s local newspapers reported a scarcity of gull eggs and suggested that the gulls may have moved their nesting grounds because of disturbance by egg collectors (Shuford and Winkler 1991). The exact effects of egg collecting on the Mono Lake's breeding gulls will never be known; however, it is clear that local settlers relied on this colony as a source of food and thought that it was declining or shifting its nesting grounds in response to egg collecting.

Populations from 1900 to 1940. Jehl et al. (1984, 1988) and Winkler and Shuford (1988) also summarized the available information on Mono Lake's nesting California gulls since 1900 (Appendix C, Table C-1). These authors reviewed most of the same references contained in the incomplete historical record. They disagreed, however, on the reliability and interpretation of historical population estimates, especially the possible inferences regarding changes in the size and distribution of the gull colony in this century (see "Environmental Setting" below).

Despite the few direct counts of the prediversion gull colony, the available observations provide evidence that at least a few thousand nesting gulls were present on Negit Island or Paoha Island before 1940 (Appendix C). Although it is much larger than Negit Island, Paoha Island was used less frequently by nesting gulls during this century because of the intermittent presence of humans, domestic goats, and coyotes (Jehl et al. 1984, McPherson pers. comm.).

Caspian Tern

Nesting Caspian terns at Mono Lake were not mentioned by Dawson (1923) or Grinnell and Storer (1924). The first observations of this species at Mono Lake apparently occurred after LADWP water diversions began (see "Environmental Setting" below).

Birds on Mono Lake's Open Waters

General

In the prediversion period, the open waters of Mono Lake served as an important stopover point for migratory water birds in the western Great Basin. The most abundant species were eared grebes, red-necked phalaropes, Wilson's phalaropes, and many species of ducks, which frequented Mono Lake in summer or fall to feed on its productive aquatic life before continuing their migrations.

Eared Grebe

Historical sources describing the status of eared grebes at Mono Lake were reviewed by Jehl (1988a, 1988b) and are summarized from this and other sources below.

Fisher (1902) reported that he collected both western and horned grebes and believed that the thousands of grebes he observed at Mono Lake belonged to these two species. The horned grebes probably were actually eared grebes (Jehl 1988a), which currently outnumber all other water birds at Mono Lake (Winkler et al. 1977; Jehl 1987a, 1988a, 1988b).

Dawson (1923) reported that eared grebes "breed abundantly at Mono Lake, and commonly east and north of the Sierra at various locations". Grinnell and Storer (1924) also noted that eared grebes were common at Mono Lake in summer and fall but concluded that most birds were probably migrants and transients attracted by the abundant supplies of brine shrimp and alkali flies. They observed no evidence of nesting at Mono Lake and suggested that its shoreline did not provide attractive breeding habitat. Nichols (1938) reported hundreds of eared grebes around Paoha Island but none around Negit Island.

Apparently no quantitative counts were made of eared grebes at Mono Lake in prediversion times. Qualitative estimates from pre-1940 observers, however, leave little doubt that thousands of eared grebes visited the lake in fall (Jehl 1988b). One prediversion resident (McPherson pers. comm.) recalled that "eared grebes were abundant in fall migration, but they were outnumbered by waterfowl".

Red-Necked Phalarope

Fisher (1902) observed "countless hundreds" of southward migrating red-necked phalaropes at Mono Lake in September 1901. Because they were relatively tame, these phalaropes "fall easy prey to pot hunters. The species is locally called `Mono Lake pigeon'." Grinnell and Storer (1924) stated that this species was numerous during migration, but apparently these observers did not visit Mono Lake in fall.

Wilson's Phalarope

Data on the prediversion status of Wilson's phalaropes at Mono Lake were summarized by Jehl (1988b). Dixon (1916) collected a Wilson's phalarope in breeding condition and observed territorial males in wet meadows near Farrington's Ranch (near Cain Ranch). Grinnell and Storer (1924) described this species as a summer visitor and probable nester in marshy meadows and pond margins of the eastern Sierra Nevada; Grinnell and Storer apparently did not visit Mono Lake in fall to observe the migrant population. Prior to 1940, McPherson (pers. comm.) saw "clouds of phalaropes in late summer and fall", but he apparently did not attempt to distinguish the species.

Wildlife on Lands and Wetlands Surrounding Mono Lake

General

Areas surrounding Mono Lake have always provided a variety of wildlife habitats. Great Basin scrub and alkali dry meadow habitats in upland areas gave way to willow scrub and mixed scrub, alkali wet meadow, and short and tall emergent marsh habitats on approach to the lakeshore. Open, alkali flats were generally absent in 1940. In the prediversion period, more than 260 acres of open water habitat existed around Mono Lake's shoreline, including freshwater ponds at DeChambeau marsh, near Bridgeport-Cottonwood Beach, Black Point, Wilson-Mill Creek delta, Rush Creek delta, and brackish lagoons along the northeastern shoreline near Sulphur Springs. Of particular importance was the use of these habitats by shorebirds and waterfowl.

Shorebirds

Fisher (1902) observed avocets, killdeers, and least sandpipers feeding on the abundance of brine flies at Mono Lake in mid-September 1901; he described the flies as forming a "black zone or band two or three feet wide next to the water all around the lake". In some years, observers recalled seeing thousands of avocets at the lagoons along the northern shoreline (McPherson pers. comm.).

Snowy Plover

Dawson (1923) noted that snowy plovers occur in the interior of California, especially near larger inland bodies of water. However, he and other early visitors such as Dixon (1916) and Grinnell and Storer (1924) did not report nesting snowy plovers at Mono Lake. These observers did not conduct thorough surveys for snowy plovers at the lake and because this species nests on barren, remote areas around the lakeshore, it could easily pass undetected.

Ducks

Observations of Early Ornithologists and Other Visitors. Pre-1900 accounts of water birds at Mono Lake suggested that ducks were numerous. Gaines (1981) reviewed historical newspapers, including an 1852 article that spoke of "wild ducks and gulls, in abundance". Gaines (1981) also referenced an 1865 article by J. Ross Browne who described a hunting expedition as, "nothing short of wholesale slaughter . . . 20 or 30 teal duck at a shot is nothing unusual . . . sportsmen find it a laborious job to carry home their game."

In mid-September 1901, Fisher (1902) observed thousands of ducks at Mono Lake. The dominant species were northern shovelers, mallards, green-winged teals, and redheads. He noted that "when the north winds drive them [the ducks] in large numbers near shore, Indians and some few whites hide behind blinds made of sage brush and mow down the unsuspecting birds in great numbers."

Other early ornithologists such as Dixon (1916), Dawson (1923), and Grinnell and Storer (1924) apparently did not visit Mono Lake in fall and did not report large waterfowl populations. However, long-time residents of Mono Basin recalled that large concentrations of fall-migrating ducks typically visited Mono Lake every year.

Observations of Long-Term Residents. A prediversion resident along Rush Creek remembered duck blinds and many hunters near the mouth of Rush Creek prior to 1940. She stated that "the sky used to go black with huge flocks of ducks. There were so many! They fed in the lake near the mouth of Rush Creek and would rinse off their feathers in the fresh creek water. The ducks would settle in big flocks on the sandbar at the creek mouth." (Clover pers. comm.)

A native Paiute born in 1913 who grew up on land near the mouth of Rush Creek, also reported many ducks using ponds on the delta. Sometimes her grandfather would return home with a gunnysack full of ducks, mostly mallards and teals. Their family made soup from the meat and blankets and pillows from the duck down (Durant pers. comm.).

A resident in Mono Basin since 1901 recalled that there used to be many more ducks at the lake, especially at the creek mouths and in "swamps" around the lakeshore. He remembered hunting for northern shovelers "spoonbills" on windy days when "there were so many ducks along the shore sometimes--that when they'd move out all together like the shore itself was moving out" (Preston pers. comm.).

A resident of the DeChambeau Ranch near Wilson Creek from 1928 until 1939 recalled that many migratory ducks visited Mono Lake every fall, noting that prediversion duck concentrations at the lake were comparable to those he has seen when hunting at Tule Lake NWR, when more than 1 million ducks were counted during aerial censuses by USFWS. He noted that ducks at Mono Lake needed to visit fresh water frequently and that major concentration areas were at the creek deltas and at the many fresh and brackish water ponds around the lakeshore. The crop contents of birds he had shot suggested that northern shovelers foraged primarily on brine shrimp, while other common ducks such as mallards, green-winged teal, American wigeon, and gadwalls consumed mostly alkali flies. (DeChambeau pers. comm.)

A Lee Vining resident since 1933 who hunted ducks at Mono Lake since childhood described large concentrations of ducks at the lake during the 1930s and 1940s that began to arrive in early September and remained until the alkali fly populations declined in late fall. Northern shovelers were the first to arrive (in early September) and were the most abundant species, but a variety of other ducks, including mallards, northern pintails, green-winged teals, and American wigeons, also were numerous at Mono Lake in this period. Ducks typically foraged along the lakeshore, but the most productive hunting areas were at sources of fresh water such as the deltas of Lee Vining and Rush Creeks and at fresh marshes and ponds at Simon's Spring, Warm Springs, and the DeChambeau marsh. In prediversion years, ducks were so numerous at Mono Lake that hunters could easily kill their limit with a single shot. (Banta pers. comm.)

A resident of Paoha Island from 1917 until 1921, who hunted waterfowl and resided in Mono Basin for most of his life, recalled that large numbers of ducks visited Mono Lake prior to 1940. He noted that on windy days lagoons along the northern shoreline near Sulphur Springs attracted flocks of migratory waterfowl seeking protected resting areas away from the high waves of the lake. Ducks often concentrated at the creek deltas and nearshore areas where he watched them forage. Large numbers of ducks also gathered in the lower Rush Creek marshes and ponds where watercress and other aquatic plants were plentiful. In prediversion times, ducks were abundant enough in fall to appear as a dark, moving, 10-foot-wide ring around the lakeshore, stretching from the mouth of Lee Vining Creek to beyond the mouth of Rush Creek. When viewed from a boat, flocks of northern shovelers and other ducks often looked like "large sandbars". This observer described prediversion waterfowling as "more like duck killing than hunting . . . you could get 25 ducks with five shots". He estimated that at least a million waterfowl gathered around the creek deltas, marshes, ponds, and lagoons of Mono Lake at one time during the peak of fall migration. (McPherson pers. comm.).

Reliability of Accounts by Nonscientists. Jehl (pers. comm.) suggested that prediversion estimates of duck numbers at Mono Lake could be inaccurate because they were not conducted by trained observers using systematic census methods. Further, he questioned whether hunters around the lakeshore could correctly identify ducks far out on the lake and he believed that many birds identified as ducks were probably eared grebes instead.

SWRCB consultants contacted three of the early witnesses cited above (Banta, DeChambeau, McPherson) to question them about their observations. All have spent many years observing ducks, grebes, and other water birds at the lake, and all emphasized that ducks are not similar to eared grebes, either physically or behaviorally. These observers, who spent years boating and observing birds at the lake through binoculars, confirmed earlier estimates that at least 1 million ducks, not grebes, regularly stopped at Mono Lake during peak migration prior to 1940.

Conclusion. Bird counts by untrained observers are usually inaccurate, but in the absence of specific census data, qualitative counts have been used to analyze long-term population trends of California gulls (Jehl et al. 1984, 1988; Shuford and Winkler 1991; Winkler and Shuford 1988) and Wilson's phalaropes and eared grebes at Mono Lake (Jehl 1988b). Similarly, prediversion duck counts do not provide precise estimates of their total abundance, but the combined recollections of several experienced observers permit evaluation of their long-term population changes. These observers all agreed that ducks, especially northern shovelers, were extremely abundant in the prediversion period. They also agreed that the lake and its associated freshwater and brackish water wetlands attracted large concentrations of ducks because they provided abundant food, fresh water, and resting habitat. It is concluded, therefore, that Mono Lake was a major stopover point for ducks migrating through the Great Basin prior to 1940.

Geese and Swans

Quantitative data also are lacking for prediversion populations of geese and swans at Mono Lake, but observers in this period reported that these species were far less abundant than ducks (Banta, DeChambeau, and McPherson pers. comms.). Most geese and swans are herbivores (Martin et al. 1951), so they would not be attracted by the abundant invertebrate prey at Mono Lake.

A Paiute descendent recalled that her grandfather frequently hunted for geese along lower Rush Creek during the early 1900s, and her family made pillows and blankets using their down. It requires the down of many birds to make a blanket, suggesting that goose hunting was relatively productive in the Rush Creek bottomlands during this period. (Durant pers. comm.).

Other long-term residents stated that perhaps a few thousand geese visited Mono Basin in fall. Canada geese were the most common species and usually about 200-300 remained for winter. Canada geese would often fly up Rush Creek and graze on the wet meadow vegetation. Occasionally, small flocks also would visit wet pastures on the Cain Ranch, west of U.S. 395. White-fronted geese were regular visitors, but they were never common in Mono Basin. Usually about 15-30 snow geese would appear in early winter and stay for short periods; when present, they were usually found near the county park along the north shore. Often 200-300 tundra swans remained at Mono Lake during the winter months. Similar to most of the ducks, geese and swans visited sources of fresh water while at Mono Lake. (Banta, DeChambeau, and McPherson pers. comms.)

Other Wildlife

No information about other prediversion wildlife in these wetland habitats was found by SWRCB consultants.

Wildlife along Streams Tributary to Mono Lake

General

Perennial streams feeding Mono Lake originate high on the eastern slope of the Sierra Nevada, and the riparian vegetation that developed along these streams provided almost continuous corridors of woodland habitat that stretched from montane conifer forests to within one-quarter mile of the lakeshore (Chapter 3C, "Vegetation"). Riparian conifer forests dominating the streamsides in the higher elevations gave way to conifer-broadleaf forests and cottonwood-willow woodlands at successively lower elevations, the latter having been especially widespread in prediversion times. These riparian forests provided wildlife with a protected corridor to move between upland and lakeshore areas, as well as important resting, foraging, and nesting habitat (Appendix D).

By 1940, this vegetation had been altered from its natural state, reflecting an 80-year history of canal building, flow manipulation, flood irrigation, and grazing, and the consequent alteration of groundwater flow patterns, as described in Chapter 3E, "Vegetation". Springflow giving rise to marsh conditions, such as in the Rush Creek bottomlands, had probably been considerably enhanced locally by irrigation of adjacent lands (Stine 1991).

Accounts of wildlife populations from this period are anecdotal, and apparently no systematic surveys were made of the wildlife inhabiting the riparian corridors of Mono Lake's major tributary streams.

Streams Diverted by LADWP

Rush Creek. In his travels through Mono Basin, Fisher (1902) made incidental observations of wildlife in meadows and willow thickets near the current Cain Ranch. He noted that the willow-lined streams flowing down Bloody Canyon and neighboring areas formed "natural highways" for secretive wildlife moving between montane areas and the lowlands of the eastern slope. They were also, he noted, inviting stopover points for migrating birds through the arid Great Basin. In his surveys of riparian corridors, he observed house wrens, yellow-rumped warblers, MacGillivray's warblers, western tanagers, and white-crowned sparrows (Fisher 1902).

Dixon (1916) and Grinnell (1915) surveyed willow and cottonwood thickets and boggy meadows along lower Rush Creek and observed a diversity of nesting and migratory bird species in this vicinity, including great horned owls, long-eared owls, house wrens, black-headed grosbeaks, Wilson's warblers, MacGillivray's warblers, yellow warblers, common yellowthroats, American robins, warbling vireos, song sparrows, red-winged blackbirds, and willow flycatchers. These are the same species that continue to visit Mono Basin today although long-eared owls, yellow warblers, and willow flycatchers have declined substantially in recent decades (see "Special-Status Species in Mono Basin and Upper Owens River" in the "Environmental Setting" section).

One long-term resident described the land near the mouth of Rush Creek as a "paradise where the vegetation was lush and green and the wildlife was abundant". According to her, it was dominated by aspens, cottonwoods, and Jeffrey pines. Her grandfather hunted for wild game, principally rabbits, deer, ducks, and geese. Mallards and teals were especially abundant in the ponds and marshes of Rush Creek bottomlands. (Durant pers. comm.)

Another resident recalled the presence of large riparian trees, mostly cottonwoods, large flocks of ducks at the mouth of the creek, and abundant waterfowl and other wildlife farther upstream. (Clover pers. comm.)

Other historical observers recalled that dense riparian vegetation in the bottomlands supported abundant wildlife, including ducks, geese, deer, mountain lions, bobcats, and coyotes (Andrews, Hess, and Preston pers. comms.). Many more deer browsing and resting in the sage scrub upland used the creek as a source of water (Andrews pers. comm.).

Lee Vining Creek. Grinnell (1915) and Taylor (1915) surveyed the aspen and conifer forests of upper Lee Vining Creek canyon in September 1915. There they observed northern flickers, American robins, mountain bluebirds, Townsend's solitaires, ruby-crowned kinglets, mountain chickadees, white-breasted nuthatches, red-breasted nuthatches, Steller's jays, Clark's nutcrackers, brown creepers, yellow-rumped warblers, MacGillivray's warblers, pine siskins, lazuli buntings, fox sparrows, song sparrows, white-crowned sparrows, and dark-eyed juncos.

They noted broad stands of lush riparian vegetation along the length of the creek, describing it as a continuous corridor for wildlife species moving between the montane forests and the shores of Mono Lake (Grinnell 1915, Taylor 1915).

Parker and Walker Creeks. A group of 30-50 sage grouse historically used the Parker Creek meadow as a lekking site (Banta pers. comm.).

Site-specific wildlife information on prediversion wildlife of Parker and Walker Creeks is scarce. It is likely, however, that these creeks served as important habitat for resident and migratory wildlife as important components of the Rush Creek corridor. By at least 1940, however, the extent of willow habitats along portions of these creeks had been reduced by sheep grazing. Despite intensive grazing pressure, however, wildlife was abundant along these riparian corridors in prediversion times. (Hess and Andrews pers. comms.)

Other Streams

The status of pre-1940 wildlife resources along streams not diverted by LADWP (i.e., Wilson, Mill, and Post Office Creeks) is undocumented. Inferences about probable wildlife communities can be drawn from vegetation types making up the creek environments; see Chapter 3C, "Vegetation". It is probable that wildlife along these creeks was similar to that along Lee Vining, Parker, and Walker Creeks discussed above.

Wildlife along the Upper Owens River

Apparently, no systematic observations of wildlife along the Upper Owens River were made in prediversion times. Populations of most game species, such as mule deer, ducks, geese, and sage grouse, appear to some to have been more abundant in the prediversion period than they are today (Arcularius pers. comm.).

Livestock grazing was a predominant influence on wildlife habitat conditions in the prediversion period. Then, as today, irrigated meadow was the primary habitat type, accompanied by some areas of riparian willow scrub in the reaches just below East Portal (Chapter 3C, "Vegetation"). The wildlife species dominating these riparian habitats and meadows were undoubtedly those tolerant of the ongoing habitat disturbances that result from livestock grazing.

Special-Status Species in Mono Basin and Upper Owens River Valley

Special-status species are animals that are legally protected under state and federal Endangered Species Acts or other regulations, and species that are considered sufficiently rare by the scientific community to qualify for such listing. These wildlife types fall into the following categories:

- animals listed or proposed for listing as threatened or endangered under the federal Endangered Species Act (50 CFR 17.11 [listed animals] and various notices in the Federal Register [proposed species]);

animals that are Category 1 or 2 candidates for possible future listing as threatened or endangered under the federal Endangered Species Act (54 Federal Register 554, January 6, 1989);

animals listed or proposed for listing by the State of California as threatened or endangered under the California Endangered Species Act (14 CCR 670.5);

animal species of special concern to the California Department of Fish and Game (Remsen 1978, California Department of Fish and Game 1991 [birds] and Williams 1986 [mammals]);

animals listed as sensitive by the local U.S. Forest Service region (Forest Service Manual 2670) or U.S. Bureau of Land Management resource area.

Thirty-nine special-status species occur or potentially occur in Mono Basin or along Upper Owens River to Lake Crowley reservoir in Long Valley. Thirteen species may have been affected by LADWP diversions, although historical information for most of these species is unavailable. They are:

Mono brine shrimp (*Artemia monica*),
American white pelican (*Pelecanus erythrorhynchos*),
osprey (*Pandion haliaetus*),
bald eagle (*Haliaeetus leucocephalus*),
northern harrier (*Circus cyaneus*),
yellow rail (*Coturnicops noveboracensis*),
western snowy plover (*Charadrius alexandrius nivosus*)
California gull (*Larus californicus*),
long-eared owl (*Asio otus*),
short-eared owl (*Asio flammeus*),
willow flycatcher (*Empidonax traillii*),
California yellow warbler (*Dendroica petechia brewsteri*), and
Sierra Nevada mountain beaver (*Aplodontia rufa californica*).

Detailed analyses of the prediversion and point-of-reference status of all 39 special-status species are provided in Appendix E, except for three special-status species described elsewhere in this report. The Mono Lake brine shrimp is discussed in Chapter 3E, "Aquatic Productivity". The California gull and snowy plover were described earlier in this chapter.

ENVIRONMENTAL SETTING

This section describes changes in wildlife resources in Mono Basin and along Upper Owens River from 1941 to the present, and identifies the status of those resources at the 1989 point of reference.

Sources of Information

SWRCB consultants reviewed the available literature on wildlife of Mono Basin that has been published since 1900 and contacted many Mono Basin researchers, including Joseph Jehl, Jr., David Shuford, David Winkler, and Margaret Rubega (birds); Robert Crabtree and John Shivik (coyote and gull predator-prey interactions); Gary Page (snowy plovers); Michael Morrison (wildlife of Paoha Island); David Herbst (alkali flies); John Harris (mammals); Scott Stine (geology and vegetation); and Peter Vorster (hydrology). Agency personnel with knowledge of wildlife in Mono Basin were also contacted, including Tina Hargis and Nancy Upham (Inyo National Forest), Ron Thomas (DFG), Terry Russi (BLM), and Brian Tillemans and Randall Orton (LADWP).

Gaines (1988) reviewed the recent status of ducks in Mono Basin, but published accounts of waterfowl at the lake are not available for the early diversion period. Thus, data from 1940 until 1970 were derived from a variety of sources, including unpublished summaries of waterfowl censuses (Dombrowski 1948), transcripts of interviews and conversations with long-term residents of Mono Basin (Andrews, Banta, DeChambeau, Hess, McPherson, Murphy, Vestal, and Taylor pers. comms.), discussions with active field ornithologists in Mono Basin (Jehl, Rubega, Shuford, Strauss, and Winkler pers. comms.), and personnel from LADWP (Tillemans pers. comm.) and DFG (Yparraguirre pers. comm.).

In 1991, SWRCB consultants conducted surveys of island, lakeshore, and streamside habitats in Mono Basin and floodplain habitats on Upper Owens River to determine the current distribution and habitat associations of bird, mammal, reptile, and amphibian species. Survey methods are fully described in Appendix D.

Study design was developed by wildlife biologists of Jones & Stokes Associates of Sacramento. Wildlife surveys of Mono Lake tributary streams, lakeshore areas, and Upper Owens River were conducted by Jones & Stokes Associates and Dr. John Harris of Mills College. Dr. Michael Morrison of the University of California, Berkeley conducted wildlife surveys on Paoha Island and upland sites near Black Point.

SWRCB consultants also reviewed historical and recent maps and aerial photographs of Mono Basin and Upper Owens River and conducted a search of the NDDB to document occurrences of special-status wildlife and sensitive communities in the project area.

General Conditions

Since the diversion of its primary tributary streams began in 1941, Mono Lake's surface elevation has fallen nearly 45 feet (NAS 1987, CORI 1988) and its surface area has been reduced by about 29% (from 55,000 acres to 39,000 acres) (Chapter 3A, "Hydrology"). These changes in the lake's size had important effects on the extent and distribution of islands, wetlands, shallowly submerged hard substrate, riparian communities, and other wildlife habitats (NAS 1987, CORI 1988). During this period, Mono Lake's salinity has almost doubled. Such changes in the lake's salinity affect the abundance and distribution of alkali fly and brine shrimp populations, Mono Lake's dominant invertebrates and the food sources for the lake's bird populations (Chapter 3E, "Aquatic Productivity"). Increased lake salinity probably also affects the character of freshwater and brackish water wetlands around the lake.

Losses of riparian vegetation along the major tributary streams because of stream dewatering and channel incision have been substantial, causing habitat discontinuities and undoubtedly affecting terrestrial wildlife populations (Chapter 3C, "Vegetation").

Approximately 100 species of water birds have been observed at Mono Lake (Gaines 1988). Mono Lake continues to provide important nesting habitat for California gulls and, since diversions began, now provides new or increased nesting habitat for snowy plovers and Caspian terns. Eared grebes, Wilson's phalaropes, and red-necked phalaropes continue to be abundant at the lake during migration, and their numbers may have increased from the prediversion period. Some bird species visit Mono Lake only briefly because they are unable to forage effectively or adapt to the physiological stresses imposed by the lake's highly saline conditions (Jehl 1987a). In contrast, a few species, such as eared grebes, prefer saline habitats and occur abundantly at the lake for extended periods (Jehl 1987a). Increased salinity and loss of freshwater habitats may be factors in the relatively substantial decrease in use of the lake by ducks since the prediversion period.

Wildlife on Mono Lake's Islands and Islets

General

Stream diversion and lowering of Mono Lake's surface resulted in the enlargement of the two major islands in the lake and the exposure and enlargement of many small islets in their vicinity (Figure 3F-1; Table 3F-1). It also resulted in episodes of land-bridging between the mainland and Negit Island and three neighboring islets (Java, Pancake, and Twain). Declines in lake elevations have generally enlarged the availability of terrestrial island habitats, while land-bridging has both enlarged habitat for mainland species, such as coyotes, and diminished the secure nesting habitat of California gulls. Most of the recently exposed island habitats are sparsely vegetated, eroding lakebed sediments and barren, rocky areas (Chapter 3C, "Vegetation"), which, except for gull and tern nesting, have relatively low wildlife habitat value (Appendix D). In addition to gulls, however, the Negit Islets support an expanding black-crowned night-heron colony, which contained 24 active nests on three islets (Twain, Little Tahiti, and Steamboat) in May 1992 (Shuford pers. comm.). Several pairs of Canada geese also nest on the Negit Islets each year (Jehl pers. comm.).

Paoha and Negit Islands generally support fewer wildlife species than the mainland, and no species are unique to the islands within Mono Basin (Morrison 1991). Paoha Island is dominated by a scrub vegetation community and supports emergent, freshwater marsh. Perhaps because it is near the only source of fresh water on the island, however, this marsh supports more species of birds than can be found at similar, mainland marshes (Appendix D). As many as 46 species of wildlife were observed on the island in 1991, including black-tailed hares, deer mice, montane voles, and coyotes. Fewer species occur on Negit Island because of the predominance of bedrock habitats; deer mice, Nuttall's cottontails, black-tailed hares, and, periodically, coyotes inhabit the island. Amphibian and reptile species have not been located on either island (Morrison 1991, Appendix D).

Changes to Negit Island and the Negit Islets. By the 1989 point of reference (6,376.3 feet) the lake surface had fallen from the 1940 prediversion elevation of 6,417 feet to a 1982 lowstand of 6,372 feet, and then risen to an elevation of 6,381 feet in 1984 because of a period of high precipitation and a lack of diversions. Land-bridging of Negit Island occurred when the lake dropped below 6,376 feet in 1977, and land-bridging of Java, Twain, and Pancake Islets occurred at the lowstand of 6,372 feet in 1982. Since 1986, the lake surface has lowered again, and in 1990 the land bridge to Negit Island was reexposed.

At the 1989 point of reference, Negit Island had enlarged from 162 acres in the prediversion period to approximately 255 acres. To the north-northeast of the island, the number of islets has grown from the nine of prediversion times to a total of 17. The combined acreage of these islets had increased from 0.7 acre to approximately 39 acres. Two islets, Little Tahiti and Twain, each exceeded 10 acres in area. Like Negit Island, these islets are made up of lava (often coated with tufa) with local sand deposits (Stine 1992).

As discussed under "California Gull" below, Negit Island has frequently provided nesting habitat for many California gulls. The emerging islets, especially the larger ones, have also been used by many gulls for nesting. Episodes of mainland-bridging to Negit Island and Twain, Pancake, and Java Islets, however, have resulted in failures in their nesting populations.

Changes to Paoha Island and Emergence of the Paoha Islets. At the 1989 point of reference, Paoha Island had enlarged from 1,236 acres in the prediversion period to approximately 2,030 acres. Much of the enlargement consists of an extensive flat of salt-encrusted lake sediments on the south and west sides of the island. A group of islets began to emerge west of the island during the early 1960s, and by 1989, about 20 islets had emerged. The islets are composed of fine, unconsolidated sediments that slid from the flank of Paoha Island when it was formed 300 years ago. (Stine 1992.)

Unlike the hard rocks that compose Negit Island and the Negit Islets, the soft sediments of the Paoha Islets are easily eroded by waves and longshore currents (Stine 1992). Erosion of the Paoha Islets creates a wave-cut platform, a low-gradient surface that terminates islandward at a cliff and lakeward at the shoreline. A lake surface that is either receding or holding stable against the islet flanks is capable of eroding only a narrow platform (Stine 1992). Low platforms (e.g., less than about 1 foot high) that are exposed to wave action are not suitable gull nesting habitat on the Paoha Islets (Jehl pers. comm.).

During periods of rising lake elevations (transgressions), waves are elevated above existing platforms where they wear back the cliffs and transform the islet flanks into new platforms (Stine 1992). For example, after a lake transgression from 6,372 feet in 1982 to 6,381 feet in 1986, the number of Paoha Islets diminished to half the number exposed at a similar lake elevation in 1974; the total islet area was reduced to about 10.6 acres, representing only about 74% of the 1974 value (Stine 1992).

As discussed in the following section, Paoha Island and its islets also have been used by California gulls for nesting. Paoha Island supported 2,000 nesting gulls as late as 1919. The higher portions of the emerging islets above the zones of active wave erosion have supported many nesting gulls, which favor areas where the substrate is irregular (Jehl pers. comm.).

California Gull

California gulls breed from western and central Canada south through the western United States, including northeastern California. Their wintering range extends from British Columbia along the Pacific Coast south to southern Baja California and the coast of Mexico (American Ornithologists' Union 1983, Jehl pers. comm.). Nesting has been recorded at lakes in northeastern California (Grinnell and Miller 1944) and in south San Francisco Bay (Jones 1986), but the state's largest breeding colony is at Mono Lake (Jehl 1984a, Winkler et al. 1977). In winter, California gulls are abundant and widespread at landfills, reservoirs, agricultural fields, and especially in coastal areas and in the Central Valley (Cogswell 1977).

Status during the Diversion Period. Jehl et al. (1984, 1988) and Winkler and Shuford (1988) summarized the history of the California gull colony at Mono Lake, and most of the information used in this report for the period 1950-1975 is derived from these sources. Most gull population estimates during this period were qualitative and incomplete, and the first attempts to count Mono Lake's entire population were not made until 1976 (Winkler et al. 1977). Gull census data provide historical trends, and data gathered prior to 1976 should not be interpreted as exact counts (Winkler and Shuford 1988). Gull population trends and dynamics during the diversion period are discussed in detail in Appendix C.

Jehl et al. (1984) characterized the gull population at Mono Lake as remaining at a relatively low level of 3,000-5,000 nesting birds from the first surveys in 1916 until the early 1950s. They described a rapid population increase to more than 50,000 nesting birds in 1976 and attributed this rapid growth to the exposure of new islets with declining lake levels, which provided new nesting substrate, together with immigration of birds from other colonies. Winkler and Shuford (1988) questioned the habitat limitation hypothesis and argued that the incomplete data gathered before 1977 were insufficient to draw conclusions regarding the rates or timing of the gull population increase at Mono Lake.

Shuford and Winkler (1991) noted that island acreage was increasing throughout (and after) the period that Negit Island supported its largest nesting colony. In 1976, for example, more than 25,000 gulls (about 75% of the 33,000 nesting adults) on Negit Island nested in habitats (primarily greasewood scrub) that stood above the lake's historical high stand (6,428 feet). Consequently, this nesting acreage was available to nesting gulls before and after lakewide habitat availability increased with falling lake elevations. Similarly, the rapid increases of gulls nesting in greasewood habitats (a more than eight fold change from about 3,000 to 25,000) appeared to be independent of any increases of lakewide nesting habitat availability (Shuford and Winkler 1991).

In 1976, the Negit Islets (total 33 acres) supported about 18,000 nesting gulls at an approximate density of 273 nests per acre (Winkler et al. 1977). In 1986, when the lake's elevation was more than 2 feet higher than that recorded in 1976, the Negit Islets supported 41,000 gulls at an approximate density of 620 nests per acre. These large increases in total population and nesting densities occurred, even though less habitat acreage was available for nesting and the lakewide gull population was relatively stable (Winkler and Shuford 1988).

Although the Paoha Islets first emerged from the lake in the early 1960s (Stine 1992), they were not occupied by nesting gulls until 1979 when the Negit Island population was disrupted by coyotes and other mainland predators crossing the newly formed land bridge (Winkler and Shuford 1988). Thus, evidence from Negit Island, the Negit Islets, and the Paoha Islets suggests that the overall population size of the Mono Lake colony was not limited by habitat availability prior to 1976, when the largest population increases occurred.

Increases in Mono Lake's nesting gull population during 1990 and 1992 (see below) also suggest that nesting habitat was not limiting to the colony at the lake elevations observed during these years. An increase in total population and nesting density occurred with a minimal change in lakewide acreage of suitable nesting habitat in both years (Stine pers. comm.). Gull densities were higher on virtually all the key nesting islets in 1990 and in 1992, suggesting that habitat had not been previously saturated at a local level (Shuford and Winkler 1991, Shuford pers. comm.).

Throughout their range, California gull populations have more than doubled during the last 50 years and have apparently benefited from increased food supplies (e.g., landfills) and habitat (e.g., reservoirs and sewage lagoons) that enhance their winter survival (Conover 1983; Jehl 1991, Court Testimony, Vol. XII, pp. 44-52). Perhaps the increase in Mono Lake's nesting gull population is part of a phenomenon occurring throughout the species' range.

Status at Point of Reference. As described in Appendix C, the total of 44,000 breeding gulls at Mono Lake in 1989 was similar to estimated totals for the previous 6 years, which varied between about 44,000 and 49,000 adult birds. Two of the ensuing 3 years provided the highest counts ever recorded, when about 61,500 and 65,000 were observed in 1990 and 1992, respectively. Similarly, gull reproductive success was the highest ever recorded in these 2 years.

The present status of gull nesting at Mono Lake is a complex interplay between several factors. Winkler (1987) described six factors that could potentially have major effects on the breeding productivity of gulls at Mono Lake, including predation, weather, parasites, food supply, nesting density, and habitat quality. The relationship of these factors to gull breeding productivity at Mono Lake in recent years is discussed in detail in Appendix C.

Despite more than a decade of research, the exact causes of year-to-year variations in gull nesting success at Mono Lake are not well understood (Shuford, Winkler, and Jehl pers. comms.). The relatively clear historical events occurred in a few years at low lake levels when coyotes crossed the newly created land bridge and caused abandonment of the colonies on Negit Island in 1979, on Twain and Java Islets in 1982, and on Pancake Islet in 1990. Nest disruption by coyotes also was observed on Java Islet in 1992. The interacting effects of predation, heat stress, food shortages, and parasites may have also reduced gull reproductive success in other years, such as 1981 and 1984 (Appendix C).

At the point-of-reference lake level (6,376.3 feet), the expanse and depth of water covering the land bridge to Negit Island may not be sufficient to prevent crossings by coyotes. Thus, the point-of-reference lake level may be considered a threshold at which, and certainly below which, coyote predation renders most of Negit Island unsuitable for successful gull reproduction.

The maintenance of Negit as an island does not appear to be crucial to the successful nesting of the Mono Lake gull population, which has adapted to this condition by shifting colonies to the islets near both Negit and Paoha Islands. Negit Island, however, may have long-term benefits to nesting gulls because it offers the largest acreage of potential nesting habitat if the colony expands in the future (Shuford and Winkler pers. comms.) Paoha Island has not supported successful nesting by gulls since the late 1920s or early 1930s, possibly due to resident coyote populations. Future nesting on Paoha Island appears to be unlikely unless the coyotes are removed. However, even when the island was free of land predators, it never supported more than about 2,000 nesting gulls (Appendix C).

In years when the lake level has been high enough to prevent predator intrusions through shallow waters or over land bridges to Twain and Java Islets, these islets have provided about one-third of the total gull nesting habitat and one-half of the lakewide gull nesting population (Dierks and Shuford 1992). Land-bridging of these islets during the 1982 nesting season, however, caused major disruption of gull nesting.

If Twain and Java Islets were again land-bridged (at approximately 6,373 feet) prior to establishment of nesting colonies, it is possible that as many as 32,000 adults nesting there might shift to other Negit and Paoha Islets because their nesting habitat would be reduced and the already densely populated islets may not be large enough to accommodate thousands of new gulls. Alternatively, the overall population at the lake could begin to diminish. Assessment of these possibilities would require an evaluation of apparent suitable islet nesting habitat at appropriate lake levels, which should account for wave erosion effects on the softer substrates of the Paoha Islets. If Negit Island and Twain and Java Islets were land-bridged for long periods, it is possible that Mono Lake's California gull population would be reduced by

30 to 50% (Jehl 1991; Court Testimony, Vol. XII, pp. 128-131; Shuford 1991a; Court Testimony, Vol. XIV, p. 20).

Importance of Mono Lake. If Mono Lake or certain key nesting areas became unsuitable for gull nesting because of loss of food supplies, safe nesting areas, or any other cause, displaced birds may be unable to relocate; none of the freshwater lakes nearby (i.e., within several hundred miles) appear to have suitable nesting islands or sufficiently abundant invertebrate food to support tens of thousands of new gulls (Dennis M. Power and Associates 1980).

Jehl (pers. comm.) noted that, aside from Great Salt Lake, Lahontan Reservoir and Pyramid Lake (and Honey Lake Wildlife Area and Stillwater National Wildlife Refuge during wet years) have islands and could potentially support many nesting gulls. However, Mono Lake is the only site for many hundreds of miles that consistently provides superior habitat for tens of thousands of nesting gulls in the form of isolated islands and an abundant invertebrate food supply. The loss or degradation of gull nesting habitat at Mono Lake could cause a long-term decline of this species' breeding population in California.

Caspian Tern

Caspian terns breed at scattered locations throughout North America, including the Pacific and Atlantic coasts and interior regions as far north as northcentral Canada (American Ornithologists' Union 1983). This species also breeds in northern Europe, southern Asia, eastern China, the Persian Gulf, Australia, New Zealand, and along both coasts of Africa (American Ornithologists' Union 1983). Since the beginning of this century, the western North American population has shifted from nesting at numerous freshwater marshes in the interior to nesting primarily in large colonies on human-created habitats along the coast; their populations have increased along the Pacific Coast since 1960 (Gill and Mewaldt 1983). In the interior of California, this species breeds at isolated lakes of the northeastern plateau (Winkler 1982). Caspian terns are fairly common on bays, beaches near river mouths, and salt ponds from April to early October and uncommon or rare the rest of the year (Grinnell and Miller 1944, Cogswell 1977).

Status during the Diversion Period. Caspian terns probably began nesting at Mono Lake in the mid-1960s when falling lake levels exposed suitable nesting habitat at the Negit Islets; this species prefers flat, sandy substrates with good visibility for its nesting substrate (Jehl 1986a). Jurek (1972) observed Caspian terns in his surveys of Mono Lake but provided no details of their nesting status. About 38 adult Caspian terns fledged 6-12 young within the California gull colony on Twain and Pancake Islets in 1976 (Winkler et al. 1977). The terns must have traveled at least 15 miles to Grant Lake reservoir to forage for fish; Mono Lake's lack of fish probably reduces its attractiveness for nesting by other species of fish-eating birds, such as common loons, white pelicans, western grebes, and double-crested cormorants (Winkler et al. 1977). Avoidance of Mono Lake as a breeding area by piscivorous birds cannot be entirely attributed to a lack of fish, however, because large breeding colonies of pelicans and cormorants occupy islands in the Great Salt Lake, where they must commute at least 30 miles to find sources of fish (Winkler et al. 1977, Jehl pers. comm.).

A small Caspian tern colony persisted on Twain Islet until 1981 (Jehl 1986a). In 1982, when coyote predation of nesting gulls on Twain Islet occurred, the Caspian terns moved to the Paoha Islets and nested within the California gull colony on the western end of Gull Islet A; an estimated 14 pairs of adults fledged about three or four young that year (Jehl 1983). In 1983, a similar sized colony was in the same location as the previous year, but the colony fledged only two young. The major cause of nesting failure was predation of eggs and chicks by gulls (Jehl 1983).

In 1984, erosion of the Paoha Islets resulting from rising lake levels caused the nesting colony of Caspian terns to relocate to Browne Islet, the closest remaining Paoha islet (Jehl 1984b). The Caspian tern population declined in 1985 when only two pairs nested unsuccessfully, and no young were produced in 1986 (Jehl 1986a). Three Caspian terns nested on the islets in 1987, but no fledglings survived (Jehl and Stewart 1988). In 1988, an estimated five pairs fledged two young (Jehl 1989).

Status at Point of Reference. The Caspian tern colony consisted of seven nests on Browne Islet in 1991; only one tern fledged that year (Jehl 1991). In 1992, however, 20 adults had 10 nests and fledged two or three young (Jehl pers. comm.). Thus, the numbers of nesting Caspian terns at Mono Lake are highly variable and are probably sustained by immigration rather than local reproduction (Jehl pers. comm.).

Although gull predation appears to be detrimental to the small population of nesting Caspian terns at Mono Lake, this species frequently nests successfully on islands with gull colonies. In most years, aside from extreme droughts, Caspian terns nest on islands with both California and ring-billed gulls at Hartson Reservoir, within the Dakin Unit of the Honey Lake Wildlife Management Area (Shuford pers. comm.). Caspian terns also nest at Bridgeport reservoir (Gaines 1988) and possibly at Lake Crowley reservoir, suggesting that some pairs may have relocated from Mono Lake (Shuford pers. comm.).

Importance of Mono Lake. Nesting Caspian terns are of interest to ornithologists and recreationists at Mono Lake and they add avian diversity to the island gull colonies. Their high nesting densities elsewhere in California and the world, however, indicate that Mono Lake is probably a marginal breeding area for this species. If the Caspian tern colony at Mono Lake increases from its current low densities, however, it could become an important component in their expanding population in the western Great Basin.

Birds on Mono Lake's Open Waters

General

Mono Lake represents a major stopover point for migratory water birds in the Great Basin (Wiens 1988) because of the lake's large size and strategic location and because it promotes abundant food in the form of brine shrimp and alkali flies (Winkler et al. 1977). Winkler et al. (1977) stated that increasing concentrations of dissolved ions in the lake's water as a result of stream diversions may put migratory birds under osmotic stress and prevent them for utilizing their primary food sources. However, Jehl (1987a) reported that gulls, grebes, phalaropes, and other water birds avoid osmotic stress by not ingesting saltwater while foraging and by consuming prey with dilute body fluids. These findings suggest that the abundance and availability of prey, rather than salinity, are the critical factors influencing the use of Mono Lake by most of these species over the range of lake levels observed to date (Jehl 1987a) (see Chapter 3E, "Mono Lake Aquatic Productivity").

Eared grebes are by far the most abundant migratory water birds at Mono Lake, followed by the two phalarope species (Winkler et al. 1977, Dennis Power and Associates 1980, Jehl 1988a, Wiens 1988).

Eared Grebe

Eared grebes are widespread in North America, Eurasia, and Africa (American Ornithologists' Union 1983). In California, they are abundant migrants and breed locally in marshy habitats of the Central Valley, northeastern plateau, and the Great Basin including Lake Crowley reservoir but not Mono Lake (Tillemans pers. comm.). Most eared grebes migrating through the state winter at the Salton Sea and in the Gulf of California (Small 1974, Cogswell 1977).

Status during the Diversion Period. Many thousands of migrant eared grebes visited Mono Lake in the early 1950s and their numbers are thought to have increased noticeably during the early and mid-1960s (Banta, DeChambeau, and McPherson pers. comms.); nesting at Mono Lake has never been recorded (Winkler et al. 1977). During aerial surveys in late August 1973, Jurek (1973) estimated their population density at about 7,100 adults per square mile, or approximately 437,500 birds on the entire lake. Qualitative observations during the mid-1970s suggested that many thousands of eared grebes frequented Mono Lake during fall migration (Small 1974, Cogswell 1977).

Winkler et al. (1977) made the first quantitative surveys of the lake's eared grebe population and estimated their numbers at approximately 707,000 in mid-September 1976. Intensive studies during the next decade indicated that migrant eared grebes at Mono Lake average about 750,000 individuals annually (Winkler and Cooper 1986, Jehl 1988a). This total represents the largest fall staging area in North American population (Jehl pers. comm.). Other Great Basin lakes such as the Great Salt Lake and Lake

Abert also support many thousands of migrant eared grebes, but their combined total in 1985 and 1986 was only about one-third of Mono Lake's population (Jehl et al. 1987).

Nonbreeding eared grebes begin to arrive at Mono Lake in mid-June, and the summer flock may contain 25,000 or more birds, mainly subadults or first year nonbreeders (Jehl 1988a). Postbreeding migrant adults typically arrive before the juveniles, and large numbers are present by mid-August (Winkler and Cooper 1986, Jehl 1988a). Juveniles and adults continue to accumulate at Mono Lake at rates of up to 10,000 individuals per day through the early fall, and their numbers peak in September and October (Winkler and Cooper 1986; Jehl 1987a, 1988a).

The lack of quantitative counts before the 1970s precludes any direct comparison of recent eared grebe numbers with historical population estimates. Although recent annual counts vary between about 600,000 and 900,000, peak numbers of eared grebe averaged about 750,000 through the mid-1980s (Jehl 1988a, 1988b).

Status at Point of Reference. Eared grebe populations at Mono Lake at the point of reference (1989) and during 1990 and 1991 were similar to those counted throughout the late 1980s. In fall 1992, peak populations were conservatively estimated at 966,800. (Jehl pers. comm.)

Ecological Requirements at Mono Lake. Postbreeding eared grebes use Mono Lake as a place to molt their plumage and to restore food reserves during migration (Winkler et al. 1977; Jehl 1988a, 1988b). Shortly after arriving at the lake, the adults begin to gain weight and molt their flight feathers (Storer and Jehl 1985). They continue to molt flight feathers and body plumage and are flightless for more than 1 month; during this period, their breast muscles may atrophy to about 50% of their arrival size (Gaunt et al. 1990). Eared grebes accumulate vast quantities of fat from the abundant invertebrate food and more than double their body weights while at Mono Lake (Storer and Jehl 1985; Jehl 1987a, 1988a).

During summer and early fall, eared grebes apparently prefer to forage on alkali flies and tend to congregate at nearshore areas dominated by hard substrate habitats (Winkler et al. 1977, Jehl 1988a). Later in fall, eared grebes forage in open waters far from shore probably because the food supply along the shoreline will not sustain them (Jehl 1988b). Brine shrimp populations increase through late summer and fall and at that time represent more than 90% of the eared grebe's diet; the remainder of its diet is composed of alkali flies and small numbers of terrestrial arthropods (Winkler and Cooper 1986). At the peak of fall migration, eared grebes at Mono Lake may consume more than 60 tons of brine shrimp daily (Jehl 1988a).

While at the lake, eared grebes require no free water and avoid salt intake by consuming prey with dilute body fluids and by minimizing their intake of saltwater while feeding (Mahoney and Jehl 1985). The eared grebe's daily and seasonal distribution at the lake varies with food availability, and shoaled pumice blocks and tufa towers are a favored feeding location because they provide an abundance of alkali fly larvae and pupae (Jehl 1987a, 1988a).

Eared grebes remain at Mono Lake continuously until late fall or early winter when brine shrimp populations collapse (Storer and Jehl 1985, Jehl 1988a); departure of grebes from the lake is probably precipitated by a lack of food (Winkler et al. 1977, Cooper et al. 1984, Winkler and Cooper 1986, Jehl 1988a). Before migrating, they regain flying condition by metabolizing fat reserves and rebuilding their breast muscles (Storer and Jehl 1985, Jehl 1988a).

Based on the findings of Cooper et al. (1984), the NAS (1987) concluded that densities of at least 20,000-25,000 brine shrimp per square meter are required for eared grebes to acquire sufficient food to gain weight. Jehl (1988b, pers. comm.) found that staging grebes in fall can maintain their weight at lakewide densities of about 3,000 shrimp per square meter. More precise calculations are complicated by the effects of patchiness in shrimp populations. In any case, alkali fly and brine shrimp populations were sufficient to meet grebe requirements at the historical low stand in 1982, the point-of-reference, and through 1992 (Jehl pers. comm.).

Factors Affecting Survival at Mono Lake. Numerous beached bird censuses revealed mortalities of no more than 0.5% of the migrant eared grebe population; beached juveniles were observed most frequently, especially in late fall just before migration (Jehl 1981a, 1982a, 1988a, 1988b). In spring 1982, an estimated 1,000 eared grebes were found dead at Mono Lake; the cause of death was not determined (Jehl 1982a, 1988c).

Slightly lower numbers of fall migrant eared grebes were recorded at Mono Lake in 1988 than were in previous years (Jehl and Yochem 1989). More than 1,000 dead eared grebes were found around the lakeshore in summer 1991; external examination of their carcasses did not reveal the cause of this mortality (Jehl, Rubega, and Strauss pers. comms.).

Mortality in other parts of the eared grebes' range (e.g., the unexplained die off of an estimated 150,000 birds at the Salton Sea in spring 1992) could affect the numbers of birds detected at Mono Lake in the next staging period. Knowledge of these major events is necessary for correctly interpreting population trends at Mono Lake (Jehl pers. comm.).

Importance of Mono Lake. Mono Lake is the largest known fall staging area for eared grebes in North America and is important as a large, saline lake with abundant and predictable food resources. With the exception of Great Salt Lake, no other sites in the Great Basin appear able to accommodate hundreds of thousands of grebes through their molting and staging period (Jehl pers. comm., Winkler 1982). The nearest alternative sites that currently support thousands of migrating grebes include Abert Lake, Oregon (more than 300 miles north) and salt ponds at the south end of San Francisco Bay (more than 100 miles west) (Jehl 1988c).

The Salton Sea (more than 300 miles south) is a major wintering and spring staging area for this species and hundreds of thousands of grebes, representing most of the North American population, occur there from January through March (Jehl pers. comm.). This area has a rich invertebrate fauna, and grebes appear to thrive there in most years (Jehl pers. comm.). However, the Salton Sea annually receives large volumes of agricultural and urban wastewater that undoubtedly expose migratory and nesting water birds to far higher levels of contamination (e.g., organochloride and organophosphate residues and inorganic elements) than they experience at Mono Lake (Audet and Skorupa pers. comms.).

No lakes within hundreds of miles of Mono Lake offer similar values to eared grebes in terms of size, stability, or abundance of invertebrate prey. For this reason, Mono Lake must be considered a critical staging area for hundreds of thousands of migratory eared grebes in western North America.

Red-Necked Phalarope

The breeding range of the red-necked phalarope includes arctic regions worldwide; in North America, their range extends from the high arctic to southeastern Alaska (American Ornithologists' Union 1983). This species migrates annually to wintering grounds on the open seas off the coast of Peru. In California, red-necked phalaropes are common to abundant in spring migration and very abundant in fall migration. This species is especially numerous along coastal areas and, in fall, at saline, interior lakes such as Mono Lake (Small 1974, Cogswell 1977).

Status during the Diversion Period. A lack of census counts before the mid-1970s precludes any direct comparison of recent red-necked phalarope numbers with the prediversion populations.

Studies of this species during 1981 to 1984 suggested that small numbers of red-necked phalaropes visit Mono Lake in spring, and fall migrants begin to return by mid-July (Jehl 1986b). Because they breed at higher latitudes than Wilson's phalaropes, migrating red-necked phalaropes arrive later at Mono Lake. Female red-necked phalaropes usually arrive first, and a rapid population increase in late July results from the arrival of postbreeding males. Juveniles begin to arrive in late July and their numbers peak in early September. Total red-necked phalarope numbers peak at Mono Lake in mid-August when adults are still present and juveniles are still arriving; numbers remain high until mid-September (Jehl 1986b).

Jurek (1973) conducted the first aerial censuses of water birds at Mono Lake in late August 1973 and estimated that 8,680 phalaropes (both species) were present at Mono Lake. Of those, most were sighted near land on the west half of the lake from Hot Springs (DeChambeau ponds) to an area northeast of Panum Crater. Tufa tower habitat east of Black Point and submerged pumice blocks near the Negit Islets were the primary concentration areas where 62% of all phalaropes were counted. Shallowly submerged tufa, pumice, and other hard substrates, especially those within 1 meter of the lake surface, provide optimal habitat for alkali fly larvae and pupae (Herbst 1992), the primary prey of phalaropes at Mono Lake (Rubega 1992).

The first systematic phalarope censuses were made by Winkler et al. (1977), who counted 21,600 red-necked phalaropes at Mono Lake on August 30, 1976, and suggested that their numbers peak in this period. They found the highest phalarope concentrations in open waters of the lake near shallowly submerged tufa and in shallow water near the creek deltas.

It has been estimated that individual red-necked phalaropes may not stay at the lake for more than 1 or 2 weeks (Winkler et al. 1977, Jehl 1986b). Rubega (1992), however, suspects that the birds may remain at the lake longer than was previously supposed, and that the absence of weight gain may result from a less than optimal diet rather than a short stay at the lake. Due to uncertainties about the duration of their stay at the lake, total population estimates are difficult to make (Rubega 1992). Within the limits of sampling error, however, total population estimates ranged between 52,000 and 65,000 from 1981 to 1984, which represents roughly 2-3% of the Western Hemisphere's population (Jehl 1987a). However, only about 30,000 red-necked phalaropes were observed in 1983, an El Nino year characterized by reduced food supplies on the birds' winter range (Jehl 1986b, 1987a).

The spatial distribution of phalaropes at Mono Lake observed by Jurek (1973) continued through the diversion period at least until the lake surface elevation dropped below 6,376 feet in 1977. Above this elevation, phalaropes foraged in large numbers near tufa groves and submerged pumice blocks along the western and northern shoreline of the lake (Jurek 1973, Ford pers. comm.). Thousands of red-necked phalaropes were also observed in the western embayment of the lake during 1983 to 1987, when the lake surface temporarily rose as high as 6,381 feet (Obst pers. comm.).

For the period 1978-1980 when the lake surface elevation first dropped below 6,376 feet, no information about phalarope distribution is apparently available.

During the period of temporary lowstand of the lake near 6,372 feet elevation in 1981 and 1982, a substantial number of birds remained in the western embayment, but a large number were also counted in the eastern half of the lake in all but one census (Jehl 1986b). A comparison of observed bird distributions in 1981 and 1982 (Jehl 1986b) revealed that they were often found along the northern shoreline, but birds were found in many parts of the lake in both years. However, Jehl (pers. comm.) indicated that his observations in these years and several years thereafter showed that distributions were similar throughout the period of lowstand and the temporary highstand. He associated the distributions with patterns of shallowly submerged tufa, although the accessibility of tufa and other hard substrates to alkali fly pupae changes with the lake elevation. The relationship of hard substrate availability to lake level is evaluated in the "Impacts" section of this report.

Other important concentrations of fall-migrating red-necked phalaropes include 242,000 individuals at the Great Salt Lake (Paul 1983), tens of thousands at Lake Abert, Oregon (Jehl 1986b); an apparently undetermined number of migrants also visit the Salton Sea (Garrett and Dunn 1981).

Status at Point of Reference. Because of uncertainty about the turnover rates of red-necked phalaropes at Mono Lake, total annual population estimates are difficult to make. For this reason, daily census data for peak periods in different years probably provide the best assessment of population changes (Rubega 1992).

Teams of observers conducted intensive, full-lake counts of phalaropes (both species) and eared grebes simultaneously from a boat and from land between August 7 and September 16, 1990 and between July 10 and August 11, 1991. The peak red-necked phalarope count in 1990 was 17,536 on September 16; in 1991 the peak count was 18,000 on August 11. (Rubega 1992.) (Jehl (pers. comm.) reported 45,000 red-necked phalaropes at the lake on September 2, 1992, and as late as September 26, 12,000 individuals remained. These high counts are unprecedented and difficult to interpret in light of census results from any previous years (Jehl pers. comm.).

Jehl's (1986b) data for the years 1981 to 1984 are the most complete and detailed information available for comparison with these recent data. His maximum counts from these years were 10,078 (August 10, 1981), 10,910 (September 2-3, 1982), 8,000 (August 10, 1983), and 12,000 (August 13, 1984). Because Jehl (1986b) and Rubega (1992) used somewhat different census techniques, some variability in their daily census results would be expected.

In recent years as the lake surface elevation has again declined below 6,376 feet, the distribution of red-necked phalaropes and Wilson's phalaropes appears to have changed substantially from distributions observed during the mid- and late-1980s. Rubega (1992) and Jehl (pers. comm.) consistently find that almost the entire migrant populations of both species currently forage and spend most of their time in the northeastern sector of the lake.

A large area of shallowly submerged pumice blocks in the northeast sector of the lake provides favorable habitat for alkali fly reproduction. Recent, intensive surveys of the distribution of alkali fly larvae and pupae at Mono Lake suggest that they typically occur in aggregated patches that often correspond to foam lines and other zones of water circulation convergence in the lake (Herbst 1992). These surveys revealed that the highest alkali fly densities (larvae, pupae, and emerging adults) were at foam lines in the northeastern sector of the lake. Foam lines at the lake are ephemeral, and when present they attract hundreds of foraging phalaropes. The largest numbers of phalaropes, however, forage most consistently in the immediate vicinity of shallowly submerged tufa formations and pumice blocks, as well as in longshore pools (formed by the longshore drift of sand) along the northeastern shoreline (Rubega 1992).

Although the lake currents and submerged hard substrates in the northeastern sector of the lake may provide sufficient prey to sustain current red-necked phalarope populations at Mono Lake, their restricted distribution suggests that they do not currently find the western embayment of the lake to be a suitable foraging habitat.

Ecological Requirements at Mono Lake. Unlike Wilson's phalaropes and eared grebes, red-necked phalaropes do not accumulate great fat stores at this point in their migration, and it follows that they do not use Mono Lake as a staging area prior to undertaking a long, nonstop migration to their wintering grounds (Jehl 1986b). While at the lake, they may visit fresh water to bathe and drink, especially at DeChambeau ponds, springs, and creek deltas (Winkler et al. 1977, Rubega pers. comm.). Thus, while the physiological requirements of this species at Mono Lake have not been determined, laboratory and field studies strongly suggest that fresh water is important to migratory red-necked phalaropes (Rubega pers. comm.).

Factors Affecting Survival at Mono Lake. NAS (1987) noted that existing data were inadequate to characterize the effects on red-necked phalaropes at Mono Lake of changes in prey densities that result from changing lake salinities, but suggested that red-necked phalaropes would eat brine shrimp if alkali fly populations were significantly reduced at Mono Lake.

Recent laboratory studies by Rubega (1992), however, revealed that red-necked phalaropes reject brine shrimp as a food source unless the birds are near their starvation weight. Moreover, phalaropes that were on a diet of only brine shrimp lost weight even though they consumed three times their body weight in brine shrimp over a 12-hour period, while birds that were maintained on diets of alkali fly adults or larvae gained weight. Although the laboratory environment differs greatly from the Mono Lake environment (the captive birds were given unlimited food and expended less energy than free-living birds), the experiments indicated that red-necked phalaropes that are unable to meet their minimal metabolic requirements on alkali flies would most likely abandon Mono Lake as a migratory stopover point before switching to a diet almost entirely of brine shrimp (Rubega 1992).

Lake levels that maximize alkali fly production are of most benefit to red-necked phalaropes. Laboratory experiments demonstrated that this species is strongly affected by changes in prey densities; at current average alkali fly densities, birds feeding in the wild make approximately 1.5 attempts to catch a single prey item as birds in the laboratory (Rubega 1992). Moreover, females do not reach an upper limit of their feeding rate at prey densities many times higher than the current lakewide average (Rubega 1992). Even the maximum local prey densities observed by Herbst (1992) in the northeastern sector of the lake (e.g., 50-100 individuals per cubic meter) are 5-10 times lower than the optimal foraging density of red-necked phalaropes under laboratory conditions (Rubega 1992).

Ongoing analyses of data from field observational studies (Rubega 1992) appear to corroborate the results of the laboratory studies. Mean feeding efficiencies on alkali fly larvae in the laboratory are significantly higher than those in the field, indicating that laboratory-based feeding studies underestimate the negative effects of decreasing prey densities in a field situation (Rubega 1992).

Rubega (1992) also observed that red-necked phalaropes, while foraging at Mono Lake, frequently display territorial behavior near fully or partially submerged tufa blocks where alkali fly larvae and pupae are locally abundant. Because defensive behaviors are energetically expensive, they are sometimes viewed as a sign of a limited or unevenly distributed food resource. Despite what has been described as a superabundance of prey at Mono Lake (NAS 1987), these observations indicate that under current conditions, prey densities do not permit red-necked phalaropes to forage at optimal rates (Rubega

1992). For this reason, it cannot be assumed that current alkali fly densities at Mono Lake are nonlimiting to red-necked phalaropes.

Importance of Mono Lake. Thousands of red-necked phalaropes migrate across the Great Basin in fall, and Mono Lake is a traditional migratory stopover point that provides abundant food important to the successful completion of their long-distance migratory flights (Winkler et al. 1977, 1982; Rubega 1992).

While at Mono Lake, red-necked phalaropes deposit sufficient fat to power flights of 1,000 miles or more (Winkler et al. 1977); after arriving at the ocean, they probably make a series of short flights rather than one long flight to their wintering grounds (Jehl 1986b). Red-necked phalaropes migrate extensively over the open sea and inland areas of both continents of the Northern Hemisphere (Hayman et al. 1986). Thus, while Mono Lake may be critical to regional populations, it is not essential to the overall survival of this species (Wiens 1988).

Fat reserves acquired at Mono Lake are especially important to regional red-necked phalarope populations because no comparable lakes (in terms of size or aquatic productivity) exist in its vicinity (Winkler 1982). Mono Lake and Great Salt Lake provide the only dependable food supplies and staging areas for red-necked phalaropes migrating through the Great Basin (Winkler 1982). The nearest alternative sites that might accommodate significant numbers of migrating phalaropes are Abert Lake in Oregon, Stillwater National Wildlife Refuge in Nevada, salt ponds at the south end of San Francisco Bay, and the Salton Sea. As discussed under "Eared Grebes", large volumes of agricultural and urban waste-water may expose waterbird populations at the Salton Sea to elevated levels of contamination (Skorupa pers. comm.).

Wilson's Phalarope

The breeding range of the Wilson's phalarope is restricted to North America and extends from British Columbia across the Canadian prairies to Manitoba and south to California (American Ornithologists' Union 1983). In California, this species rarely nests in the Central Valley but is an uncommon breeder in Great Basin marshlands, including Mono Basin (Small 1974, Cogswell 1977, Jehl pers. comm.). Wilson's phalaropes migrate annually to wintering grounds at high latitude saline lakes in southern Bolivia, northern Chile, and Argentina (Jehl 1988a). During migration, they are especially common at interior saline wetlands such as Mono Lake.

Status during the Diversion Period. A lack of counts before the mid-1970s precludes any direct comparison of recent Wilson's phalarope numbers with historical population estimates (Jehl 1988a).

During aerial censuses of Mono Lake in August 1973, Jurek (1973) estimated that 8,680 phalaropes (both species) were present, most of which were near land along the western lakeshore (see

"Red-Necked Phalarope" above). Winkler et al. (1977) estimated the Wilson's phalarope population at Mono Lake to be about 93,000 on July 26, 1976 and suggested that their numbers peak in this period.

Adult females begin to arrive at Mono Lake in mid-June and are followed by smaller numbers of adult males in early July. Small numbers of juveniles (2% of the total population) arrive in late July and early August when peak numbers are present at the lake (Jehl 1988a). Most adults have migrated south by mid-August, and the juveniles have departed by early September (Jehl 1988a).

The total number of Wilson's phalaropes at Mono Lake varies annually, and correct estimates of their population there requires information on turnover rates. Jehl (1988a) considered evidence from arrival and departure weights, molt condition, and distributional data from other localities to estimate the Mono Lake flock at 77,950 in 1981 and 65,780 in 1982. Within the limits of censusing accuracy, Jehl (pers. comm.) detected no differences in Wilson's phalarope population size between 1980 and 1986, when the flock was estimated at 50,000-60,000 individuals. After 1986, however, the number of individuals of this species began to decline.

Surveys conducted in the western United States and Canada indicate that the Great Salt Lake supported the highest concentration of Wilson's phalaropes with an estimated 404,000 present in late July 1982 (Paul 1983). About 387,000 Wilson's phalaropes were present at the Great Salt Lake during late July 1986 (Paul and McKay 1989). Other important fall concentration areas for this species include salt lakes in Canada, Montana, Nevada, and South San Francisco Bay (Jehl 1988a, 1988c).

Status at Point of Reference. Rubega (1992) recently made systematic censuses of phalaropes at Mono Lake (see "Red-Necked Phalarope" section). Her data suggest a possible decline of this species from Jehl's (1988a) counts from 1980 to 1986. Rubega's (1992) peak counts included 9,037 on August 10, 1990, and 35,225 on July 18, 1991. During his study, Jehl (1988a) made a maximum peak estimate of 70,000 +/- 10,000, which is approximately twice Rubega's (1992) highest count. Jehl (pers. comm.) noted that Wilson's phalarope numbers in 1992 were very low, and the peak count was 3,400 individuals on August 10. He also reported low counts for this species at the Great Salt Lake, suggesting a possible response to the long-term drought on their prairie breeding grounds.

Jehl (pers. comm.) indicated that the major foraging and roosting areas of Wilson's phalaropes have tended to be on the eastern side of Mono Lake through the 1980s, regardless of lake level. He also noted that some years they are found in the western embayment and substantial variations between years obscure any general trends about phalarope distribution at the lake.

Others, however, observed large phalarope concentrations (e.g., thousands of individuals) in the western embayment of the lake in the mid-1980s when lake elevations were higher (Banta and Obst pers. comms.). Further, Rubega (pers. comm.) reported that both Wilson's and red-necked phalaropes have been consistently in the northeastern sector of the lake since 1989; the lake's elevation fell to about 6,376 feet in that year and exposed large acreages of tufa and pumice blocks (Stine 1992) that were formerly used as hard substrates for the attachment of alkali fly pupae (Herbst et al. 1984). Thus, evidence from the early 1990s suggests that important foraging areas along the western shoreline are currently unavailable to this species.

Ecological Requirements at Mono Lake. Winkler et al. (1977) observed territorial male Wilson's phalaropes at Mono County Park and at Sneaker Flat along the western shoreline during May and June 1976, but they did not confirm that this species nested at Mono Lake. They considered Wilson's phalaropes probable breeders because of the presence of large areas of wet meadow and low marsh nesting habitat and estimated that the species' total nesting population did not exceed 30 pairs. In 1984, Shuford (pers. comm.) observed a Wilson's phalarope nest at Mono Lake County Park, confirming nesting at the lake. Similarly, Jehl (pers. comm.) has confirmed that this species is nesting at Simon's Spring, and he feels that 30 pairs is probably the maximum reasonable estimate.

Migrant Wilson's phalaropes may not require fresh water for drinking; the dilute body fluids of their prey probably supply most of their water needs (Mahoney and Jehl 1985). While at Mono Lake, however, thousands of Wilson's phalaropes have been observed making early morning, evening, and nocturnal visits to County Park, South Tufa Grove, Simon's Spring, Rush Creek, DeChambeau ponds, Gull Bath (at the mouth of Wilson Creek), and other freshwater wetlands to bathe and possibly to drink (Jehl 1987a, 1988a; Rubega, Strauss, and Shuford pers. comms.).

Adult Wilson's phalaropes remain at Mono Lake continuously for 30-40 days to molt and accumulate their fat reserves (Jehl 1988a, 1988b). During this period, they molt their body plumage and most wing and tail feathers, and often double their body weight (Jehl 1988a, 1988b). The rate of molting and fattening is extremely rapid compared to other birds and is made possible by the invertebrate food available at Mono Lake (Jehl 1988a). Juveniles do not attain the great weight characteristic of premigratory adults, and they do not use Mono Lake as a migratory staging area (Jehl 1988a).

Adult females represent about 70% of the lake's population, and they tend to congregate in open water where they forage for brine shrimp and smaller amounts of alkali fly pupae (Jehl 1988a, 1988b). Males forage closer to shore and consume a higher proportion of alkali flies; flies also predominate in the juveniles' diet (Jehl 1988a). Herbst et al. (1984) found that all developmental stages of alkali flies were nutritionally superior to brine shrimp, both in total caloric value and lipid content. During the final 2 weeks of their stay at Mono Lake, however, both males and females forage primarily on brine shrimp because their increased weight makes it difficult to capture agile fly larvae (Jehl 1988b).

Factors Affecting Survival at Mono Lake. The relationship of alkali fly abundance to survival of red-necked phalaropes was discussed in the "Red-Necked Phalarope" section above. Much of this assessment also may apply to Wilson's phalaropes, especially juveniles, which depend substantially on alkali flies for their diet at Mono Lake (Jehl 1987a, Rubega 1992).

Importance of Mono Lake. Mono Lake is one of the world's most important migratory stopover points for Wilson's phalaropes (Winkler 1982, Jehl 1988a), serving as a critical staging area before this species' nonstop, 3,000-mile migratory flight to its wintering grounds (Winkler et al. 1977, Jehl 1988a).

No similar lakes (in terms of size or invertebrate productivity) exist in the vicinity of Mono Lake, which therefore provides one of the few dependable food supplies and staging area for Wilson's phalaropes migrating through the western Great Basin (Jehl 1981b, 1988a; Winkler 1982). The nearest alternative sites in California that might accommodate significant numbers of migrating phalaropes are the contaminated Salton Sea and salt ponds at the south end of San Francisco Bay. Abert Lake, Oregon, is also a dependable migratory stopover point, and it occasionally holds as many or more staging birds as Mono Lake (Jehl pers. comm.). Other alternative sites include Stillwater National Wildlife Refuge (often dry) and evaporation ponds in the Tulare Lake Basin where selenium levels in bird tissues are higher than those recorded at Kesterson National Wildlife Refuge (Skorupa pers. comm.).

Wildlife on Lands and Wetlands Surrounding Mono Lake

General

Substantial populations of migratory shorebirds continue to stop at Mono Lake. Snowy plovers, federal candidates for threatened or endangered status, that were not observed at Mono Lake in prediversion times breed there today. The large populations of migratory waterfowl in the prediversion period, however, are no longer present.

By 1989, stream diversions and the resultant lowering of Mono Lake had exposed approximately 14,560 acres of formerly submerged lakebed (the "relicted" lands). Almost 6,000 acres of this area (Table 3F-2) are covered with an alkaline salt crust (alkali flats) that supports no vegetation and provides extremely low wildlife habitat value except for snowy plovers (Appendix D).

Wetlands proximate to the lake also changed. The lower lake level and tributary stream incision resulted in the drainage of ponds on the deltas; lakeshore marshes, ponds, and the extensive lagoons in the northeastern shoreline area desiccated due to a drop in the water table. Overall, almost 260 acres of open-water habitat around the lakeshore lost during the diversion period were replaced with large expanses of saline wetlands having little open water area (Table 3F-2).

Current lakeshore areas are dominated by alkali flats (about 50% of the current shoreline acreage), dry and alkali meadows, and tall and short emergent marshes (Table 3F-2), which support relatively few wildlife species (Appendix D).

Wetland Habitats

Alkali and Dry Meadows. Alkali and dry meadows currently occupy almost 4,000 acres around the Mono Lake shoreline, representing a 95% increase since the prediversion period (Table 3F-2). Wildlife species in these habitats are relatively few because vertical structure, vegetative diversity, and moisture are lacking. The large acreage of alkali and dry meadow habitats around Mono Lake provides some cover and limited foraging opportunities, but no water. Species that use this habitat include horned larks, violet-green swallows, savannah sparrows, red-winged blackbirds, Brewer's blackbirds, black-tailed hares, Panamint kangaroo rats, deer mice, and coyotes (Appendix D).

Wet meadows (including brackish and freshwater conditions) currently occupy about 50 acres around the lake's shoreline (Table 3F-2). Despite their typically high plant diversity, wet meadows receive limited wildlife use due to their limited extent and lack of open water. Species using wet meadows include killdeer, Wilson's phalaropes, horned larks, violet-green swallows, cliff swallows, song sparrows, red-winged blackbirds, western meadowlarks, Brewer's blackbirds, montane voles, and Great Basin spadefoot toads (Appendix D).

Emergent Marsh. Currently, almost 1,000 acres of short and tall emergent marshes exist around Mono Lake, representing more than 90% increase in these habitats since the prediversion period (Table 3F-2). Most existing emergent marsh habitats at the lake are very dense and typically lack open-water areas that are attractive to waterfowl and other common marsh inhabitants. Short emergent marsh vegetation supports killdeer, American avocets, Wilson's phalaropes, violet-green swallows, savannah sparrows, red-winged blackbirds, yellow-headed blackbirds, and Brewer's blackbirds (Appendix D). Tall emergent marsh vegetation provides important nesting habitat and hiding cover for Virginia rails, yellow-headed blackbirds, and other marsh-nesting birds requiring tall cattails and bulrushes. The relative lack of fresh or brackish open water near the lakeshore, however, limits the accessibility of this habitat to waterfowl, herons, egrets, and other birds that typically frequent tall marsh vegetation in the Great Basin.

Snowy Plover

This species' breeding range extends across much of North America, Eurasia, and portions of South American (American Ornithologists' Union 1983). In North America, it breeds along the Gulf coast and Pacific coast from Washington south to California; in California, it nests commonly along the coast where there are suitable sandy beaches free from human disturbance. Recent statewide surveys revealed that breeding adults, however, were more common at interior locations, such as Mono Lake, Owens Lake, the Salton Sea, and Alkali Lakes in Surprise Valley, rather than along the coast (Page and Stenzel 1981, Page and Bruce 1989). Recent surveys of Western North America suggest about 7,800 breeding adults at interior locations and about 1,900 adults along the coast (Page et al. 1991).

Status during the Diversion Period. Winkler et al. (1977) first recorded nesting snowy plovers at Mono Lake and estimated at least 10 nesting pairs and more than 100 total birds during fall migration. However, this species probably had nested at Mono Lake in previous years and remained undiscovered because it nests in barren and remote portions of the lakeshore (Winkler 1987).

In 1978, statewide censuses for this species revealed 384 individuals at Mono Lake (Page et al. 1979), representing 11% of California's breeding population and the state's second largest concentration of nesting birds (Page and Stenzel 1981). Regional surveys in the late 1980s indicated that the Mono Lake breeding population had declined by 42 individuals since the 1978 surveys (Page and Bruce 1989). This apparent population decline may have resulted from variable census coverage and intensity in different years rather than an actual decline in Mono Lake's snowy plover population (Page and Bruce 1989, Page pers. comm.).

Page et al. (1983) and Winkler (1987) analyzed the adult survival rate and reproductive success of snowy plovers at Mono Lake and determined that large-scale population increases or decreases were not evident during the mid-1980s when the lake's levels fluctuated dramatically. This suggests that potential snowy plover nesting habitat may be superabundant at Mono Lake, because its population did not increase significantly during the late 1980s when the falling lake level exposed large acreages of potential alkali-flat breeding habitat (Page pers. comm.). Conversely, the nesting population did not decrease significantly during 1983 and 1984 when the lake elevation rose by 9 feet and inundated thousands of acres of alkali flats.

The snowy plover population at the historic lakebed of Owens Lake was the state's largest in 1978 (Page and Stenzel 1981, Swarth 1983). However, this population declined by more than 60% during the next decade for unknown reasons (Page and Bruce 1989, Page pers. comm.).

Status at Point of Reference. Mono Lake's snowy plover population has not been censused systematically since 1988 (Page pers. comm.), so its status at the 1989 point of reference cannot be assessed. Page and Bruce (1989), however, found little change in this population in the last decade despite major changes in the amount of potential alkali flat breeding habitat. For this reason, one can assume that the population in 1989 was similar to that reported the previous year by Page and Bruce (1989).

At the point of reference (6,376.3 feet), snowy plovers had almost 10,000 acres of potential nesting habitat on alkali flats (about 6,000 acres) and pumice berms and other barren habitats (Chapter 3C, "Vegetation") around Mono Lake's shoreline. Assuming nesting densities of one pair per 6 hectares (about 14.8 acres; see discussion in the "Factors Affecting Survival at Mono Lake" section below), about 2,516 acres of breeding habitat would be required to support the current nesting population of 340 adults (about 170 pairs). Thus, approximately 6,500 acres or 72% of the potentially suitable habitat at Mono Lake were unoccupied by nesting snowy plovers at the point of reference.

Ecological Requirements at Mono Lake. Snowy plovers nest in alkali flats and sand dune habitats around the eastern half of the lake and a small population also exists along the northwestern shoreline near the county park (Winkler 1987). In most years, snowy plovers nest on pumice berms far from the current lakeshore early in the breeding season (i.e., mid-April to late May) and are more typical on the low, alkali flats in the late season (i.e., early June to mid-July) (Page et al. 1983, Page pers. comm.).

Snowy plovers lay three eggs in pebble-lined scrapes; their nesting season at Mono Lake extends from mid-April to mid-July (Page et al. 1983, Winkler 1987). Clutches located near objects are typically less successful than those laid in the open or beneath objects; those on sand-gravel substrates tend to fail more often than those on open alkali flats (Page et al. 1985). The young leave the nests almost immediately and begin foraging with their parents (Winkler 1987).

Snowy plovers probably forage over large, open areas of alkali flat and dune habitats, but adults and juveniles concentrate most of their feeding in moist areas because such areas typically attract abundant insect prey (Winkler 1987). Swarth (1983) examined densities of the snowy plover's prey, mostly flies and beetles, in five major microhabitats around Mono Lake and determined that the region within 25 meters of the lakeshore and freshwater seeps had the highest abundance of ground-dwelling arthropods. More snowy plovers tended to forage along the shoreline than at seeps, which can be more than 1 mile from their nesting sites (Swarth 1983, Page pers. comm.). Their diet consists primarily of alkali fly adults and larvae and two species of beetles (Swarth 1983).

Access to a water source (either fresh water or saltwater) may be a breeding requirement for snowy plovers, but they may nest hundreds of meters away from water when unobstructed corridors are available for the chicks to walk to the source (Page and Stenzel 1981). Thus, snowy plovers can breed successfully in relatively flat shoreline areas at Mono Lake where the water line may retreat during the nesting season (Page and Stenzel 1981).

Factors Affecting Survival at Mono Lake. During 1978 and 1981, Page et al. (1983) observed the failure of 122 clutches at Mono Lake. The cause of 71 failures could not be determined. The other clutches were lost because of predators (41), humans (one), wind (one), and desertion (eight). The primary predators of snowy plover clutches were California gulls (28), coyotes or domestic dogs (seven), and common ravens (six). Continuing field observations at Mono Lake suggest that gulls prey on snowy plover nests incidentally while scavenging along the shoreline. Coyotes and dogs also are considered incidental predators of snowy plover nests (Page pers. comm.). Ravens, however, are predators that systematically search the alkali flats for nests.

Page et al. (1983) conducted a series of experiments with artificial nests to determine the effects of nest spacing as a defense against predation. Using artificial nests with quail eggs marked to resemble snowy plover eggs, they demonstrated that predators could have an adverse effect on snowy plover reproductive success if nests are placed close together. With high nest densities, gulls and other predators can find nests more easily and reduce their searching time. Based on this work, Page et al. (1983)

hypothesized that low nesting densities (approximately one nest per 6 hectares [14.8 acres]) over large areas are an effective defense against gull predation.

The declining water levels of Mono Lake during the past 50 years have exposed large acreages of alkali flats. As a result of increased breeding habitat, snowy plover populations at the lake have probably expanded. Presumably, shallow creeks, seeps, and saline groundwater in lakebed sediments would sustain moist conditions and continue to attract sufficient arthropod prey to sustain nesting snowy plovers.

Importance of Mono Lake. Western snowy plovers are federal candidates (Category 2) for listing as threatened or endangered (56 FR 58804-58836). USFWS has also proposed the coastal population of this subspecies as threatened, under the federal Endangered Species Act of 1973 (57 FR 1443-1449, January 14, 1992). Interior snowy plover populations, such as those breeding at Mono Lake, were not included in this listing proposal because the intermixing of coastal and interior populations has been documented only on a few occasions. Because of the overall declines of this federal candidate species, however, the large population at Mono Lake has regional significance as one of the state's most important breeding concentrations.

Other Shorebirds

Status during the Diversion Period. Repeated shorebird surveys were conducted at the Mono Marina and at the South Boat Ramp between 1971 and 1973 (Jurek 1974). These surveys revealed large numbers of killdeer, western sandpipers, American avocets, Wilson's phalaropes, and red-necked phalaropes, suggesting that Mono Lake is one of the state's most important inland stopover points for migratory shorebirds (Jurek 1974).

Jurek (1973) estimated 4,030 American avocets during aerial surveys of Mono Lake in August; these birds were concentrated along the northwest, south, and east shorelines and exposed lakebed sediments. Winkler et al. (1977) did not document nesting of American avocets at Mono Lake but suggested that this species may have nested on Paoha Island in the mid-1960s, and on the land bridge to Negit Island in the early 1980s (Gaines 1988).

An additional 25 shorebird species were identified at Mono Lake during the 1976 surveys, and nesting was confirmed for snowy plover, killdeer, common snipe, and spotted sandpiper (Winkler et al. 1977). American avocets, Wilson's phalaropes, and probably black-necked stilts also have nested at Mono Lake (Gaines 1988). Large, freshwater mudflats, springs, and seeps along the southeastern shoreline of Mono Lake (i.e., Simon's Spring and its vicinity) were reported to contain the highest quality shorebird habitats, where 19 shorebird species reached peak abundance. A survey of lakes in northeastern California concluded that Mono Lake was of outstanding importance to several species of migratory shorebirds (Winkler 1982).

Status at Point of Reference. The Point Reyes Bird Observatory (PRBO) has sponsored spring and fall shorebird counts at coastal and inland areas of California since 1989 (Shuford pers. comm.).

PRBO shorebird counts conducted at Mono Lake in late August of 1989, 1990, and 1991 revealed the presence of 27 shorebird species. Aside from the phalaropes, high counts for the most abundant species included American avocet (8,467), western sandpiper (4,043), least sandpiper (1,408), and killdeer (202). High spring counts of the most abundant species in this 3-year period included semipalmated plover (286), American avocet (1,564), western sandpiper (19,107), and least sandpiper (4,810) (Shuford pers. comm.). Wilson's and red-necked phalaropes were counted during the PRBO surveys, but land-based counts of these species in late August were not considered estimates of their peak populations at Mono Lake (Shuford pers. comm.).

Because of its importance as a migratory stopover point for Wilson's phalaropes and other shorebirds, Mono Lake was designated as part of the Western Hemisphere Shorebird Network in September 1991. As one of only 17 sites in the Western Hemisphere to receive this designation, Mono Lake is considered a shorebird habitat of international importance.

Ducks

Status during the Diversion Period

Populations from 1940 to 1945. According to long-term residents of Mono Basin, early diversions appeared to have had little effect on migratory duck populations at Mono Lake. Major concentrations continued to be present through the 1940s, and ducks were especially abundant at lakeshore ponds, lagoons, and marshes, as well as at the creek deltas where freshwater streamflows floated over the more saline waters of the lake for variable distances (Banta, DeChambeau, and McPherson pers. comms.). In the early 1940s, about 260 acres of open water habitat existed around the lakeshore. The largest areas of open water were a discontinuous chain of brackish lagoons along the northeastern shoreline near Sulphur Springs; the DeChambeau lagoon near Black Point; and ponds near the deltas of Lee Vining, Rush, and Wilson Creeks (Stine 1993).

Creek deltas and ponds offered sources of fresh water for drinking and bathing, and the lagoons provided relatively sheltered areas for foraging and resting away from the frequently turbulent waters of Mono Lake (Banta, DeChambeau, McPherson pers. comms.). During peak fall migration, concentrations of northern shovelers and other ducks in these areas reportedly were so dense that, at a distance, they made the shallow water "look like land" (DeChambeau and McPherson pers. comms.).

A cattail-lined pond on the west side of Lee Vining Creek was an especially good place to hunt during windy conditions when the ducks would leave the lake in search of calmer waters. The pond existed before the diversion of Lee Vining Creek, and it remained until the early 1950s (Banta pers. comm.). Mallards, American wigeons, green-winged teals, and northern pintails were common species at freshwater bodies away from the lakeshore in the early diversion period. Diving ducks such as canvasbacks and redheads frequented deeper ponds near the lake, such as the DeChambeau lagoon (Banta, DeChambeau, and McPherson pers. comms.).

Populations from 1945 to 1949. In the mid-1940s, about 50 acres of artificial ponds were created for a duck club near the mouth of Rush Creek (Stine 1993). These ponds were watered by diversions from Rush Creek, so they probably contained water only intermittently after 1947 when full-scale diversions of the tributary streams began (Stine pers. comm.). As long as water was available, however, these ponds offered excellent duck hunting (Banta, DeChambeau, and McPherson pers. comms.).

The first systematic waterfowl surveys at Mono Lake were performed by DFG biologist Walter Dombrowski[1], who also managed the Rush Creek duck club and acted as a duck hunting guide in Mono Basin. His surveys were part of the Bureau of Sport Fisheries and Wildlife's (now USFWS) Pacific Flyway Waterfowl Investigations (Dombrowski 1948). Apparently, these nationwide counts were done only in 1948 (and not in subsequent years) to assess the need for creating federal wildlife refuges to decrease waterfowl depredation of agricultural crops (Yparraguirre pers. comm.).

The most abundant species reported in Dombrowski's surveys were northern shovelers, and on November 1, 1948, Dombrowski estimated the total number of waterfowl in Mono Basin at 1 million birds, which were mainly concentrated in the Rush Creek delta (45%), Lee Vining Creek delta (10%), DeChambeau lagoon (15%), Warm Springs (5%), Simon's Spring (15%), and South Tufa (5%). Other observers said that Dombrowski's estimate of 1 million ducks was consistent with their recollections of peak fall duck concentrations in the late 1940s (Banta, DeChambeau, McPherson, and Vestal pers. comms.).

Populations from 1950 to 1969. From 1947 through 1951, diversions of Rush, Lee Vining, Parker, and Walker Creeks were increased to the point that these streams had little or no flow below the diversion points. Thereafter, freshwater inflows to the lake at the deltas of Rush and Lee Vining Creeks were reduced to a low level, except during flood periods when runoff surpassed aqueduct capacity. (Stine pers. comm.)

Despite the reduction of freshwater flows in the creeks and the loss of the Rush Creek duck ponds in the late 1940s, large concentrations of ducks continued to be reported at Mono Lake through the 1950s. The largest flocks of ducks and the best hunting were usually at lagoons along the northern and eastern shorelines, the DeChambeau lagoon, and at marshlands of the Rush Creek delta, Warm Springs, and Simon's Spring (Banta, DeChambeau, McPherson, and Vestal pers. comms.). In the mid-1950s, a 1-mile-long, spring-fed pond formed behind a lakeshore berm at Simon's Spring (Stine pers. comm.). This ponded area supported dense beds of watercress and other aquatic plants and attracted large flocks of mallards, American wigeons, green-winged teals, and other ducks (Banta and McPherson pers. comms.).

[1] Banta, DeChambeau, McPherson, and Vestal (pers. comms.) knew Dombrowski well and reported that he censused ducks at his ponds and at Mono Lake using binoculars and a 20X scope to view distant flocks. These observers emphasized that Dombrowski was an avid waterfowl observer and careful census taker who was able to correctly identify ducks in flight and on the water from great distances. During his six systematic censuses in 1948, he drove around the entire lakeshore and estimated the number of ducks present at major concentration areas. He also estimated duck population numbers from his motor boat while cruising around the lakeshore. Whether using land- or water-based surveys, Dombrowski employed a grid pattern, marked by natural landmarks such as partially submerged tufa towers, to avoid counting the same flocks twice (Vestal pers. comm.).

As the lake's surface elevation dropped during the diversion period, the acreage of marshlands around the lake actually increased, but most of the marshlands that formed were saline or brackish and lacked significant open water areas attractive to waterfowl (Banta, DeChambeau, and McPherson pers. comms.). Existing freshwater ponds were lost by incision of their drainage channels to the lake or, in the case of the delta ponds, by incision of the tributary streams, drop in water table, and lack of flow in recharge ditches (Stine 1993).

The large lagoons along the northeastern shoreline gradually diminished in size with declining lake elevations and disappeared when the lake fell below 6,405 feet in 1957; open water areas at DeChambeau lagoon and at the creek deltas were lost when the lake fell below about 6,400 feet in the early 1960s (Stine 1993). Similarly, in 1967 Rush Creek incised its delta, forcing a drop in the water table and converting former ponds and marshes to arid scrublands (Stine 1993).

Systematic duck census data at Mono Lake are not available from the 1950s or 1960s. DFG-sponsored waterfowl counts in Mono County during these decades were not specific to Mono Lake and were conducted in late January, long after most ducks had departed from Mono Basin (Yparraguirre pers. comm.). Despite the lack of census data, the combined recollections of long-term residents suggested that the loss of open water habitats and sources of fresh water around the lakeshore coincided with the abrupt declines of migratory duck populations at Mono Lake. By the early 1960s, peak duck concentrations were about half their former numbers (i.e., about 500,000); by the end of the decade, so few ducks remained that hunting was sporadic and often unproductive (Banta, DeChambeau, McPherson, and Murphy pers. comms.).

In contrast to the declines of most ducks during the 1960s, ruddy ducks may have become more common during that decade. Long-term residents recalled that, unlike most ducks, ruddy ducks tended to be scattered across the entire lake and did not concentrate at fresh water (Banta, DeChambeau, and McPherson pers. comms.).

Populations from 1970 to 1988. During the 1970s and 1980s, Mono Lake's elevation varied between a high of about 6,386 feet in the early 1970s to its historical lowstand of about 6,372 feet in 1982. Even at the highest lake elevation reached in these decades, however, few areas of protected open-water habitat or sources of fresh water were available for migratory ducks (Stine 1993).

Populations of most migratory ducks declined across North America during the 1970s and 1980s (Caithamer et al. 1992), and populations at Mono Lake reflected this rangewide trend. Censuses conducted at the lake during these decades suggested that no more than a few thousand ducks were present at Mono Lake at one time. For example, during an all-lake census on September 14, 1976, Winkler et al. (1977) observed a total of about 3,700 ducks at the lake, including more than 2,200 northern shovelers, almost 1,000 "unidentifiable teal", and almost 300 northern pintails.

Gaines (1988) reviewed bird distributional records from Mono Basin, and the highest recent duck counts he reported were 3,000 mallards at Simon's Spring on November 17, 1982, and 2,230 northern shovelers at Mono Lake on September 14, 1976. He noted that green-winged teals often outnumber all other ducks at the lake and cited a high count of 580 on January 1, 1984.

A professional wildlife biologist, who hunted ducks at Mono Lake for more than 25 years, confirmed that duck populations declined noticeably during the 1980s. He saw the fewest ducks in the late 1980s, during a period of persistent drought. (Taylor pers. comm.) Aside from frequent ruddy ducks and occasional flocks of northern shovelers on the open water, the most reliable places to find ducks around the lake are at remaining sources of fresh water such as the deltas, Simon's Spring, Warm Springs, and DeChambeau marsh. (Taylor pers. comm.)

Taylor (pers. comm.) has seen nearshore flocks with as many as 1,000 northern shovelers on a few occasions and scattered flocks totaling up to 1,000 ruddy ducks often visible from the shoreline. On most hunting trips during the late 1980s, however, he was unlikely to see more than a hundred ducks other than ruddy ducks on the entire lake.

Status at Point of Reference

Populations at Mono Lake. Based on observations made during hundreds of hunting trips in the 1980s and early 1990s, Taylor (pers. comm.) estimates the current annual lakewide populations of migratory ducks at about 11,000, including 5,000 ruddy ducks, 2,000 northern shovelers, 2,000 green-winged teals, 1,000 mallards, 500 northern pintails, 250 American wigeons, 100 gadwalls, and possibly as many as 150 assorted individuals of other species such as diving ducks (Taylor pers. comm.).

Jehl (pers. comm.) estimates the current number of migratory ducks at about 15,000, including about 5,000 ruddy ducks, 500 mallards, 5,000 northern shovelers, 2,500 green-winged teals, 750 American wigeons, 400 gadwalls, 400 cinnamon teals, and 300 miscellaneous diving ducks. His peak count in 1992 was nearly 5,000 ducks, which included about 2,000 ruddy ducks.

Thus, estimates of Mono Lake's migratory duck population at the point of reference, and in subsequent years, vary between about 11,000 to about 15,000 individuals per year. Clearly, current duck populations at Mono Lake represent a small fraction of the numbers present before diversions and through the early 1950s. Long-time residents of the region agreed the declining duck populations were the most pronounced of the changes occurring in Mono Lake's avifauna since the prediversion period (Banta, DeChambeau, McPherson, and Vestal pers. comms.).

Regional Duck Populations. It is possible that duck populations that formerly stopped at Mono Lake no longer exist or have shifted their fall migrations to other Great Basin lakes or the Central Valley (Reid pers. comm.). Duck populations have declined throughout North America in recent decades

(Caithamer et al. 1992), principally due to losses of breeding and wintering habitat. For example, total waterfowl populations (i.e., including ducks, geese, and swans) in the Central Valley have declined from 10-12 million birds in the mid-1960s to a current population of 4-5 million, representing an approximate decline of about 40-60% in these years (Reid pers. comm.).

Systematic duck census data are not available from Mono Lake from peak migration periods during the 1960s (Yparraguirre pers. comm.), but local residents reported that major declines in the lake's duck populations began at about that time (Banta, McPherson, and Murphy pers. comms.). Assuming that their numbers declined by about half between the late 1940s and early 1960s (i.e., to about 500,000), and assuming about 15,000 ducks visited Mono Lake at the point of reference, the lake's duck populations have declined by about 97% since the mid-1960s. Compared to the magnitude of the decline in waterfowl in the Central Valley, the greatly reduced numbers of ducks in Mono Basin since the 1960s suggest that fundamental changes in the quality of the duck habitat at the lake have occurred during the diversion period (Reid pers. comm.).

Ecological Requirements at Mono Lake. Prediversion accounts indicated that most ducks at Mono Lake concentrated near sources of fresh water, such as deltas and springs, to bathe and drink (Banta, McPherson, Preston, and Vestal pers. comms.). Similarly, the few remaining migratory ducks at the lake frequently visit extant sources of fresh water, such as the DeChambeau ponds and the creek deltas (Banta, Rubega, Shuford, Strauss, and Taylor pers. comms.). Ruddy ducks, currently one of the most common ducks at Mono Lake, have a higher salinity tolerance than other ducks and visit sources of fresh water less often (Jehl pers. comm.). The effects of salinity on waterfowl are discussed in the survival factors section below.

Systematic studies of waterfowl foraging behavior at Mono Lake have not been performed. DeChambeau and Taylor have examined the crop contents of mallards, northern pintails, green-winged teals, and many other ducks shot at the lake and the dominant prey were larvae and pupae of alkali flies. DeChambeau recalled ducks foraging in windrows of alkali flies along the lakeshore. Banta, DeChambeau, and McPherson have observed northern shovelers foraging at close range; the shovelers appeared to be consuming mostly brine shrimp and algae while at Mono Lake (DeChambeau, Taylor, Banta, and McPherson pers. comms.).

Factors Affecting Survival at Mono Lake. Swanson et al. (1984) examined the factors influencing waterfowl use of saline lakes in North Dakota and concluded that ducklings were closely associated with freshwater inflows from spring seepages or adjacent wetlands with low salt concentrations. In general, ducks tended to use lakes with sheltered bays and chemically stratified water that provided a thin layer of fresh water on the surface (Swanson pers. comm.).

Under laboratory conditions, ducklings 1-3 days old experienced some mortality at 16 g/l and would not tolerate concentrations greater than 20 g/l unless a source of fresh water was available nearby (Swanson et al. 1984). Salt concentrations greater than 17 g/l significantly reduced duckling growth, and high levels of magnesium and sulfates caused the birds greater physiological stress than equivalent concentrations of sodium chloride. Mitcham and Wobeser (1988) also reported numerous sublethal effects on growth and feather development among mallard ducklings that were fed brackish or moderately saline water; some mortality resulted when ducklings raised on fresh water were abruptly fed saline water.

The chemistry of Mono Lake is very different from prairie lakes, but a similar phenomenon of salt avoidance behavior apparently occurs. Mono Lake's waters are high in sulfates but magnesium is present only in trace amounts (NAS 1987). Under prediversion conditions, the lake's salinity was approximately 50 g/l and far exceeded the apparent limits of successful waterfowl reproduction. Significant amounts of fresh water also floated on the surface, especially near the deltas, which probably enhanced the attractiveness of these areas to ducks. As described earlier, prediversion observations suggested that migratory ducks probably spent most of their time at deltas, freshwater and brackish water marshes, ponds, and lagoons around the lakeshore.

At the point of reference, Mono Lake's salinity was about 90 g/l, more than twice its prediversion levels (NAS 1987). The highly saline waters may now be unattractive to ducks; the salt glands of ducks (aside from ruddy ducks) at Mono Lake are probably not as well developed as those of grebes, gulls, and phalaropes (Swanson pers. comm.).

Flightless gadwall ducklings captured at the lake have holes in the webbing of their feet and lesions on their legs (Jehl pers. comm.). The cause of this condition has not been determined, but it could be related to a foot pox (bacteriological or viral) and it could be specific to gadwalls (Jehl pers. comm.). Studies from the upper midwest, however, suggest that ducklings have a lower tolerance of highly saline lakes than adults. Further research is needed on the effects of Mono Lake's highly saline waters on young ducklings, possibly in combination with disease factors (Swanson pers. comm.).

It is unlikely that short-term migrant ducks experience any adverse physical effects caused by prolonged contact with Mono Lake's waters (Jehl pers. comm.). However, studies in the southern San Joaquin Valley suggest that, with the exception of ruddy ducks, most species of migrant and wintering ducks select freshwater wetlands in preference to highly saline evaporation ponds (Coe 1990). Because they offer large areas of fresh water, many ducks in the vicinity of Mono Lake may prefer alternative migratory stopover points such as Bridgeport Reservoir (currently nearly dry) and Lake Crowley reservoir (Gaines and Shuford pers. comms.).

The acreage of tall and short emergent vegetation around the lakeshore has increased by more than 900 acres since prediversion times (Chapter 3C, "Vegetation"), but most of these wetlands are highly saline and lack any substantial freshwater or brackish water sources that most ducks require. The combined effects of increased salinity of the lake; the reduction of freshwater inflows from Rush and Lee Vining Creeks; and the loss of springs, ponds, lagoons, and other wetlands around the lakeshore have likely caused an overall degradation of the waterfowl habitat of Mono Lake.

Importance of Mono Lake. As described earlier, in the prediversion and early diversion periods, Mono Lake was a major stopover point for at least 1 million migratory ducks. The loss of freshwater and brackish water wetlands around the lakeshore and the increasing salinity of the lake made it less attractive to migratory ducks. Estimates of current duck populations at Mono Lake range between about 11,000 and 15,000 individuals per year; even the high estimate, however, represents only about 3% of the duck populations reported at one time during the prediversion years and through the 1950s. As noted earlier, this rate of decline appears to be substantially higher than overall population declines in California.

Lake Crowley reservoir currently supports 10,000 or more ruddy ducks in fall migration (Tillemans pers. comm.) and Bridgeport Reservoir (currently nearly dry) also provides habitat for thousands of migratory ducks when it has adequate water (Gaines 1988, Shuford pers. comm.). Grant Lake reservoir also provides some potential duck habitat, but its denuded shoreline, lack of emergent vegetation, and heavy recreational boating use make it relatively unattractive waterfowl habitat (Taylor and Shuford pers. comms.). Based on numerous accounts, however, it appears that these reservoirs provide only a fraction of the duck habitat value that was once available at Mono Lake. Therefore, it is concluded that the degradation or loss of suitable habitat at Mono Lake has resulted in greatly reduced numbers of ducks stopping there during fall migration.

Geese and Swans

Seven species of swans and geese have been observed in Mono Basin and Upper Owens River, but only the Canada goose, tundra swan, greater white-fronted goose, and snow goose are likely to frequent the eastern Sierra each year; of these species, the Canada goose is by far the most common and is the only one that regularly nests in the eastern Sierra (Gaines 1988).

Status during the Diversion Period. Banta and McPherson (pers. comms.) reported that Canada geese were fairly common during the 1940s and 1950s, and they were the only geese that were likely to occur in Mono Basin at any time of year. Tundra swans and snow geese also were regular visitors to the lake in November and December. Due to their vegetarian habits, geese in Mono Basin could usually be found in wet pastures around the lakeshore or in wet meadows of the Rush Creek bottomlands. Flights of geese were frequent enough to attract local hunters, but geese represented only a small fraction of the waterfowl present in Mono Basin in this period (Banta and McPherson pers. comms.).

Status at Point of Reference. Small numbers of Canada geese nest each year on the Negit Islets, and about 30-50 individuals are present in Mono Basin year-round (Jehl pers. comm.). In addition to Canada geese, tundra swans and a few snow geese still visit Mono Basin in fall and winter (Banta, Jehl, and Taylor pers. comms.). In general, the number of geese and swans has declined from the prediversion period but not to the same extent as the ducks (Banta and McPherson pers. comms.).

Currently, Canada geese are common in Long Valley and Bridgeport Valley where they often graze in wet pastures with cattle and loaf on larger reservoirs where they are safe from mainland predators (Gaines 1988, Shuford pers. comm.). A resident population of 35-45 individuals lives near Lake Crowley reservoir, and as many as 1,000 birds may be present in this area during the peak of fall migration (Tillemans pers. comm.).

Importance of Mono Lake. Mono Lake was apparently a frequently used area by geese and swans in the prediversion period and reduced numbers currently visit the area. At present, however, other nearby areas such as the Bridgeport and Long Valleys may provide more attractive habitat for these species (Shuford pers. comm.).

Wildlife along Streams Tributary to Mono Lake

Assessment Methods

The status of wildlife along the streams tributary to Mono Lake at the point of reference was assessed by establishing the distribution of habitat types and surveying their wildlife use. The distribution of habitat types prior to diversions was also established, allowing assessment of changes in wildlife habitat and wildlife value over the diversion period (Table 3F-3).

SWRCB consultants mapped approximately 2,080 acres of riparian and upland vegetation types in the LADWP-diverted stream channel corridors as they existed in 1989 (Chapter 3C, "Vegetation"). They then grouped these vegetation types into wildlife habitat types (Table 3F-3) and conducted wildlife surveys on 45 plots. The surveys involved recording reptile, bird, and mammal species trapped or observed during systematic surveys. Species observed outside systematic survey periods were also recorded. This study, comprising Appendix D, provides the basis for the information presented in this section.

Major Habitat Changes

As described in Chapter 3C, "Vegetation", by 1989 major losses of mature riparian vegetation had occurred along Rush and Lee Vining Creeks due to dewatering followed by torrential spills, stream incision, lowering of groundwater tables, and reduction in groundwater recharge. About 180 acres of cottonwood-willow woodland habitat and 19 acres of conifer-broadleaf forest were lost during the diversion period (Table 3F-3). These habitat losses have caused significant reductions in wildlife habitat value (Appendix D). These riparian forest and woodland habitats are relatively rich in numbers of species when compared to other habitats in Mono Basin (Appendix D). Although still extensive, more than 90 acres of montane habitat in the stream floodplains were also lost (Table 3F-3), but this habitat type has moderate species richness, especially when compared to mature riparian forests (Appendix D).

These vegetation losses have also created discontinuities in the formerly continuous riparian woodland corridors. These openings prevent or impede the movements of wildlife species that are intolerant of open habitats, some using the corridor to travel from upland forest to the delta habitats. As the lake receded, the dominance of unvegetated habitats also imposed a considerable separation between riparian woodland and the lakeshore, increasing from 300-400 feet in 1940 to 1,800 feet in 1989 along lower Lee Vining Creek and increasing from 1,000-1,200 feet to 2,500 feet along lower Rush Creek.

Reduction of Cottonwood-Willow Woodlands. Cottonwood-willow woodlands declined by a greater acreage than any other habitat along Mono Lake's diverted tributary streams (Table 3F-3) and most existing stands are in early successional stages. In the prediversion years, cottonwood-willow woodlands formed broad, extensive riparian corridors of mature forest covering about 50 and 160 acres along Lee Vining and Rush Creeks, respectively. Currently, only about 4 acres of narrow, regenerating cottonwood-willow woodlands are present in patches along each creek. The extent of mature cottonwood-willow forests has been reduced by almost 93% on Lee Vining Creek and by more than 97% on Rush Creek (Chapter 3C, "Vegetation", Appendix D).

Current cottonwood-willow woodlands along Lee Vining and Rush Creeks lack mature, multistoried vegetation (e.g., groundcover, shrub layer, saplings, and mature trees) that characterized prediversion riparian corridors (Chapter 3C, "Vegetation"). Narrow, discontinuous stands of small trees and shrubs offer nesting, foraging, and resting opportunities for fewer wildlife species than mature riparian corridors (Verner and Boss 1980). Studies in Mono Basin revealed significant relationships between bird species diversity and the number of vegetative layers, percent cover of tall trees, the presence of shrubs and low trees, and relatively moist soils (Appendix D). Because of their small acreages, lack of tall trees, and general absence of understory or midstory vegetation, these stands probably provide greatly reduced wildlife habitat values compared to conditions that existed under prediversion flow regimes (Appendix D). Similarly, bird distributional summaries (e.g., Gaines 1988, Hart and Gaines 1983) suggest that prediversion cottonwood-willow woodlands probably supported more species than any other terrestrial habitat in Mono Basin.

Other Habitat Reductions. The remaining conifer-broadleaf forest habitat provides the greatest diversity of plant species and vegetative structure of the habitat types now present along the tributary streams and throughout Mono Basin (Chapter 3C, "Vegetation"). The vertical structure of the habitat type is complex, and conifers and deciduous trees provide abundant cavities for nesting and support a variety of insect food for wildlife. Accordingly, this type has the highest wildlife species richness of any habitat type currently existing along the diverted tributary streams and probably throughout Mono Basin (Appendix D).

New Habitats. The lost woody riparian habitats have been replaced principally with unvegetated floodplain habitats (increased more than 180 acres) and Great Basin scrub habitats (increased more than 140 acres) (Table 3F-3), which generally support relatively low or moderate species richness

(Appendix D). The increased Great Basin scrub habitat represents a conversion to a widespread, nonriparian habitat, replacing a high-value habitat with low- to moderate-value habitat (Appendix D).

Moderate increases in mixed riparian and riparian willow scrub habitats have also occurred (Table 3F-3). Minimum streamflows, judicially mandated by the point of reference, are causing these habitats to recover in formerly unvegetated floodplain habitat present in the early 1980s; this recovery is ongoing (Chapter 3C, "Vegetation"). These habitats, when mature, support relatively high species richness (Appendix D).

Riparian willow scrub and Great Basin scrub are the dominant habitats establishing on the lowermost 114 acres of the Rush and Lee Vining Creeks corridors where they flow over relicted lands exposed by lowering lake levels. These particular riparian willow scrub habitats currently provide lower wildlife values than similar but mature habitats above the relicted lands, because newly established shrubs lack the size, number of vegetation layers, and cover provided by the more mature habitats. Through time, however, they will probably develop higher species richness typical of this habitat type.

Important Wildlife Species

Typical, or representative, species observed in the tributary stream habitats in 1991 plot surveys are described in Appendix D.

Streams Diverted by LADWP

Rush Creek

Habitats. During the diversion period, the acreage of riparian habitats along Rush Creek increased by about 75 acres over relicted lands as the lake receded. Nonetheless, cottonwood-willow woodland (all successional stages), conifer-broadleaf forest, and montane meadow habitats had diminished by 85%, 70%, and 70%, respectively; habitat losses totaled 240 acres. These habitats were principally converted to unvegetated floodplain habitat, which had increased threefold or 125 acres, and to nonriparian Great Basin scrub habitat, which had increased 103 acres. Smaller but significant gains in riparian willow scrub habitats and mixed riparian scrub habitats also occurred (Table 3F-3).

Wildlife Use. A total of 48 species of birds, mammals, and reptiles were observed using the Rush Creek habitats during systematic surveys conducted in 1991 (Appendix D). All species recorded by prediversion observers (see "Prediversion Conditions") are present in Mono Basin and were observed during the 1991 surveys. Breeding populations of long-eared owls, willow flycatchers, and yellow warblers have declined statewide during the diversion period (Remsen 1978); their declines in Mono Basin are discussed below under "Special-Status Species".

Lee Vining Creek

Habitats. As the lake receded during the diversion period, the acreage of riparian habitats along Lee Vining Creek increased by about 42 acres. This increase notwithstanding, cottonwood-willow woodland (all types), conifer-broadleaf forest, and montane meadow habitats diminished by 75%, 19%, and 26%, respectively; this resulted in a combined change in these habitats of 66 acres. These habitats were principally converted to unvegetated floodplain habitat, which more than doubled (increasing by 40 acres), and to nonriparian Great Basin scrub habitat, which increased 56 acres. Smaller gains in riparian willow scrub habitats and mixed riparian scrub habitats also occurred (Table 3F-3).

Many of the large cottonwoods, aspens, and Jeffrey pines along Lee Vining Creek died after the creek was dewatered in the late 1940s, and most of the remainder, desiccated by the dewatering, were destroyed by a large fire in the early 1950s (Stine 1991).

Wildlife Use. Forty-three species of birds, mammals, and reptiles were observed on systematic wildlife plot surveys conducted along Lee Vining Creek in 1991 (Appendix D). Of the species reported by early observers along Lee Vining Creek prior to the diversion period (see "Prediversion Conditions"), only pine siskins were not observed during the 1991 surveys. The absence of pine siskin observations does not indicate low populations because this species sometimes occurs irregularly on the east slope of the Sierra Nevada (Gaines 1988).

Parker and Walker Creeks

Habitats. Unlike Rush and Lee Vining Creeks, Parker and Walker Creeks support very little riparian forest or woodland habitat; they primarily support montane meadow and willow woodland habitats (Table 3F-3). Reaches of these creeks were dewatered during the diversion period, but habitat losses were much less than along the larger streams. Some reaches were used for irrigation water conveyance, and irrigation of the stream's alluvial fans was extensive, apparently preventing larger losses of willow woodlands. Reductions in willow woodlands were 18% along Parker Creek and 38% along Walker Creek.

Loss of riparian willow scrub habitat is probably attributable to a low replacement of mature willows by juveniles. Resulting increases in the acreage of montane meadow were the intended result of livestock management practices on the Cain Ranch to promote the establishment of a desirable forage crop. Along Walker Creek, however, increases in unvegetated floodplain habitats were twice as large as increases in montane meadow habitat (Table 3F-3).

Wildlife Use. Thirty-two and 29 species of birds, mammals, and reptiles were observed during surveys conducted on Parker and Walker Creeks, respectively (Appendix D). The current status of a sage grouse lekking site used by 30-50 grouse on the Parker Creek meadow prior to the diversion period (see "Prediversion Conditions") is unknown. A sage grouse was observed near Parker Creek in

1991, suggesting that this species persists in Mono Basin, although numbers have probably declined (Gaines 1988) (see also Appendix E).

Other Streams

Riparian habitat gains occurred along other perennial streams tributary to Mono Lake during the diversion period. Post Office Creek lengthened by over 1,000 feet due to lake recession, and it did not incise. Riparian scrub habitat developed along the new channel, and no upstream losses occurred. The habitat gain has been about 24 acres but, because the new habitat does not yet extend to the lakeshore, another 6 acres of habitat may yet develop. (Stine 1991.)

Wilson and Mill Creeks lengthened about 2,100 and 2,200 feet, respectively, during the diversion period, but both channels incised and now support only about 2 acres of riparian vegetation. The incision, however, did not cause losses of riparian habitat above the relicted lands (Stine 1991).

Systematic wildlife surveys were not conducted on Post Office, Wilson, or Mill Creeks in 1991, but informal surveys there suggested that wildlife present in the newly developed riparian scrub habitats was similar to that in the riparian scrub and cottonwood-willow habitats along the diverted tributary streams (Appendix D). Accordingly, significant wildlife value has been created along Post Office Creek over the diversion period.

Wildlife along the Upper Owens River

Habitat Changes

The distribution of habitats along Upper Owens River has not changed significantly with augmentation of flows from Mono Basin (Chapter 3C, "Vegetation"). Some riparian willow scrub continues to border the upper reaches of the stream below East Portal, while most of the river valley is irrigated meadow habitat. Densities of willow have decreased downstream from East Portal by about 12.4 acres during the diversion period, representing a 77% decline in the extent of this habitat (Chapter 3C, "Vegetation"). Increased soil saturation resulting from augmented streamflows to the adverse effects of livestock browsing may have caused this decline (Stromberg and Patten 1991). Some bank collapse and possibly channel-widening is ongoing along the river, gradually reducing irrigated meadow habitat.

The use of Upper Owens River valley for livestock grazing continues, but the human presence has increased considerably during the diversion period through the growth of summer cabins and commercial recreational fishing.

Wildlife Use

Forty-two species of birds and mammals were observed along the Upper Owens River during the 1991 surveys (Appendix D). Populations of game species, such as waterfowl, sage grouse, and mule deer, have generally declined since 1940 (Arcularius pers. comm.). Population declines, however, are probably not associated with augmentation of flows, because these species have also declined regionally during the same period. The loss of riparian willow-scrub habitat may be important to migratory birds and other wildlife because scrub vegetation is otherwise absent from the river's banks upstream from Lake Crowley reservoir (Chapter 3C, "Vegetation").

Immediately downstream from East Portal, a small ponded marsh was created during construction of East Portal outflow. This habitat is atypical on the Upper Owens River and is used by species, such as cinnamon teal, American wigeon, American coots, and yellow-headed blackbirds, thereby enhancing overall species richness of the Upper Owens River.

Special-Status Species in Mono Basin and Upper Owens River Valley

As noted previously, 39 special-status species occur or potentially occur in the areas of concern in Mono Basin and along the Upper Owens River. Three of these species are described elsewhere: the Mono Lake brine shrimp is discussed in Chapter 3E, "Aquatic Productivity", and the California gull and western snowy plover in prior sections of this chapter. Appendix E describes the prediversion status, the current status, and the possible effects of LADWP diversion on the remaining 36 special-status species.

Several conclusions arise from the assessment in Appendix E:

- Ospreys and bald eagles would probably benefit from restoration of fisheries on Lee Vining and Rush Creeks.

- Reductions of spring flows and grazing in Mono Basin and construction of Lake Crowley reservoir probably reduced the availability of habitat for yellow rails, which prefer to nest in shallow, freshwater marshes with low, sparse emergent vegetation.

- Long-eared owls, yellow warblers, yellow-breasted chats, and willow flycatchers probably declined in the project area during the diversion period due to a loss of riparian broadleaf and willow scrub vegetation along diverted tributary streams.

IMPACT ASSESSMENT METHODOLOGY

Impact Prediction Methodology

This section describes the methods used to predict the benefits and adverse impacts of each alternative on wildlife habitat and populations in Mono Basin and the Upper Owens River. Assumptions, analytical methods, and significance criteria are identified for each environmental variable used to assess impacts. The purpose of this section is to provide the necessary background information and rationale for predicting impacts and making findings of significance under each alternative.

California Gull Nesting Colony at Mono Lake

As described in the "Environmental Setting" section and in Appendix C, the only clear trend in the gull colony that can be attributed directly to changes in the surface elevation of Mono Lake is abandonment of nesting islands and islets in response to land-bridging, and subsequent predation. Thus, the objectives of this analysis were to:

- estimate the acreage of suitable gull nesting habitat available for the Mono Lake colony under each alternative and

- determine whether the availability of suitable island nesting habitat could potentially limit the size of the colony under each alternative.

As discussed in the following sections, estimating the potential nesting capacity of individual islands and islets involved categorizing exposed substrates according to their size, habitat characteristics, and long-term occupancy by nesting gulls.

Preparation of Base Maps. Stine (1992) prepared base maps of each major nesting island and islet at Mono Lake using 1991 aerial photographs taken at a lake elevation of 6,375 feet (Figures 3F-2, 3F-3a, 3F-3b, and 3F-4). For Negit Island and the Negit Islets, the contours of alternative target lake elevations (i.e., 6,372 feet, 6,377 feet, 6,383.5 feet, 6,390 feet, and 6,410 feet) were superimposed on the maps using USGS 7.5-inch topographic maps, Pacific Western Aerial survey maps, the revised topographic map prepared by SWRCB consultants (Appendix G), and a chrono-cartographic map sequence derived from aerial photographs taken in 1930, 1940, 1956, 1964, 1973, 1975, 1979, and 1982 (Stine 1992).

In contrast to the hard rocks of Negit Island and the Negit Islets, the soft sediments composing the Paoha Islets are eroded by waves and longshore currents during periods of rising lake elevations (Stine 1992). For this reason, Stine (1992) depicted the size and configurations of these islets as they would likely appear following a rise to the normal maximum lake elevation predicted under each alternative (Figure 3F-4).

For the 6,372-Ft Alternative, the average shorelines of the Paoha Islets are shown at 6,375 feet (the average surface elevation predicted under the 6,372-Ft Alternative) and the uplands are depicted as all areas above the 6,380.9-foot contour (i.e., the highest elevation of the last lake transgression in 1986). Similarly, uplands under the 6,377-Ft Alternative are shown as the areas above the 6,382.9-foot contour, the highest lake elevation predicted under this alternative.

A lake transgression to 6,389.5 feet is the normal maximum under the 6,383.5-Ft Alternative. At this and all higher elevations, all existing uplands on the Paoha Islets would be reduced to low, wave-cut platforms; these remnant islets would have limited value to nesting gulls and therefore were not mapped on Figure 3F-4 (Stine pers. comm.).

Characterization of Nesting Habitat Potential. Gull researchers on Negit Island (Winkler pers. comm.) and the Negit Islets (Shuford pers. comm.) categorized the gull habitat suitability of each major nesting substrate as high, moderate, low, or unsuitable. These categories represented the researchers' best estimates of the future nesting capacity of various substrates and exposures integrated over a period of years; the categories were not intended to predict the specific density or nest dispersion observed in a particular year (Shuford and Winkler pers. comms.).

Winkler based his habitat categorization on the map of the Negit Island gull colony he prepared in 1976 and later observations of PRBO researchers (Dierks 1990, 1991; Dierks and Shuford 1992). He mapped low-gradient scrublands that were used by high densities of nesting gulls during 1976-1978 as high suitability habitat. Similar, but historically unoccupied scrublands and rocky shoreline areas used by nesting gulls between 1985 and 1991 were mapped as moderate suitability. All remaining lava flows, cinder cones, and other steep, rocky areas on Negit Island were considered unsuitable gull nesting habitat (Winkler pers. comm.).

Stine (1992) and Shuford (pers. comm.) made onsite inspections of the Negit Islets to identify areas with similar habitat characteristics, including substrate type, slope, surface elevation, and exposure. They also considered the distribution and density of nests during the past decade when assigning specific areas to habitat suitability categories. They mapped tufa-encrusted areas with gentle slopes and historically high nesting densities as high suitability. Sandy beach areas lacking surface debris and steeper rocky slopes were mapped as moderate suitability. Low suitability areas included steep, rocky slopes and water proximate, windward wave-cut platforms that supported few nesting gulls during the last decade. Unsuitable habitats included vertical, rocky cliffs and the lowest wave-exposed platforms that have never supported nesting gulls.

Jehl (pers. comm.) refined Stine's (1992) base map of potential nesting habitat on the Paoha Islets during the 1992 breeding season. He made onsite inspections to confirm the size and configuration of individual islets and sketched the areas with rugose substrates (e.g., tufa-encrusted areas, small boulders, logs, and other debris) currently preferred by nesting gulls. The first, and often most densely, settled portions of these islets tend to be on protected, rugose substrates near the shoreline; open, sandy areas, especially those at interior locations, are usually settled later but sometimes attain nesting densities approaching those on rugose substrates. Wave-cut platforms less than about 1 foot above the water's surface on windward sides of islands and steep wave-cut cliffs were mapped as unsuitable habitat because they do not support nesting gulls.

Nesting Density Assumptions for Negit Island and the Negit Islets. Shuford (pers. comm.) provided detailed maps of gull nesting densities observed on the most important Negit Islets in 1992. These data were used in combination with fixed-plot nest counts from the Negit Islets (Dierks 1990, 1991; Dierks and Shuford 1992) to provide a quantitative basis for defining habitat suitability categories.

Based on the maximum nest counts observed at specific mapped habitats on the Negit Islets and consultation with gull researchers (Shuford and Winkler pers. comms.), SWRCB consultants defined the potential nesting capacities of each suitability category as: high = 1,300 nests per acre, moderate = 600 nests per acre, and low = 200 nests per acre. Areas mapped as unsuitable by the gull researchers were not included in acreage calculations.

Nesting Density Assumptions for the Paoha Islets. Jehl (pers. comm.) indicated that he could not apply the habitat suitability values derived from the Negit Islets to the Paoha Islets. He noted that similar maximum nesting densities have been observed on rugose and nonrugose substrates of these islets and suggested that the both habitats are potentially capable of supporting increasing numbers of nesting gulls if the Mono Lake colony expands in the future. Based on his observations at Mono Lake and other large nesting colonies (e.g., Bamforth Lake, Wyoming Lake, and Great Salt Lake), he indicated that 1,000 nests per acre would be a realistic maximum nesting capacity for all suitable breeding habitats on the Paoha Islets.

Island and Islet Area Measurements. The habitat suitability maps prepared by Stine (1992) and the gull researchers were used to calculate the approximate acreages of potential nesting habitats available under each alternative. Using a planimeter, acreages were estimated for each habitat suitability category (i.e., high, moderate, low, or unsuitable on Negit Island and the Negit Islets and rugose and nonrugose on the Paoha Islets) and were summed for each island and islet.

Predation and Land Bridging. As described in the "Environmental Setting" section, Negit Island and Pancake Islet become accessible to mainland predators at lake elevations of about 6,376.5 feet, and Java and Twain Islets are accessible to predators at about 6,373.5 feet. Thus, at lower alternatives (e.g., the 6,372-Ft and No-Restriction Alternatives) these areas were not included in the calculations of potential habitat available for nesting gulls.

Predicting Population Effects. For Negit Island and the Negit Islets, potential gull nesting capacity values for each habitat suitability category (i.e., high = 1,300 nests per acre, moderate = 600 nests per acre, low = 200 nests per acre) were multiplied by their estimated acreages on each island and islet.

For comparative purposes, potential nesting capacity of the Paoha Islets was calculated using two sets of density assumptions:

- # rugose substrates were regarded as high suitability (i.e., 1,300 nests per acre) and other nonrugose, upland substrates were regarded as moderate suitabilities (i.e., 600 nests per acre), as derived from maximum counts at similar habitats on the Negit Islets and

- # all upland substrates (rugose and nonrugose) were assumed to have high suitability (i.e., 1,000 nests per acre), as observed at other large nesting colonies.

The calculated habitat acreage and nesting capacity estimates were summed for Negit Island and for the Negit and Paoha islets under each alternative. These values were compared to point-of-reference and current maximum nesting populations to determine if the availability of suitable nesting habitat under each alternative could potentially limit the size or reproductive success of the California gull colony.

Effects of Invertebrate Productivity on Migratory and Nesting Water Birds at Mono Lake

This analysis focused on the most abundant migratory water birds at Mono Lake: eared grebes, Wilson's phalaropes, and red-necked phalaropes (whose status and ecological requirements are described in the "Environmental Setting" section).

Invertebrate Productivity. Trends in alkali fly and brine shrimp productivity at Mono Lake, which are described in Chapter 3E, "Aquatic Productivity", formed the basis for assessing the relative amounts of food available for water birds under each alternative.

Food Limitations on Bird Populations. Aside from Rubega's (1992) field and laboratory studies of red-necked phalaropes, the prey density requirements of most water birds at Mono Lake have not been examined in detail. Rubega's (1992) data were used to compare the potential responses of red-necked phalaropes to changes in prey densities and for comparative purposes, the responses of Wilson's phalaropes were assumed to be similar to those of red-necked phalaropes. The observed distributions of foraging phalaropes at different lake levels were also utilized as an indication of foraging efficiency.

Potential responses of eared grebes to changing prey densities were compared using the observations of various researchers of this species at different lake elevations.

Predicting Bird Population Effects. Levels of invertebrate productivity were evaluated for each alternative to determine whether lakewide prey densities could potentially limit the population size or foraging efficiency of migrant grebes or phalaropes at Mono Lake.

Abundance of Migratory Ducks at Mono Lake

Population Effects. Past and current population trends and the habitat requirements of migratory ducks at Mono Lake are described in the "Environmental Setting" section. Based on that discussion, it is assumed that the freshwater habitats are currently limiting duck use of Mono Lake. Thus, the acreage of open water around the lakeshore and the volume of fresh water at the creek deltas are assumed to represent the habitat available and usable for migratory ducks under any of the alternatives compared to point-of-reference conditions. The predictions of invertebrate food potentially available to migratory ducks were based on analysis in Chapter 3E, "Aquatic Productivity".

Habitat Availability. Methods for calculating the acreages of suitable habitats (e.g., creek deltas, ponds, and lagoons) under each alternative are described in Chapter 3C, "Vegetation". In particular, Stine's (1993) estimates of the surface elevations required for reemergence of ponds and lagoons were used to estimate availability of these habitats under each alternative.

Freshwater inflows at the creek deltas were estimated for the months of September, October, November, and December from the cumulative frequency tables presented in Chapter 3A, "Hydrology". The 20th, 50th, and 80th percentiles were used to represent dry, average, and wet year conditions, respectively.

Snowy Plover Nesting Habitat at Mono Lake

Nesting Habitat Availability. Characteristics of suitable snowy plover nesting habitats (i.e., pumice berms, alkali flats, wetlands, and other barren habitats within 1 mile of the lakeshore or other water source) are described in the "Environmental Setting" section. Methods for calculating the acreages of these habitats under each alternative are described in Chapter 3C, "Vegetation".

Population Effects. Acreages of suitable snowy plover nesting habitat potentially available under each alternative were compared to the estimated nest area requirement of this species. These carrying capacities were compared to the point-of-reference capacity to determine whether available habitat could potentially limit the size of Mono Lake's snowy plover population under any of the alternatives.

Page et al. (1983) calculated the nesting densities of snowy plovers at Mono Lake to be about one nest per 6 hectares (about 15 acres). The 170 nesting pairs present under point-of-reference conditions therefore occupied about 2,500 acres of nesting habitat around the lakeshore. The responses of nesting snowy plovers to changing lake elevations, however, have not been adequately examined (Page pers. comm.), and continued monitoring of their population at Mono Lake should be an element of the SWRCB's mitigation monitoring plan.

Wildlife Habitat Values of the Mono Lake Shoreline

Habitat Availability. Methods for calculating the acreages of lakeshore habitats are described in Chapter 3C, "Vegetation".

Wildlife Value. A specific wildlife habitat index (WHI) was derived for each major lakeshore habitat by estimating its species richness relative to other wildlife habitats in Mono Basin and the Upper Owens River (Appendix D). Total wildlife habitat value or "units" (WHUs) for the prediversion and point-of-reference conditions and the alternatives were calculated by multiplying the habitat-specific WHI values by the acreages predicted to occur.

Special-Status Species. The overall wildlife value of each habitat reflects its potential to support special-status species, including snowy plovers, ospreys, and yellow rails (Appendix E). WHUs for lakeshore ponds and lagoons were not calculated because prediversion and point-of-reference species counts were not available for these habitats.

Wildlife Habitat Values along Streams Tributary to Mono Lake

Wildlife Habitat Value. The same process used for shoreline habitats (described above) was used to compare wildlife habitat values for various alternatives and conditions.

Special-Status Species. The overall wildlife value of each habitat reflects its potential to support special-status species, including bald eagles, ospreys, long-eared owls, willow flycatchers, yellow warblers, yellow-breasted chats, and mountain beavers (Appendix E).

Wildlife Habitat Values along the Upper Owens River

Wildlife Habitat Value. The same process used to compare wildlife habitat values for various alternatives and conditions as described above for shoreline habitats was used for riparian willow scrub and irrigated meadow habitats, estimating their species richness relative to other wildlife habitats in Mono Basin and the Upper Owens River (Appendix D).

Special-Status Species. The overall wildlife value of each habitat reflects its potential to support special-status species, including willow flycatchers, yellow warblers, and yellow-breasted chats (Appendix E).

Criteria for Determining Impact Significance

For each response variable, all beneficial and adverse impacts are measured as changes from point-of-reference conditions. Where possible, quantitative criteria are employed to assess the degree of change that would likely occur under each alternative. The thresholds used to determine whether predicted adverse changes would be significant are described below.

California Gull Nesting Colony at Mono Lake

The potential habitat acreage and estimated lakewide nesting capacity secure from terrestrial predators were evaluated for each alternative to determine whether they could potentially accommodate the maximum breeding colony observed at Mono Lake. During the past 16 years of record (i.e., 1976-1992), the gull colony averaged about 24,000 nests, with maximums of about 31,000 nests and 32,500 nests in 1990 and 1992, respectively. Thus, significant adverse impacts were identified for alternatives if the predicted lakewide nesting capacity would be less than 32,500 nests (assumed to represent the point-of-reference condition). Beneficial effects were identified for alternatives that would increase the lakewide nesting capacity by more than a minor amount (10%) from point-of-reference conditions.

Effects of Invertebrate Food Productivity on Migratory and Nesting Water Birds at Mono Lake

At the point of reference, thousands of red-necked and Wilson's phalaropes continued to visit Mono Lake; however, they were restricted to the lake's northeastern sector where they foraged at less than optimal efficiency (Rubega 1992). Thus, lakewide productivity of alkali flies at the point of reference may be approaching a threshold for successful phalarope foraging. For these reasons, significant impacts on phalaropes are defined as more than minor (10%) declines in the lakewide alkali fly productivity from point-of-reference conditions. Beneficial impacts were defined similarly.

Brine shrimp populations were sufficient to meet eared grebe foraging requirements at the historical lowstand in 1982 (elevation 6,372 feet), the point of reference, and through 1992. Thus, significant adverse impacts on this species are defined as more than minor (10%) declines of brine shrimp productivity from the historical lowstand. Beneficial impacts were defined similarly.

Abundance of Migratory Ducks at Mono Lake

As stated in the "Environmental Setting" section of this chapter, migratory duck populations at Mono Lake at the point of reference were greatly reduced from prediversion conditions. Thus, significant adverse impacts are defined as any more-than-minor (10%) reduction of freshwater inflows, open water habitat acreage, or invertebrate food supplies compared to point-of-reference conditions. Beneficial impacts are defined similarly.

Snowy Plover Nesting Habitat at Mono Lake

Significant adverse impacts on snowy plovers are identified for alternatives for which the lakewide acreage of suitable nesting habitat would fall below 2,500 acres. Any decrease in the size of occupied habitat at the point of reference for this candidate threatened species is considered significant.

Wildlife Habitat Values of the Mono Lake Shoreline, Tributary Streams, and the Upper Owens River

Under each alternative, declines of more than a minor amount (10%) in the total WHUs are considered significant adverse impacts for shoreline, tributary stream, and Upper Owens River areas. Any permanent losses of habitat occupied by special-status species at the point of reference were also considered significantly adverse. Beneficial impacts are similarly defined.

SUMMARY COMPARISON OF IMPACTS AND BENEFITS OF THE ALTERNATIVES

As described above in the "Impact Assessment Methodology" section, relative wildlife effects of the alternatives are addressed in this chapter through several key variables:

- acreage of secure nesting habitat for California gulls,
- productivity of invertebrate food for migratory water birds,
- feeding behavior and distribution of phalaropes,
- availability of freshwater habitats for migratory ducks,
- availability of nesting habitat for snowy plovers, and
- acreage and species richness of lakeshore and tributary stream habitats.

Table 3F-4 provides a summary comparison of the alternatives using these variables. Values of the variables for each alternative are compared to values for the prediversion and point-of-reference conditions. Those values representing significant adverse direct or cumulative impacts are indicted. A discussion of these variables for each alternative is provided in the following sections of this chapter.

As the summary table indicates, the 6,377-Ft Alternative and lower elevation alternatives would have significant impacts on gull nesting, migratory bird feeding, and phalarope behavior. High lake levels also have some significant impacts: decreasing wildlife value of shorelines and, for the No-Diversion Alternative, diminished habitat for snowy plovers.

Two significant cumulative effects, relatived to prediversion conditions, would occur under most alternatives. The loss of freshwater habitats for migrating ducks and other water birds could be substantially reduced only under the highest lake level alternatives or through mitigation. Due to stream incision, losses of terrestrial habitat value along the tributary streams could be fully reversed only through habitat restoration.

Table 3F-5 shows the potential acreage and nesting capacity for California gulls on the Mono Lake islands under the alternatives. As shown, the amount of habitat available under both the No-Restriction and 6,372-Ft Alternatives would be inadequate to support point-of-reference gull populations. Potential nesting capacity would at least double under all the other alternatives; however, periodic land bridging of Negit Island predicted under the 6,377-Ft Alternative would disrupt nesting gulls.

Table 3F-6 gives the acreages and wildlife habitat values of the Mono Lake shoreline and tributary streams for each of the alternatives. Compared to the point of reference, wildlife habitat values of the tributary streams would decline under the No-Restriction Alternative but would increase under all the other alternatives. Terrestrial wildlife habitat values of the shoreline habitats would increase slightly under the 6,372-Ft Alternative but would gradually decline under increasingly higher lake elevation alternatives. Most shoreline vegetation would be inundated under both the 6,410-Ft and No-Diversion Alternatives, but lakeshore ponds and lagoons would be restored to near their prediversion acreages, providing significant benefits to migrating ducks.

IMPACTS AND MITIGATION MEASURES FOR THE NO-RESTRICTION ALTERNATIVE

Changes in Resource Condition

California Gull Nesting Colony at Mono Lake

Under this alternative, Mono Lake's surface elevation would gradually decline from the point of reference (6,376.3 feet) to an average elevation of about 6,355 feet. In wet years, the lake could rise to a maximum elevation of about 6,365.5 feet, and under an extreme drought, it could decline to a minimum elevation of about 6,336.5 feet (see Chapter 2, "Project Description").

Near-Term Changes. At the point of reference, Negit Island would be effectively land bridged and accessible to coyotes and probably would support few nesting gulls. This condition would not change under the No-Restriction Alternative, but during at least the first few years gulls would find suitable nesting habitat on the Negit and Paoha Islets. However, Twain and Java Islets would become effectively land bridged at about 6,373.5 feet, which could disrupt up to half of the Mono Lake colony (see discussion for the 6,372-Ft Alternative).

Long-Term Changes. After a period of years under the No-Restriction Alternative, the lake's surface elevation would fall to an average of about 6,355 feet. At this elevation, most historically important nesting areas on the Negit Islets (e.g., Twain, Java, Little Tahiti, Little Norway, Krakatoa, Geographic, Comma, Saddle, and Winkler) would be land bridged and only about 8 acres of potential nesting habitat would remain (Stine pers. comm.). Similarly, most of the historically occupied Paoha Islets (e.g., Anderson, Browne, Coyote, Cluster, Conway, Gull, Russell, McPherson, and Smith) would be land bridged to Paoha Island under this alternative and only about 4 acres of potential gull nesting habitat would remain (Stine pers. comm.). Land bridging of most of the Negit and Paoha Islets would result in a loss of more than 80% of the potential habitat acreage and gull nesting capacity compared to the point of reference (Table 3F-5).

In addition to the loss of secure nesting habitat, the lakewide productivity of alkali flies and brine shrimp would decline to extremely low levels under the No-Restriction Alternative (see "Effects of Invertebrate Food Productivity on Migratory and Nesting Water Birds" below). Alkali flies and brine shrimp are the primary food sources of gulls nesting at Mono Lake, and severe declines of these invertebrate prey species would further jeopardize the remaining breeding colony.

Drought Effects. Under extreme drought conditions, virtually all potential gull nesting substrates would be land bridged (Stine pers. comm.) and the increasing saline and alkaline conditions would virtually eliminate alkali fly and brine shrimp populations at Mono Lake (see Chapter 3E, "Aquatic Productivity"). Drought conditions would further degrade gull nesting habitat at Mono Lake, but most adverse effects on this species would probably be apparent at all lake elevations predicted under the No-Restriction Alternative.

Effects of Invertebrate Productivity on Migratory Water Birds

Near-Term Changes. During the first few years under this alternative, the lake's invertebrate productivity would decline from the point of reference (see Chapter 3E, "Aquatic Productivity"). The effects of these declines, however, are difficult to determine because precise calculations of the minimum densities of alkali flies and brine shrimp required by migratory eared grebes, Wilson's phalaropes, and red-necked phalaropes are complicated by patchiness of invertebrate productivity at Mono Lake (Jehl and Rubega pers. comms.).

At the lake's lowest historical elevation (i.e., 6,372 feet in 1982) sufficient food was apparently available to support populations of eared grebes and phalaropes at levels similar to the point of reference. Laboratory and field studies of red-necked phalaropes, however, suggest that this species foraged at less than optimal efficiency at these prey densities (see discussion for the 6,372-Ft Alternative).

Long-Term Changes. At the average elevations predicted under this alternative (i.e., about 6,355 feet), Mono Lake's salinity would increase to about 150 g/l. This value is near the upper limit for successful reproduction of alkali flies and brine shrimp, and both species are predicted to decline to very low levels under this alternative (see Chapter 3E, "Aquatic Productivity"). For example, production of third instar alkali fly larvae (the life stage with the highest caloric value) would decline by more than 60% from point-of-reference conditions and brine shrimp populations would decline by more than 50%. Major declines in their preferred prey species would probably cause most eared grebes, phalaropes, and other water birds to abandon Mono Lake as a migratory staging area.

Drought Effects. During extreme droughts, Mono Lake's salinity would decline substantially from the average conditions predicted under this alternative. Alkali fly and brine shrimp productivity would probably cease (see Chapter 3E, "Aquatic Productivity") and few, if any, water birds would continue to visit Mono Lake.

Abundance of Migratory Ducks at Mono Lake

Near-Term Changes. Less than 1 acre of open water habitat existed around the lakeshore at the point of reference (Table 3F-6); this habitat would dry out during the first few years under this alternative (see Chapter 3C, "Vegetation"). Similarly, all flows into Mono Lake's tributary streams would cease, except in maximum runoff years when LADWP's diversion structures would not be able to accommodate all the runoff.

In the near term, the lake would become more saline and ducks requiring fresh water probably would abandon the lake as a migratory stopover point. Ruddy ducks and a few other diving ducks probably would continue to visit the lake, however, because they do not require frequent access to fresh water. In the near term, lakewide invertebrate productivity probably would be sufficient to maintain point-of-reference populations of these species.

Long-Term Changes. Long-term changes under this alternative would include elimination of all open water habitats and freshwater inflows in the tributary streams. Similar to other migratory water birds, ducks would also experience adverse impacts as the lakewide invertebrate productivity declined to very low levels. Under these conditions, migratory ducks (including ruddy ducks) probably would be absent from Mono Lake.

Drought Effects. During extreme droughts, the lake's salinity would decline significantly from the average conditions predicted under this alternative. Alkali fly and brine shrimp productivity probably would cease (see Chapter 3E, "Aquatic Productivity") and few, if any, migratory ducks would continue to visit Mono Lake.

Snowy Plover Nesting Habitat at Mono Lake

Near-Term Changes. During the first few years under the No-Restriction Alternative, the lake's elevation would decline and expose more alkali lakebed, which could then be used by nesting snowy plovers. At the point of reference, however, this species had almost 10,000 acres of potential nesting habitat on alkali flats (about 6,000 acres), pumice berms, barren sands, and other unvegetated habitats around the lakeshore (see Chapter 3C, "Vegetation"). Only about 2,500 acres of barren habitat are required to support the current snowy plover population (see "Environmental Setting"). Because about 75% of the potential lakeshore habitat is currently unoccupied by snowy plovers, the near-term addition of new alkali flat acreage under this alternative probably would have no effect on the population at Mono Lake.

Long-Term Changes. The bathymetry of Mono Lake indicates the presence of a shallow, submarine terrace to about 6,368 feet (the "nick point"), and all lake elevations predicted under this alternative would be below this nick point. Under such conditions, Stine (1987a) predicted that steep cliffs and deep erosional features would form near the lakeshore. If such topography were to form in current snowy plover breeding areas, it could potentially impede and endanger access to the lakeshore and its feeding areas, especially for plover chicks (Winkler 1987, Page pers. comm.). Deeply incised hollows would also put snowy plovers at a disadvantage in the long-range detection of predators, which could elevate the predation risks to adults and chicks of this species.

Under this alternative, about 9,500 acres of alkali lakeshore would still exist above the nick point, providing breeding habitat for snowy plovers (Table 3F-6). However, the altered shoreline topography and difficult access to other water sources (i.e., than within 1 mile of the nesting site) probably would reduce the attractiveness of these areas to nesting snowy plovers. Further, productivity of alkali flies would be greatly reduced or eliminated under this alternative (see Chapter 3E, "Aquatic Productivity"). The combined effects of altered habitat and reduced food supply probably would cause most snowy plovers to abandon Mono Lake as a breeding area.

Drought Effects. If the lake's elevation declined to 6,336 feet during an extreme drought, the amount of suitable snowy plover habitat around the shoreline would be further reduced from the point of reference. Under such conditions, potential habitat and food supplies would be so reduced that snowy plovers could be eliminated as a breeding species at Mono Lake.

Wildlife Habitat Values of the Mono Lake Shoreline

Near-Term Changes. During the first few years under this alternative, the acreage and overall wildlife values of lakeshore marsh, meadow, and wetlands scrub habitats would be similar to the point of reference (see Chapter 3C, "Vegetation").

Long-Term Changes. At the average elevations predicted under this alternative, the acreage of lakeshore habitats would increase slightly from the point of reference, but the WHUs (methods for calculating WHUs are provided in Appendix D) would decrease by more than 40% (Table 3F-6). The overall wildlife value of the lakeshore would be low under this alternative because most of the newly exposed habitat would be alkali flats which provide habitat only for snowy plovers and few other species (Appendix D). Marsh, alkali and wet meadow, and wetland scrub habitats would decline by more than

80% compared to the point of reference (Table 3F-6), and sources of fresh water would not exist around the lakeshore (see Chapter 3C, "Vegetation").

Drought Effects. Extreme droughts would result in steep, incised shoreline topography that would not support marsh, meadow, or wetland scrub habitats (see Chapter 3C, "Vegetation"). Under these conditions, the shoreline of Mono Lake probably would support only incidental use by most wildlife species.

Wildlife Habitat Values along Streams Tributary to Mono Lake

Under this alternative, no water would be released into any of the tributary streams in most years, except for infrequent spilling flows in extremely wet years (see Chapter 2, "Project Description").

Near-Term Changes. Most of the mature and establishing riparian trees and shrubs present along Lee Vining and Rush Creeks at the point of reference would die because streamflows and groundwater would be inadequate to sustain them. For example, more than half of the mature cottonwood-willow woodland along Lee Vining and Rush Creeks that was present at the point of reference would be lost (Table 3F-6). Meadow and wetland vegetation along these two creeks also would be reduced by about 45%, and most of these areas would revert to Great Basin scrub, dry meadow, or unvegetated habitats (see Chapter 3C, "Vegetation").

A smaller proportion of the riparian vegetation, meadow, and wetland vegetation along Parker and Walker Creeks would die because these habitats had already been modified at the point of reference by the previous 50 years of water diversions and grazing (see Chapter 3C, "Vegetation").

In the near term, many wildlife species that were present at the point of reference would continue to use riparian and meadow habitats along the four diverted tributary streams. As the acreage of riparian, meadow, and wetland habitat declined through time, however, their value to wildlife would be reduced proportionally. Overall, the acreage and WHUs of tributary riparian streams could decline by more than 50% compared to the point of reference (Table 3F-6).

Reduced acreage and increased fragmentation of existing riparian habitats in Mono Basin would degrade habitat value for resident and migratory wildlife. Similarly, special-status species such as long-eared owls, willow flycatchers, yellow warblers, yellow-breasted chats, and mountain beavers would experience significant reductions in potential habitat. Bald eagles, ospreys, and other fish-eating birds also could experience adverse effects from the loss of fisheries in the tributary streams (Appendix E).

Long-Term Changes. Infrequent spilling flows in the creeks would cause further channel incision when the lake's elevation dropped below the historical lowstand of 6,372 feet (see Chapter 3C, "Vegetation"). Increased channel incision and decreased groundwater would cause most trees and wetland-dependent shrubs along the lower reaches of Lee Vining and Rush Creeks to die, resulting in a potential loss of up to 160 acres of mature riparian habitat (see Chapter 3C, "Vegetation"). Extensive areas of dead riparian trees and shrubs could promote fires, such as those that occurred along lower Lee Vining Creek during the early 1950s.

Long-term loss and degradation of woody vegetation along the diverted tributary streams would cause most riparian-dependent species to abandon these habitats, and the resulting wildlife habitat values would be similar to those in surrounding Great Basin scrub areas. Impacts on special-status species would be identical to those described for near-term changes above.

Drought Effects. Drought effects would not differ from the near- and long-term effects of this alternative because the streams would be dry in all but the wettest years (see Chapter 3C, "Vegetation").

Wildlife Habitat Values along the Upper Owens River

Under this alternative, the increased frequency of high flows (i.e., greater than 200 cfs) could increase channel instability and result in moderate losses of willow scrub habitat. However, the acreage and WHUs of willow scrub and wet meadow habitats along the Upper Owens River probably would not change significantly (i.e., more than 10%) in response to altered flows compared to the point of reference (see Chapter 3C, "Vegetation") and no significant impacts on wildlife are expected.

Summary of Benefits and Significant Impacts and Identification of Mitigation Measures (No-Restriction Alternative)

Significantly reduces or eliminates the California gull colony due to reduced food supply and permanent land bridging of Negit Island and most of the historically occupied Negit and Paoha Islets.

Mitigation Measures. None are available.

Significantly reduces populations of migratory eared grebes and Wilson's and red-necked phalaropes due to major declines in alkali flies (60%) and brine shrimp abundance (50%); under extreme droughts, invertebrate productivity would probably cease and most water birds would abandon the lake as a migratory staging area.

Mitigation Measures. None are available.

- # Significantly reduces migratory duck populations due to elimination of existing ponds and freshwater inflows at creek deltas and large reductions in invertebrate food supplies; under extreme droughts, invertebrate productivity would probably cease and most ducks would abandon the lake as a migratory staging area.

  Mitigation Measures. None are available.

- # Significantly reduces snowy plover populations due to altered lakeshore topography, reduced access to water, and major declines of lakewide alkali fly productivity.

  Mitigation Measures. None are available.

- # Causes loss of more than 80% in the acreage and wildlife habitat value of marshes, meadows, and wetland scrub habitats; a large increase in alkali lakebed acreage would offer few benefits to wildlife.

  Mitigation Measures. None are available.

- # Causes loss of more than 50% in the acreage and WHUs of tributary riparian streams; under extreme droughts most wetland-dependent vegetation and riparian wildlife would be lost, resulting in probable declines of special-status species such as long-eared owls, willow flycatchers, yellow warblers, yellow-breasted chats, and mountain beavers; bald eagles and ospreys could also decline in Mono Basin due to loss of fisheries.

  Mitigation Measures. None are available.

IMPACTS AND MITIGATION MEASURES FOR THE 6,372-FT ALTERNATIVE

Changes in Resource Condition

California Gull Nesting Habitat at Mono Lake

Under this alternative, Mono Lake's surface elevation would fluctuate near an average elevation of 6,375 feet, slightly less than the point-of-reference elevation (6,376.3 feet). In wet years the lake could rise to a maximum elevation of nearly 6,379 feet, and under an extreme drought it could decline to a minimum elevation of about 6,370 feet (see Chapter 2, "Project Description").

Near-Term Changes. At the point-of-reference lake elevation, Negit Island would be effectively land bridged to the mainland and would not provide secure gull nesting habitat; this condition would not change under the 6,372-Ft Alternative. At lake elevations above 6,377 feet, Negit Island provides about 155 acres of potential gull nesting habitat (Table 3F-5) and offers the only large area available for future expansion of the Mono Lake colony (see the discussion for 6,377-Ft Alternative).

Long-Term Changes. Long-term management of the lake under this alternative would cause the surface elevation to drop below about 6,374 feet with a predicted frequency of about 20%. At these lake elevations, Twain and Java Islets would effectively be land bridged and would provide coyotes and other land predators access to about 50% of the breeding adults in the Mono Lake colony (Appendix C). Overall, potential gull habitat acreage would decline by almost 20% under this alternative compared to point-of-reference conditions (Table 3F-5).

Lacking a "natural experiment" in which the lake's elevation would be managed at 6,374 feet or lower for at least several years, the long-term effects of land bridging Twain and Java Islets on the overall reproductive success of the Mono Lake colony are unknown. If land bridging events occurred during the breeding season, however, the nesting efforts of up to half the colony likely would be disrupted.

If land bridging of Twain and Java Islets occurred during the nonbreeding season, at least some breeding adults probably would relocate to other Negit or Paoha islets (Jehl, Shuford, and Winkler pers. comms.). If Twain and Java Islets were unavailable for gull nesting, the remaining 22.3 acres of the Negit Islets would have a predicted capacity of about 12,500 gull nests under this alternative (Table 3F-5). The sum of the maximum densities observed on the remaining islets (i.e., all islets but Twain and Java) in any previous year was about 12,400 nests (Dierks and Shuford 1992), suggesting that habitat suitability categories used in this analysis accurately predicted the maximum nesting capacity of the Negit Islets.

The maximum nesting capacity of the Paoha Islets predicted under this alternative range between about 16,000 and 19,000 nests (Table 3F-5), depending on which density factors are used (i.e, high, moderate, and low suitable habitat having 1,300, 600, and 200 nests per acre or all suitable nesting habitats having 1,000 nests per acre). Although, theoretically, the Paoha Islets could support up to 19,000 nests, such densities would represent more than twice the highest nest count ever recorded on these islets (i.e., about 9,300 nests in 1992). The 1992 high count represented an increase of more than 200% from the 10-year average of about 4,590 nests on the Paoha Islets (with a standard deviation of 2,280).

Under current conditions, gulls on the Paoha Islets tend to nest in dense clusters separated by large unoccupied or low-density nesting areas (Appendix C). Densities as high as 1,000 nests per acre are rarely achieved over large areas (e.g., 1 acre or more) for long periods at most gull colonies because extremely high nesting concentrations often deplete local food supplies, attract predators, or promote the spread of disease (Jehl and Winkler pers. comms.). Thus, it is likely that the actual nesting capacity of the Paoha Islets is lower than either calculated value but probably somewhat higher than the maximum of 9,300 nests observed there in 1992 (Jehl pers. comm.).

During 1992, the Mono Lake colony supported about 32,500 nests (about 65,000 breeding adults) and about 17,000 of those were on Twain and Java Islets (Appendix C). The combined total for the other Negit Islets that year was about 6,300 nests, indicating a potential unused capacity of about 6,200 nests (i.e., 12,500 minus 6,300). Similarly, estimates of the unused capacity on the Paoha Islets in 1992 ranged between 6,700 nests and 9,700 nests (i.e., 16,000 or 19,000 minus 9,300). Assuming these nesting capacity values for the Negit and Paoha Islets, a minimum of about 1,300 nests and a maximum of 4,300 nests would be displaced if both Twain and Java Islets were land bridged under 1992 conditions (i.e,. 11,000 minus 9,700 or 6,700).

Alternatively, assuming the highest densities ever observed on the Paoha Islets (i.e., 9,300 nests) and Negit Islets (i.e., 12,500 nests) approaches the maximum nesting capacities of these areas, the land bridging of Twain and Java Islets could cause long-term displacement of about 11,000 nests (i.e., 17,000 displaced nests minus about 6,200 nests that could be relocated to other Negit Islets).

Observations at Mono Lake and at other California gull colonies suggest that adults displaced from their nests during the breeding season may prey on the eggs and chicks of other adults (Appendix C). The potential effects of predation by displaced gulls are unknown but may be short-term reductions in the overall reproductive success of the Mono Lake colony. Thus, the exact number of displaced gulls or their effects on other breeding adults cannot be accurately predicted. Depending on the initial assumptions, however, the number of displaced gull nests at Mono Lake is predicted to range from a low of about 1,300 (2,600 adults) to a high of about 11,000 (22,000 adults) under this alternative.

Drought Effects. Because the lake has not fallen to 6,370 feet in the historical period, the effects of drought under this alternative cannot be accurately predicted. Under extreme drought conditions, however, Twain and Java Islets would be continually land bridged and other nearby nesting islets such as Little Tahiti would become more accessible to coyotes and other land predators. Increased predation probably would cause further reductions in the size and reproductive success of the Mono Lake colony compared to the average lake elevations predicted under this alternative.

Effects of Invertebrate Availability on Migratory Water Birds

At the average elevation predicted under this alternative (i.e., 6,375 feet) levels of alkali fly and brine shrimp productivity would be similar to those observed at the point of reference (see Chapter 3E, "Aquatic Productivity"). Within the range of elevations that could occur during extreme droughts or very wet periods (i.e., 6,370-6,379 feet), however, the amount of hard substrate available for the attachment of alkali fly pupae changes substantially. For example, the number of alkali fly larvae (pupating third instars) at the point of reference would be about 40% higher than those at 6,370 feet but only about 65% of those at 6,379 feet (see Chapter 3E, "Aquatic Productivity").

At lower lake elevations (i.e., less than 6,376 feet), red-necked phalaropes would be generally restricted to the lake's northeastern sector where they would forage at less than optimal efficiency (Rubega 1992). Phalaropes are attracted to this area probably because it is the only suitable foraging habitat for these species remaining at lower elevations of Mono Lake. The prevailing southwesterly winds of Mono Basin cause lake currents to move in opposite directions along the northern and eastern shorelines until they collide in the lake's northeastern sector (Stine 1993b). This merging of currents from a large area tends to concentrate free-floating alkali fly larvae in densities higher than in any other portion of the lake (Herbst 1992). At elevations below the point of reference, this area would continue to provide ample prey to support migratory phalaropes while the remainder of Mono Lake probably would be unsuitable foraging habitat. At higher elevations (i.e., above 6,376 feet), however, lakewide prey densities would increase significantly (see Chapter 3E, "Aquatic Productivity") and phalaropes probably would be widespread at Mono Lake.

Brine shrimp populations would decline as lake elevation was reduced from the point of reference; however, even at the historical lowstand (i.e., 6,372 feet) this prey species was sufficiently abundant to support hundreds of thousands of eared grebes. Brine shrimp are unlikely to experience significant declines (i.e., more than 10%) from the point of reference if the lake falls as low as 6,372 feet. During an extreme drought, however, the lake could fall to 6,370 feet under this alternative, but the effect of the elevation change on eared grebes cannot be assessed because the lake never reached 6,370 feet elevation in the historical period.

Abundance of Migratory Ducks at Mono Lake

At the average and maximum surface elevations predicted under this alternative, Mono Lake probably would support point-of-reference populations of migratory ducks (i.e., 11,000-15,000 individuals per year). About 0.5 acre of open water habitat would exist near the mouth of Wilson Creek and a few small ponds (i.e., less than 0.1 acre) at Simon's Spring and Warm Springs would also be present. Compared to point-of-reference conditions, average freshwater inflows at the Rush and Lee Vining Creek deltas would increase by about 40% and 75%, respectively. Additional freshwater at the creek deltas would make them more attractive to migratory ducks.

In about half the years under this alternative, alkali fly productivity would be reduced from point-of-reference conditions and during extreme droughts lakewide densities of alkali files could decline by 40% (see Chapter 3E, "Aquatic Productivity"). The diets of most ducks at Mono Lake have not been examined in detail, but declining alkali fly productivity would probably reduce the food available to most species at the lake. Thus, the benefits of increased delta outflows could be offset by declines in lakewide alkali fly productivity and duck populations under this alternative probably would not change significantly from point-of-reference conditions.

Snowy Plover Nesting Habitat at Mono Lake

Mono Lake would remain above the nick point (i.e., 6,368 feet) at all surface elevations predicted under this alternative, including extreme droughts when it could fall as low as about 6,370 feet. At the point of reference, only about 25% of the potential habitat around the lakeshore was occupied by nesting snowy plovers and this condition would not change under the 6,372-Ft Alternative. During extremely wet periods, the lake's elevation could rise to about 6,379 feet, which would inundate more than 3,000 acres of alkali lakeshore. However, a similar 9-foot change in the lake's elevation from 1982 to 1986 had no measurable effect on the breeding snowy plover population (Page pers. comm.). Thus, the range of lake elevations predicted under this alternative would be unlikely to affect this species compared to the point of reference.

Wildlife Habitat Values of the Mono Lake Shoreline

Near-Term Changes. During the first few years under this alternative, the acreage and overall wildlife values of lakeshore marshes, meadows, and wetlands scrub habitats would be similar to the point of reference (see Chapter 3C, "Vegetation").

Long-Term Changes. At the average elevations predicted under this alternative, the acreage of lakeshore habitats would decrease by more than 10%, but the WHUs would be similar to the point of reference (Table 3F-6). Significant impacts on wildlife would not be expected.

Drought Effects. Extreme droughts would not result in steep, incised shoreline topography because the lake's surface elevation would not fall below the nick point (see Chapter 3C, "Vegetation"). Thus, lakeshore habitats and wildlife populations would not be expected to change significantly from the point of reference.

Wildlife Habitat Values along Streams Tributary to Mono Lake

Under this alternative, minimum flows would be required in the four diverted tributary streams to maintain fisheries and riparian vegetation; the range of flows would be similar in dry, normal, and wet years and would represent a significant increase from the point of reference (see Chapter 2, "Project Description").

Near-Term Changes. Mature riparian trees and shrubs existing along these streams would continue to grow and the acreage of establishing vegetation would increase in response to rewatering the channels. Compared to the point of reference, these riparian habitats would have improved plant vigor, canopy density, and vegetative layering (see Chapter 3C, "Vegetation"). These changes would have significant beneficial effects on wildlife.

Meadow and wetland vegetation on Lee Vining and Rush Creeks could increase slightly in extent and vigor in the near term due to increased groundwater and a moratorium on grazing (see Chapter 3C, "Vegetation"). These changes would have minor beneficial effects on wildlife.

Long-Term Changes. Most areas with mature riparian vegetation would continue to live and grow, and most areas with establishing vegetation would eventually support mature riparian habitat (see Chapter 3C, "Vegetation"). Similarly, meadow and wetland vegetation may expand slightly, especially if grazing continues to be excluded.

The acreage of mature cottonwood-willow woodland would increase by more than 110 acres under this alternative compared to the point of reference (Table 3F-6). This increased acreage would have major benefits for resident and migratory wildlife and for riparian-dependent special-status species such as long-eared owls, yellow warblers, yellow-breasted chats, and mountain beavers (Appendix E). Partial restoration of the riparian corridor would facilitate wildlife movement between the eastern flank of the Sierra and the shores of Mono Lake. Under this alternative, however, the relatively low lake elevation and deeply incised creek channels would disrupt the continuity of riparian corridors on the lower reaches of Lee Vining and Rush Creeks.

The acreage of riparian habitats along Parker and Walker Creeks under this alternative would be identical to the point of reference (see Chapter 3C, "Vegetation"); similarly, the wildlife habitat values would not change.

Wildlife Habitat Values along the Upper Owens River

Under this alternative, the increased frequency of high flows (i.e., greater than 200 cfs) could increase channel instability and result in moderate losses of willow scrub habitat; continued cattle browsing would also decrease the extent of this habitat (see Chapter 3C, "Vegetation"). Minor flow-induced changes in willow scrub acreage, however, would not cause significant impacts on wildlife compared to the point of reference.

Summary of Benefits and Significant Impacts and Identification of Mitigation Measures (6,372-Ft Alternative)

- Allows nesting gulls to be disturbed by coyotes that could invade Negit Island 80% of the time and Twain and Java Islets 20% of time; half the gull colony could be affected if these islets were land bridged during the breeding season, and between 2,600 and 22,000 nesting adults could experience long-term displacement if these islets were permanently unavailable for gull nesting.

Mitigation Measures. Two methods of restricting coyote access to Negit Island have been attempted: predator-proof fences and channel blasting. Neither of these methods was effective, and substantial barriers of open water are probably required to prevent coyote predation of island nesting colonies (Appendix C). No mitigation measures are available.

- # Significantly reduces alkali fly productivity in about half the years, which could be detrimental to phalaropes, ducks, and other migratory water birds; during wet periods, the lake's alkali fly productivity could increase by about 35%, which would benefit most migratory water birds.

Mitigation Measures. None are available; only managing diversions for high lake levels could avoid this impact.

- # Increases cottonwood-willow woodlands by more than 110 acres, providing major benefits to resident and migratory wildlife and restoring the riparian corridor along tributary streams; new habitat also would provide significant benefits to special-status species such as long-eared owls, yellow warblers, yellow-breasted chats, and mountain beavers; bald eagles and ospreys could also benefit from enhanced fisheries.

IMPACTS AND MITIGATION MEASURES FOR THE 6,377-FT ALTERNATIVE

Changes in Resource Condition

California Gull Nesting Habitat at Mono Lake

Under this alternative, Mono Lake's surface elevation would gradually increase from the point of reference (6,376.3 feet) to an average elevation of about 6,379 feet. In wet years the lake could rise to a maximum elevation of about 6,383 feet, and under an extreme drought it could decline to a minimum elevation of about 6,373 feet (see Chapter 2, "Project Description").

Near-Term Changes. Compared to the point of reference, the target minimum lake elevation predicted under this alternative would protect about 155 acres of potential gull nesting habitat on Negit Island. The potential gull nesting capacity of Mono Lake would be maximized under this alternative; more than 180 acres of suitable nesting habitat would be available, representing an increase of about 360% from point-of-reference conditions (Table 3F-5).

Long-Term Changes. At lake elevations above 6,377 feet, Negit Island provides about 155 acres of potential gull nesting habitat (Table 3F-5) and offers the only large area available for future expansion of the Mono Lake colony. Overall, this would be considered a beneficial effect compared to point-of-reference conditions.

Drought Effects. Normal minimum runoff conditions under this alternative would cause the lake's elevation to fall below 6,376.5 feet in 2-4% of the years. This elevation could permit coyotes to cross the land bridge to Negit Island and could disrupt the nesting efforts of any gulls that recolonized this area. Episodes of gull colonization of Negit Island under this alternative would therefore be punctuated by periodic land bridging and subsequent coyote invasions that would have an overall disruptive effect on the Mono Lake colony. Similarly, Twain and Java Islets could be land bridged about 1% of the years during extreme droughts and would cause identical impacts to those described for the 6,372-Ft Alternative.

Effects of Invertebrate Productivity on Migratory Water Birds

At the average lake elevations predicted under this alternative the lakewide productivity of alkali flies would increase by about 40% from point-of-reference conditions, which would benefit phalaropes and other migratory water birds. Under extreme droughts, however, the lake's elevation could fall to about 6,373 feet and impacts on migratory water birds would be similar to those described for the 6,372-Ft Alternative.

Abundance of Migratory Ducks at Mono Lake

At the average lake elevations predicted under this alternative, the acreage of open water habitat around the lakeshore would not change from point-of-reference conditions (see Chapter 3C, "Vegetation"). Average freshwater outflows at the creek deltas (September-December) would be identical to those described for the 6,372-Ft Alternative, but normal maximum flows would be about 65% higher.

Migratory ducks would benefit from the 40% increase in lakewide alkali fly productivity compared to point-of-reference conditions (see Chapter 3E, "Aquatic Productivity"). Similarly, brine shrimp populations would increase by about 15%, which could provide benefits to northern shovelers and possibly other duck species.

Snowy Plover Nesting Habitat at Mono Lake

Mono Lake would remain above the nick point (i.e., 6,368 feet) at all surface elevations predicted under this alternative, including extreme droughts. Most alkali lakeshore habitat currently occupied by nesting snowy plovers would be inundated at the highest lake elevations (i.e., about 6,383 feet) but almost 5,000 acres of suitable habitat would remain on barren sands, pumice plains, and other unvegetated areas around the lakeshore (see Chapter 3C, "Vegetation"). Because this acreage represents more than twice the habitat area occupied by snowy plovers at the point of reference, the range of lake elevations predicted under this alternative would be unlikely to affect this species.

Wildlife Habitat Values of the Mono Lake Shoreline

Near-Term Changes. During the first few years under this alternative, the acreage and overall wildlife values of lakeshore marshes, meadows, and wetlands scrub habitats would be similar to the point of reference (see Chapter 3C, "Vegetation").

Long-Term Changes. At the average elevations predicted under this alternative, the acreage of lakeshore habitats would decrease by almost 40%, but the WHUs would be similar to the point of reference (Table 3F-6) and significant impacts on wildlife are not expected.

Drought Effects. Extreme droughts would result in increased acreage of alkali lakeshore habitats, which would have low value to wildlife. Thus, lakeshore habitats and wildlife populations are not expected to change significantly from the point of reference.

Wildlife Habitat Values Along Streams Tributary to Mono Lake

Under this alternative, minimum flows would be required in the four diverted tributary streams to maintain fisheries and riparian vegetation. Compared to the 6,372-Ft Alternative and the point of reference, however, ecosystem maintenance flows would be more frequent in summer (see Chapter 2, "Project Description").

Near-Term Changes. Similar to the 6,372-Ft Alternative, mature riparian trees and shrubs existing along the tributary streams would continue to grow and the acreage of establishing vegetation would increase. Implementation of the 6,377-Ft Alternative would increase the acreage of cottonwood-willow woodlands by about 120 acres, which would provide major benefits to resident and migratory wildlife. Compared to the point of reference, these riparian habitats would have improved plant vigor, canopy density, and vegetative layering (see Chapter 3C, "Vegetation") and would benefit more wildlife species than any other habitat in Mono Basin (Appendix D).

Meadow and wetland vegetation on Lee Vining and Rush Creeks could increase slightly in extent and vigor in the near term due to increased areas of shallow groundwater and a moratorium on grazing (see Chapter 3C, "Vegetation"). These changes would have beneficial but less-than-significant benefits on wildlife.

Long-Term Changes. Most areas with mature riparian vegetation would continue to live and grow and most areas with establishing vegetation would eventually support mature riparian habitat. Similarly, increased areas of shallow groundwater would permit a slight increase in the extent of meadow and wetland vegetation under this alternative, especially if the grazing moratorium is continued (see Chapter 3C, "Vegetation").

The acreage of mature cottonwood-willow woodland would increase by more than 120 acres under this alternative compared to the point of reference (Table 3F-6). The riparian corridor would become more continuous than under the 6,372-Ft Alternative, because vegetation beyond the low-flow channels would support establishing riparian trees and shrubs. Increased acreage and continuity would have major benefits for resident and migratory wildlife and for riparian-dependent special-status species such as long-eared owls, yellow warblers, yellow-breasted chats, and mountain beavers.

The acreage of riparian habitats along Parker and Walker Creeks under this alternative would be similar to the point of reference (see Chapter 3C, "Vegetation"); similarly, the wildlife habitat values would not change.

Wildlife Habitat Values along the Upper Owens River

Under this alternative, the frequency of high flows (i.e., greater than 200 cfs) would decrease slightly from the point of reference and the minor beneficial impacts would be similar to those described for the 6,372-ft Alternative.

Summary of Benefits and Significant Impacts and Identification of Mitigation Measures (6,377-Ft Alternative)

Maximizes potential gull nesting habitat in most years because Negit Island would be protected and additional habitat would be available on the Negit and Paoha Islets. In 2-4% of the years, however, Negit Island would be land bridged and gull nesting efforts would be disrupted; during extreme droughts, Twain and Java Islets would be land bridged and the impacts would be similar to those described previously for the 6,372-Ft Alternative.

Mitigation Measures. No mitigation measures are available.

Increases productivity of alkali flies (35%) and brine shrimp (15%) at the higher elevations predicted under this alternative, potentially providing significant benefits to most species of migratory water birds at Mono Lake. During extreme droughts, however, lakewide alkali fly productivity could be reduced by 40% and the adverse impacts on phalaropes and other water birds would be identical to those described for the 6,372-Ft Alternative.

Mitigation Measures. None are available.

Extreme droughts could reduce lakewide alkali fly productivity by 40%; the adverse impacts on migratory ducks would be similar to those described for the 6,372-Ft Alternative; benefits

migrating ducks by increased productivity of alkali flies (35%) and brine shrimp (15%) at the higher elevations predicted under this alternative.

Mitigation Measures. None are available.

Partially restores the wildlife movement corridor along the tributary streams because of increase of more than 120 acres in cottonwood-willow habitat. Increases value of the riparian zone to resident and migratory wildlife and special-status species due to increased vigor, density, and continuity, compared to the 6,372-Ft Alternative.

IMPACTS AND MITIGATION MEASURES FOR THE 6,383.5-FT ALTERNATIVE

Changes in Resource Condition

California Gull Nesting Habitat at Mono Lake

Under this alternative, Mono Lake's surface elevation would gradually increase from the point-of-reference (6,376.3 feet) to an average elevation of about 6,386 feet. In wet years the lake could rise to a maximum elevation of about 6,389 feet, and under an extreme drought it could decline to a minimum elevation of about 6,378 feet (see Chapter 2, "Project Description").

Near-Term Changes. Compared to the point of reference, the target minimum lake elevation predicted under this alternative would protect about 142 acres of gull nesting habitat on Negit Island, and the lakewide nesting capacity would increase by about 330% from the point of reference (Table 3F-5).

Long-Term Changes. At lake elevations above 6,389 feet, most of the Paoha Islets would be lost due to wave erosion (Stine 1993), a loss of almost 20 acres of potential gull nesting habitat. The presence of Negit Island, however, represents an increase of more than 330% in lakewide habitat acreage under this alternative compared to point-of-reference conditions (Table 3F-5). Thus, the loss of the Paoha Islets would not be considered a significant adverse impact because abundant potential habitat would be available for the Mono Lake colony.

Drought Effects. Even under conditions of extreme drought, Negit Island would be protected under this alternative and no significant impacts on the gull colony are expected.

Effects of Invertebrate Productivity on Migratory Water Birds

Lakewide productivity of alkali flies would be maximized at the range of surface elevations predicted under this alternative (see Chapter 3E, "Aquatic Productivity"). For example, at the average elevation (i.e., about 6,386 feet) the predicted production of third instar larvae would be about 40% higher than populations observed at the point of reference. Overall, this increase in food supply would be a substantial benefit to phalaropes and other water birds and it would enhance the value of Mono Lake as a migratory staging area for these species.

Brine shrimp populations would increase by about 20% under this alternative compared to the point of reference, which would be a substantial beneficial impact on eared grebes and other migratory water birds at the lake.

Abundance of Migratory Ducks at Mono Lake

Approximately 6 acres of ponds would be present around the lakeshore under this alternative (see Chapter 3C, "Vegetation"), providing migratory ducks with isolated sources of fresh water for drinking and bathing, which would offer substantial benefits compared to the point of reference. Normal minimum and average flows at the Rush and Lee Vining Creek deltas (September-December) would have identical benefits to those described for the 6,372-Ft Alternative.

Similar to phalaropes and other migratory water birds, ducks would benefit from increased alkali fly (40%) and brine shrimp (20%) productivity predicted under this alternative (see Chapter 3E, "Aquatic Productivity").

Snowy Plover Nesting Habitat at Mono Lake

During average lake elevations (i.e., about 6,386 feet) predicted under this alternative, only about 800 acres of alkali lakeshore habitat would exist for nesting snowy plovers. However, about 5,000 acres of suitable breeding habitat would still be available for this species on barren sands, pumice plains, and other unvegetated areas around the lakeshore (see Chapter 3C, "Vegetation"). Thus, effects on snowy plovers would be identical to those described for the 6,377-Ft Alternative.

Wildlife Habitat Values of the Mono Lake Shoreline

Near-Term Changes. During the first few years under this alternative, the acreage and overall wildlife values of lakeshore marshes, meadows, and wetland scrub habitats would be similar to the point of reference (see Chapter 3C, "Vegetation").

Long-Term Changes. At the average elevations predicted under this alternative, the acreage of lakeshore habitats would decrease by about 55% and the WHUs would decrease by more than 20% from the point of reference (Table 3F-6). Most of the inundated acreage, however, would be alkali lakeshore, which has extremely low wildlife habitat value (Appendix D).

After a period of years, approximately 6 acres of freshwater ponds would also form at the Rush Creek delta under this alternative, which would provide significant benefits to ducks, shorebirds, wading birds, and other migratory water birds. Thus, the adverse effects of inundating low-value lakeshore habitats would be more than offset by the re-creation of important new sources of water around the lakeshore; significant effects on wildlife are not expected.

Drought Effects. Extreme droughts would result in increased acreage of alkali lakeshore habitats, which would have low value to wildlife. Drought effects probably would be similar to the long-term changes described for this alternative.

Wildlife Habitat Values along Streams Tributary to Mono Lake

Under this alternative, minimum flows would be required in the four diverted tributary streams to maintain fisheries and riparian vegetation. Compared to the 6,377-Ft Alternative and the point of reference, however, ecosystem maintenance flows would be more frequent (see Chapter 2, "Project Description").

Near-Term Changes. Similar to the 6,377-Ft Alternative, mature riparian trees and shrubs existing along the tributary streams would continue to grow and the acreage of establishing vegetation would increase. The 6,383.5-Ft Alternative would increase the acreage of cottonwood-willow woodlands by about 125 acres, which would provide major benefits to resident and migratory wildlife. Compared to the point of reference, these riparian habitats would have improved plant vigor, canopy density, and vegetative layering (see Chapter 3C, "Vegetation") and would benefit more wildlife species than any other habitat in Mono Basin (Appendix D).

Meadow and wetland vegetation on Lee Vining and Rush Creeks could increase slightly in extent and vigor in the near-term due to increased groundwater and a moratorium on grazing (see Chapter 3C, "Vegetation"). These changes would have minor beneficial effects on wildlife.

Long-Term Changes. Most areas with mature riparian vegetation would continue to live and grow, and most areas with establishing vegetation would eventually support mature riparian habitat. Similarly, increased areas of shallow groundwater would permit a slight increase in the extent of meadow and wetland vegetation under this alternative, especially if the grazing moratorium is continued (see Chapter 3C, "Vegetation").

The riparian corridor would become more continuous than under the 6,377-Ft Alternative, because vegetation beyond the low flow channels would support establishing riparian trees and shrubs. Increased acreage and continuity would have major benefits for resident and migratory wildlife and for riparian-dependent special-status species such as long-eared owls, yellow warblers, yellow-breasted chats, and mountain beavers.

The acreage of riparian habitats along Parker and Walker Creeks under this alternative would be similar to the point of reference (see Chapter 3C, "Vegetation"); similarly, the wildlife habitat values would not change.

Wildlife Habitat Values along the Upper Owens River

Under this alternative, the frequency of high flows (i.e., greater than 200 cfs) would decrease from the point of reference and the minor beneficial impacts would be similar to those described for the 6,372-Ft Alternative.

Summary of Benefits and Significant Impacts and Identification of Mitigation Measures (6,383.5-Ft Alternative)

Provides long-term protection to Negit Island and Twain and Java Islets from coyote predation and increases the lakewide acreage of potential gull nesting habitat by more than 330%. Similar to phalaropes and ducks, gulls would benefit from maximum lakewide productivity of brine shrimp and alkali flies predicted under this alternative.

Substantially benefits eared grebes, phalaropes, and other migratory water birds by increased productivity of alkali flies (40%) and brine shrimp (20%) at the average elevations predicted under this alternative.

Substantially benefits migratory ducks through 6 acres of new ponds, increased flows at creek deltas, and increased productivity of alkali flies (40%) and brine shrimp (20%) predicted under this alternative.

Partially restores the wildlife movement corridor along the tributary streams because of increase of more than 125 acres of cottonwood-willow habitat. Due to increased vigor, density, and continuity, increases the value of the riparian zone to resident and migratory wildlife and special-status species.

IMPACTS AND MITIGATION MEASURES FOR THE 6,390-FT ALTERNATIVE

Changes in Resource Condition

California Gull Nesting Habitat at Mono Lake

Under this alternative, Mono Lake would gradually increase from the point-of-reference surface elevation (6,376.3 feet) to an average elevation of about 6,392 feet. In wet years the lake could rise to a maximum elevation of about 6,395 feet, and under an extreme drought it could decline to a minimum elevation of about 6,383 feet (see Chapter 2, "Project Description"). Project impacts would be identical to those previously described for the 6,383.5-Ft Alternative, except that the potential habitat acreage for nesting gulls would not increase as much from the point-of-reference conditions (260%) because of inundation of habitat (Table 3F-5).

Effects of Invertebrate Productivity on Migratory Water Birds

Compared to point-of-reference populations, alkali flies and brine shrimp populations would both increase by about 30% under this alternative. Abundant invertebrate food would increase Mono Lake's attractiveness to grebes, phalaropes, and other migratory water birds, similar but somewhat less than the 6,383.5-Ft Alternative.

Abundance of Migratory Ducks at Mono Lake

After a period of years, approximately 16 acres of ponds would form at the Rush Creek delta and on Paoha Island under this alternative (see Chapter 3C, "Vegetation"), providing migratory ducks with new sources of fresh water for drinking and bathing. Normal minimum and average flows at the Rush and Lee Vining Creek deltas (September-December) would be identical to those described for the 6,372-Ft Alternative. Migratory ducks also would benefit from 30% increases in alkali fly and brine shrimp productivity. Increased sources of fresh water around the lakeshore would also provide substantial benefits to shorebirds, wading birds, and other migratory water birds.

Snowy Plover Nesting Habitat at Mono Lake

During average lake elevations predicted under this alternative (i.e., about 6,392 feet), all alkali lakeshore habitats would be inundated but about 4,870 acres of suitable habitat would still be available for nesting snowy plovers on barren sands, pumice plains, and other unvegetated areas around the lakeshore (see Chapter 3C, "Vegetation"). Thus, effects on snowy plovers would be identical to those described for the 6,377-Ft Alternative.

Wildlife Habitat Values of the Mono Lake Shoreline

Near-Term Changes. During the first few years under this alternative, the acreage and overall wildlife values of lakeshore marshes, meadows, and wetlands scrub habitats would be similar to the point of reference (see Chapter 3C, "Vegetation").

Long-Term Changes. At the average elevations predicted under this alternative, the acreage of lakeshore habitats would decrease by about 68%, and the WHUs would decrease by more than 40% from the point of reference and would displace resident wildlife (Table 3F-6). Most of the inundated acreage, however, would be alkali lakeshore and dry meadows, which have low wildlife habitat values (Appendix D).

As the lake's elevation gradually approached 6,390 feet under this alternative, nesting ospreys would probably be displaced from their current nesting site on a tufa tower just offshore from Navy Beach. With increasing lake elevations this site would be exposed to wave action and possibly inundation. Although ospreys often nest at the same site in multiple years, they will select a new nest site if the old one is destroyed (Airola and Shubert 1981); evidence suggests that this species will readily accept artificial platforms if they are provided (Garber et al. 1974). Under the higher lake level alternatives, numerous large, partially submerged tufa towers would be available to nesting ospreys near Navy Beach and South Tufa State Reserve if the current tufa tower became close to the lake surface or was submerged; some towers would presumably provide suitable habitat.

Drought Effects. Extreme droughts would result in increased acreage of alkali lakeshore and dry meadow habitats, which would have low value to wildlife. Thus, drought effects probably would be similar to the long-term changes described for this alternative.

Wildlife Habitat Values along Streams Tributary to Mono Lake

Beneficial impacts on wildlife of increased riparian habitat would be identical to those described for the 6,383.5-Ft Alternative.

Wildlife Habitat Values along the Upper Owens River

Under this alternative, the frequency of high flows (i.e., greater than 200 cfs) would decrease from the point of reference and the minor beneficial effects would be similar to those described for the 6,372-ft Alternative.

Summary of Benefits and Significant Impacts and Identification of Mitigation Measures (6,390-Ft Alternative)

- # Benefits to gulls would be similar to those described for the 6,383.5-Ft Alternative, except that the increase in lakewide acreage of potential nesting habitat from point-of-reference conditions (260%) would be somewhat less.

- # Offers substantial but less than maximum benefits to eared grebes, phalaropes, and other migratory water birds because of increased productivity of alkali flies (30%) and brine shrimp (30%) compared to point-of-reference conditions.

- # Offers substantial benefits to migratory ducks because of 16 acres of new ponds and increased productivity of alkali flies and brine shrimp compared to point-of-reference conditions.

- # Benefits to wildlife of increased riparian habitat along diverted tributary streams would be identical to those described for the 6,383.5-Ft Alternative.

- # Through inundation, loss of more than 1,000 acres of existing marshlands, wet meadows, and scrublands and displacement of resident wildlife.

  Mitigation Measure. None are available.

IMPACTS AND MITIGATION MEASURES FOR THE 6,410-FT ALTERNATIVE

Changes in Resource Condition

California Gull Nesting Habitat at Mono Lake

Under this alternative, Mono Lake would gradually increase from the point-of-reference surface elevation (6,376.3 feet) to an average of about 6,411 feet. In wet years the lake could rise to a maximum elevation of about 6,415 feet, and under an extreme drought it could decline to a minimum elevation of about 6,401 feet (see Chapter 2, "Project Description"). Project impacts would be identical to those previously described for the 6,383.5-Ft Alternative, except that the potential habitat acreage for nesting gulls would not increase as much from the point-of-reference conditions (195%) because of inundation of habitat (Table 3F-5).

Effects of Invertebrate Productivity for Migratory and Nesting Water Birds

Based on the occurrence of hard substrates, productivity of alkali flies is predicted to be 20% higher than under point-of-reference conditions (see Chapter 3E, "Aquatic Productivity). However, that analysis does not consider submerged lakeshore vegetation that could potentially serve as additional hard substrate for the attachment of alkali fly pupae (Herbst pers. comm.).

Due to uncertainties regarding the extent of submerged vegetation and algae around the lakeshore, the actual productivity of alkali flies cannot be accurately predicted at lake elevations above about 6,390 feet. Accounts by prediversion observers indicate that alkali flies may have been more abundant at the lake prior to 1940 than they were at the point of reference (Fisher 1902; Banta, DeChambeau, and McPherson pers. comms.).

Brine shrimp populations would increase by about 35% under this alternative compared to the point of reference. This increase would substantially benefit eared grebes. Thus, overall increase in invertebrate food supplies under this alternative is expected to increase Mono Lake's attractiveness to eared grebes, phalaropes, and other migratory water birds that consume brine shrimp.

Abundance of Migratory Ducks at Mono Lake

Approximately 260 acres of ponds and lagoons would reform at the north Mono shorelands (i.e., Black Point, Bridgeport embayment, Dune Lagoons), at South Tufa, and at the Wilson-Mill, Lee Vining, and Rush Creek deltas under this alternative (see Chapter 3C, "Vegetation") that would provide migratory ducks, shorebirds, and wading birds with new sources of fresh water for foraging, drinking, and bathing. Similarly, the average flows at the deltas of Rush and Lee Vining Creeks would increase by about 60% and 80%, respectively, from the point of reference. Thus, the increased acreage of open water, streamflows, and abundance of invertebrate food predicted under this alternative would provide habitat conditions for migratory ducks similar to those described in the prediversion period.

Restoration of prediversion habitats probably would permit substantial increases in the number of migratory ducks visiting Mono Lake compared to the point of reference. Populations of most species have declined throughout North America since 1940, however, and the number of ducks using restored habitats at the lake would likely be far less than maximum counts from the prediversion period. The actual number of ducks visiting Mono Lake each year probably would vary depending on the population size and reproductive success of these species in western North America.

Snowy Plover Nesting Habitat at Mono Lake

During average lake elevations predicted under this alternative, all alkali lakeshore habitats would be inundated but about 4,800 acres of suitable habitat would still be available for nesting snowy plovers on barren sands, pumice plains, and other unvegetated areas around the lakeshore (see Chapter 3C, "Vegetation"). Thus, impacts on snowy plovers would be identical to those described for the 6,377-Ft Alternative.

Wildlife Habitat Values of the Mono Lake Shoreline

Near-Term Changes. During the first few years under this alternative, the acreage and overall wildlife values of lakeshore marshes, meadows, and wetlands scrub habitats would be similar to the point of reference (see Chapter 3C, "Vegetation").

Long-Term Changes. At the average elevations predicted under this alternative, the acreage of lakeshore habitats would decrease by about 84%, and the WHUs would decrease by more than 75% from the point of reference (Table 3F-6). Much of the inundated acreage would be alkali lakeshore and dry meadows, but more than 2,000 acres of marshes, wet meadows, and wetland scrub habitats also would be inundated and would displace resident wildlife. Effects on nesting ospreys would be similar to those described for the 6,390-Ft Alternative, except that the tufa groves along the south shoreline of the lake would be inundated (Stine pers. comm.). By the time this impact materialized, however, alternate nesting sites for this species would develop in tall trees or live snags along Rush and Lee Vining Creeks.

Drought Effects. Extreme droughts would result in increased acreage of alkali lakeshore and dry meadow habitats, which would have low value to wildlife. Thus, drought effects probably would be similar to the long-term changes described for this alternative.

Wildlife Habitat Values along Streams Tributary to Mono Lake

Benefits to wildlife of increased riparian habitat would be identical to those described for the 6,383.5-Ft Alternative.

Wildlife Habitat Values along the Upper Owens River

Under this alternative, the frequency of high flows (i.e., greater than 200 cfs) would decrease from the point of reference and the minor benefits would be similar to those described for the 6,372-Ft Alternative.

Summary of Benefits and Significant Impacts and Identification of Mitigation Measures (6,410-Ft Alternative)

- Benefits to gulls would be similar to those described for the 6,383.5-Ft Alternative, except that the lakewide increase in acreage of potential nesting habitat from point-of-reference conditions (195%) would be somewhat less.

- Benefits to eared grebes, phalaropes, and other water birds probably would be somewhat less or similar to those described for the 6,383.5-Ft Alternative.

- Provides significant potential for increases in migratory duck habitat through restoration of 260 acres of ponds and lagoons, increased flows at the creek deltas, and abundant invertebrate food.

- Results in major benefits for shorebirds, wading birds, and other migratory water birds because ponds and lagoons would be restored to their prediversion acreages.

- Through inundation loss of 2,000 acres of existing marshlands, wet meadows, and scrublands; resident wildlife would be displaced.

- Benefits to wildlife of increased riparian habitat along diverted tributary streams would be identical to those described for the 6,383.5-Ft Alternative.

Mitigation Measures. None are available.

IMPACTS AND MITIGATION MEASURES FOR THE NO-DIVERSION ALTERNATIVE

Changes in Resource Condition

California Gull Nesting Habitat at Mono Lake

Under this alternative, Mono Lake would gradually increase from the point-of-reference surface elevation (6,376.3 feet) to an average of about 6,427 feet. In wet years the lake could rise to a maximum elevation of about 6,436 feet, and under an extreme drought it could decline to a minimum elevation of about 6,416 feet (see Chapter 2, "Project Description"). Project impacts would be identical to those previously described for the 6,383.5-Ft Alternative, except that the potential habitat acreage for nesting gulls would not increase as much from point-of-reference conditions (184%) because of inundation of habitat (Table 3F-5).

Effects of Invertebrate Productivity on Migratory Water Birds

Based on the occurrence of hard substrates, productivity of alkali flies is predicted to be 12% higher than under point-of-reference conditions, and brine shrimp productivity would be 50% higher. Benefits to eared grebes probably would be similar to those described for the 6,383.5-Ft Alternative. Due to uncertainties regarding the extent of submerged vegetation and algae around the lakeshore, the productivity of alkali flies cannot be accurately predicted at the lake levels involved under this alternative, as described previously.

Abundance of Migratory Ducks at Mono Lake

Benefits to migratory ducks would be identical to those described for the 6,410-Ft Alternative.

Snowy Plover Nesting Habitat at Mono Lake

During average lake elevations predicted under this alternative (i.e., 6,425-6,430 feet), all alkali lakeshore habitats and many other barren areas would be inundated by the rising waters of Mono Lake. Under such conditions, the available habitat could fall below point-of-reference requirements for this species (i.e., a minimum of 2,500 acres) and significant adverse impacts on snowy plovers could result.

Wildlife Habitat Values of the Mono Lake Shoreline

Adverse impacts of inundating 95% of the lakeshore wetland habitat would be similar to those described for the 6,410-Ft Alternative. Effects on nesting ospreys would be similar to those described for the 6,410-Ft Alternative.

Wildlife Habitat Values along Streams Tributary to Mono Lake

Benefits to wildlife of increased riparian habitat would be similar to those described for the 6,383.5-Ft Alternative, except that the cottonwood-willow habitat would be slightly more extensive (Table 3F-6).

Wildlife Habitat Values along the Upper Owens River

Under this alternative, the frequency of high flows (i.e., greater than 200 cfs) would decrease from the point of reference and the minor benefits would be similar to those described for the 6,372-Ft Alternative.

Summary of Benefits and Significant Impacts and Identification of Mitigation Measures (No-Diversion Alternative)

Benefits to gulls would be similar to those described for the 6,383.5-Ft Alternative, except that the lakewide increase in acreage of potential nesting habitat from point-of-reference conditions (180%) would be somewhat less.

Benefits to eared grebes would be similar to those described for the 6,383.5-Ft Alternative; benefits to phalaropes would be less or similar to those described for the 6,383.5-Ft Alternative.

Benefits to migratory ducks would be identical to those described for the 6,410-Ft Alternative.

Adverse impacts of inundating 95% of the lakeshore marshes, wet meadows, and wetland scrub habitats would be similar to those described for the 6,410-Ft Alternative.

Mitigation Measure. None are available.

Causes the acreage of potential snowy plover habitat to fall below the minimum requirements of the point-of-reference population.

Mitigation Measures. None are available.

Restores ponds and lagoons to their prediversion acreages; benefits to wildlife would be identical to those described under the 6,410-Ft Alternative.

Benefits to wildlife of increased riparian habitat along diverted tributary streams would be similar to those described for the 6,383.5-Ft Alternative, except that cottonwood-willow woodlands would be slightly more extensive.

CUMULATIVE IMPACTS OF THE ALTERNATIVES

Related Impacts of Earlier Stream Diversions by LADWP

Changes in California Gull Nesting Habitat Availability at Mono Lake

The lakewide acreage of potential gull nesting habitat increased during the diversion period with the exposure of the Negit and Paoha Islets (Table 3F-5). As discussed above however, Negit Island provides more than twice the acreage of suitable habitat required to accommodate the largest gull colony ever recorded at Mono Lake (i.e., 65,000 adults in 1992). The newly exposed nesting habitat on the Negit and Paoha Islets was eventually occupied by nesting gulls, but it was not essential to the colony as long as Negit Island was isolated from the mainland and predator-free (i.e., at lake elevations above about 6,376.5 feet). Thus, the increased potential nesting acreage during the diversion period is considered a minor cumulative benefit to gulls.

After Negit Island became accessible to coyotes (i.e., below 6,376.5 feet), adequate habitat remained on the Negit and Paoha Islets to support the lake's largest recorded colony (Table 3F-5). The loss of Twain and Java Islets at lake elevations below about 6,373.5 feet, however, caused short-term displacement of about half of the lake's nesting adults.

Decline of Invertebrate Food Supply for Nesting and Migratory Birds

The productivity of alkali flies in the prediversion period could not be predicted with accuracy (see Chapter 3E, "Aquatic Productivity"), but qualitative descriptions and photographs suggest that flies gathered in dense windrows around the entire lakeshore and offered superabundant food for large flocks of water birds (Fisher 1902; Dawson 1923; Banta, DeChambeau, and McPherson pers. comms.). These windrows were a major source of food of native Paiutes in Mono Basin (Chapter 3K, "Cultural Resources").

Based on the occurrence of hard substrates around the lakeshore, maximum fly productivity may occur between about 6,380 and 6,390 feet and, depending on the amount of submerged vegetation and algae, at higher lake elevations. In contrast, brine shrimp would increase in direct proportion with declining salinities; they probably reached their greatest abundance in the prediversion years when the lake's salinity was about half that at the point of reference (see Chapter 3E, "Aquatic Productivity").

Similarly, the lack of prediversion census data for most water birds at the lake prohibits comparisons with counts made in recent decades. Qualitative accounts, however, suggest that eared grebes may have increased in the diversion years while phalaropes probably were always abundant and widespread around the lakeshore. Because they are nutritionally and calorically superior to brine shrimp, however, alkali flies offer the most important invertebrate food at the lake, and surface elevations that maximize their productivity would offer the greatest overall benefits to migratory water birds. As discussed previously, phalaropes foraged at less than optimal efficiencies at when lakewide productivity of alkali flies was similar to the point of reference.

Loss of Habitat for Migratory Ducks

As discussed in the "Environmental Setting" section, at least one million ducks were present at one time during fall migration in the prediversion years; the total number ducks visiting the lake during an entire year was never estimated (Banta, DeChambeau, and McPherson pers. comms.). Between 11,000 to 15,000 ducks currently visit the lake each year, over a 98% decline from the prediversion period. As also discussed previously, the decline in Mono Lake's duck population far exceeded declines observed in other parts of California during the same period. For example, duck populations in the Central Valley have declined by only 40% to 60% since the mid-1960s.

The declines of migratory ducks at Mono Lake were most abrupt during the 1960s when about 260 acres of lakeshore ponds and lagoons were lost (i.e., when the lake surface fell below about 6,400 feet) and freshwater inflows at the creek deltas ceased. The lack of freshwater sources for drinking and bathing apparently contributed significantly to the decline.

Creation of Snowy Plover Nesting Habitat

As discussed in the "Environmental Setting" section, snowy plovers were not recorded at Mono Lake before the prediversion period and their breeding populations were not discovered until 1976. Declining lake elevations expanded the area of potential breeding habitat to more than 10,000 acres, which was beneficial to this species. At the point of reference, however, approximately 75% of this habitat was not occupied and thousands of acres (including about 6,000 acres of alkali shoreline) could be inundated without causing cumulative, adverse impacts on snowy plovers at Mono Lake.

Increased Acreage of Vegetated Lakeshore Habitats

About 4,000 acres of alkali and dry meadows, tall and short emergent marsh, and wetland scrub habitats have colonized the lake's shoreline during the diversion period. By virtue of their large acreage alone, these habitats benefit wildlife. Overall, however, current shoreline habitats support a few bird species and almost no small mammals, reptiles, or amphibians (Appendix D). Similarly, the expansion of vegetation around the lakeshore coincided with the loss of freshwater springs, ponds, and lagoons, which provided essential habitat for migratory ducks and shorebirds. Compared to the prediversion years, current wildlife use of Mono Lake's shoreline habitats probably is greatly reduced and the creation of saline marsh, meadow, and scrub habitats did not compensate for the loss of ponds and lagoons.

Loss of Wildlife Habitat Values along Streams Tributary to Mono Lake

As discussed in the "Environmental Setting" section, the riparian habitats along the tributary streams were eliminated or greatly reduced by dewatering, channel incision, and grazing during the diversion years (see Chapter 3C, "Vegetation"). For example, more than 200 acres of mature cottonwood-willow riparian habitat were lost along Lee Vining and Rush Creeks, which destroyed an important wildlife movement corridor and removed a rare, diverse, and productive wildlife habitat of the eastern Sierra Nevada. This habitat loss also contributed to the decline of riparian-dependent special-status species in Mono Basin, including long-eared owls, willow flycatchers, yellow warblers, yellow-breasted chats, and mountain beavers.

In addition to desiccation of riparian corridors below the diversion points, significant areas of riparian habitats were lost along upper Rush Creek due to the construction and inundation of Grant Lake reservoir.

Almost 45 acres of riparian habitat were lost along lower Mill Creek during the diversion years. Similar to Rush Creek, Mill Creek experienced incision due to declines in the lake's elevation and uncontrolled spilling flows (see Chapter 3C, "Vegetation"). This loss of riparian habitat would contribute to the cumulative loss of riparian habitat values and disruption of movement corridors previously described for the diverted tributary streams.

Decreased Wildlife Habitat Values along the Upper Owens River

As described previously, minor losses of willow scrub riparian habitat may have occurred due to increased flows and channel instability below East Portal. About 11.8 acres of this habitat has been lost during the diversion years, but some was removed by cattle browsing (see Chapter 3C, "Vegetation").

Related Impacts of Other Past, Present, or Anticipated Projects or Events

Past Grazing Practices

As described in Chapter 3C, "Vegetation", grazing in the riparian corridors and surrounding uplands of Lee Vining, Rush, Walker, and Parker Creeks since the 1860s has apparently accelerated the loss of riparian and meadow habitats.

Other Projects

Other projects described in Chapter 3C, "Vegetation" (i.e., past highway construction, SCE construction, anticipated widening of U.S. 395, and interim stream restoration) could cause short-term disruption of wildlife and probably would contribute to long-term cumulative impacts if permanent losses of riparian habitat occurred.

Significant Adverse Cumulative Impacts

No-Restriction Alternative

- # Eliminates California gull nesting habitat on most islands and islets; causes possible abandonment of Mono Lake as a breeding area.

- # Eliminates invertebrate food supply for water birds; causes possible abandonment of Mono Lake as a migratory staging area for eared grebes, phalaropes, and ducks.

- # Eliminates tributary riparian habitats and associated wildlife.

6,372-Ft Alternative

- # Results in long-term loss of Negit Island and in loss of Twain and Java Islets as California gull nesting habitat 20% of the time.

- # Results in decline of alkali fly and brine shrimp productivity, especially during droughts.

- # Causes degraded habitat for migratory ducks due to loss of 260 acres of ponds and lagoons and reduced inflows at creek deltas.

- # Causes reduced wildlife habitat values and corridor continuity due to loss of 61 acres of cottonwood-willow riparian habitat along the tributary streams.

6,377-Ft Alternative

- # Potentially reduces alkali fly productivity and potential food for migratory water birds.

- # Degrades habitat for migratory ducks due to loss of 260 acres of ponds and lagoons and reduced inflows at creek deltas.

- # Reduces wildlife habitat values and corridor continuity due to loss of 52 acres of cottonwood-willow riparian habitat along the tributary streams.

6,383.5-Ft Alternative

- # Degrades habitat for migratory ducks due to loss of 254 acres of ponds and lagoons and reduced inflows at stream deltas.

- # Reduces wildlife habitat values and corridor continuity due to loss of 50 acres of cottonwood-willow riparian habitat along the tributary streams.

6,390-Ft Alternative

- # Degrades habitat for migratory ducks due to loss of 245 acres of ponds and lagoons; potentially restores some lost values by increasing inflows at creek deltas.

- # Reduces wildlife habitat values and corridor continuity due to loss of 48 acres of cottonwood-willow habitat along the tributary streams.

6,410-Ft Alternative

- # Reduces wildlife habitat values and corridor continuity due to loss of 46 acres of cottonwood-willow habitat along the tributary streams.

No-Diversion Alternative

- # Reduces wildlife habitat values and corridor continuity due to loss of 44 acres of cottonwood-willow habitat along the tributary streams.

Mitigation Measures for Significant Cumulative Impacts

Mono Lake

Cumulative impacts on nesting gulls and feeding of migratory water birds can be avoided only by selection of higher lake-level alternatives; no other mitigation measures are available. Predation of Twain and Java Islets could be avoided by maintaining the lake's elevation above about 6,374 feet; similarly, the land bridge to Negit Island would be covered at about 6,376.5 feet. The net loss of freshwater habitats providing migratory duck habitat can be mitigated.

Restore Lakeshore and Creek Delta Ponds to Provide Habitat for Migratory Ducks and Other Water Birds. Minor excavations and diversion of surface flows could be used to restore freshwater ponds at the deltas of Lee Vining and Rush Creeks (see Chapter 3A, "Hydrology"). Restoring freshwater ponds on the creeks and around the lakeshore (e.g., DeChambeau ponds) would offer major benefits for migratory ducks. Specific restoration plans should be prepared for each area that would specify soil types, construction techniques, water sources, vegetation establishment, and target wildlife habitat values. Overall, the goal should be to restore at least 260 acres of ponds and lagoons (i.e., the prediversion acreage) around the lakeshore. Due to declines in their populations throughout North America, ducks probably would not return to their former abundance in Mono Basin; however, restored lakeshore wetlands would enable ducks to expand their use of the lake.

Tributary Streams

Several measures are available.

Rewater Subsidiary Channels on Rush and Lee Vining Creeks. Techniques for rewatering of subsidiary channels on lower Rush and Lee Vining Creeks are described in Chapter 3C, "Vegetation". Restoring these habitats would have major benefits for wildlife, especially those species that avoid the swift-moving waters of the primary channels or are dependent on food and cover provided by cottonwood-willow corridors.

Manage Streamflows to Optimize Conditions for Natural Vegetation Recovery. Techniques for optimizing natural vegetation recovery described in Chapter 3C, "Vegetation" would offer major benefits to wildlife, including a variety of special-status species.

End Livestock Grazing in the Tributary Stream Riparian Corridors Permanently. As described in Chapter 3C, "Vegetation", a permanent ban on sheep grazing in the riparian corridors would enhance vegetation recovery and the wildlife habitat value of these areas. A single entry into a riparian corridor by a large flock of sheep can destroy a year's worth of restoration effort in a few hours.

Plant Woody Riparian Vegetation Onsite and Offsite. As described in Chapter 3C, "Vegetation", planting woody riparian vegetation onsite and offsite would enhance the recovery of riparian corridors. This would facilitate wildlife use of the restored areas.

Construct Freshwater Ponds at Cain Ranch, DeChambeau Ranch, and along Lower Lee Vining and Rush Creeks. Techniques for constructing freshwater ponds at Cain Ranch, and on lower Rush and Lee Vining Creeks are described in Chapter 3C, "Vegetation". Restoring these habitats would have major benefits for wildlife, especially migratory ducks.

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Personal Communications

Andrews, Jerry. Long-time resident of Mono Basin, CA. October 29, 1991 - summary of interview with Ilene Mandelbaum and Emilie Strauss.

Arcularius, John. Owner. Arcularius fishing ranch, Mono County, CA. May 1991 - telephone conversations with Pete Rawlings.

Audet, Dan. Contaminant specialist. U.S. Fish and Wildlife Service, Ventura, CA. July 15, 1992 - memorandum.

Banta, Don. Long-time resident of Mono Basin, CA. October 29, November 6, and December 31, 1991 - summary of interview with Emilie Strauss; October 6 and 20, 1992 - telephone conversations with Ted Beedy.

Cain, John R., Jr. Science associate. Mono Lake Committee, Lee Vining, CA. September 16, 1991 - telephone conversation with Ted Beedy.

Carle, David. Mono Lake Tufa State Reserve, Lee Vining, CA. May 3, 1993 - telephone conversation with Ted Beedy.

Clover, Katherine. Property owner on Rush Creek, Mono County, CA. April 23, 1985 - summary of telephone interview with Ilene Mandelbaum.

DeChambeau, Kent. Attorney. State Legislature (retired). January 6, 1993 - meetings and telephone conversation with Ted Beedy.

Durant, Jessie. Historical resident on Rush Creek, Mono County, CA. October 13, 1991 -summary of interview with Emilie Strauss.

Elphnick, Chris. Research assistant. University of California, Irvine, CA. August 1991 - conversation with Ted Beedy.

Ford, Larry. Biologist. U.S. Forest Service, Inyo National Forest, Lee Vining, CA. 1989 - conversations with Margaret Rubega.

Gaines, David. Founder and chairperson. Mono Lake Committee, Lee Vining, CA. April 24, 1985 - progress report to Mono Lake Committee; numerous conversations with Ted Beedy during 1976 through 1987.

Harris, John H. Associate professor of biology. Mills College, Oakland, CA. May-November 1991 - meetings and telephone conversations with Ted Beedy.

Herbst, David. Researcher. Sierra Nevada Aquatic Research Laboratory, University of California, Mammoth Lakes, CA. June 1991-June 1992 - multiple telephone conversations and meetings in the field with Ted Beedy; October 15, 1992 - telephone conversation with Ted Beedy.

Hess, August. Long-time resident of Mono Basin. October 29 and December 20, 1991 - summary of interviews with Ilene Mandelbaum and Emilie Strauss.

Jehl, Joseph R., Jr. Director of research. Hubbs Marine Research Institute, San Diego, CA. March 1991-July 1991 - meetings and correspondence with Ted Beedy.

Mandelbaum, Ilene. Associate director. Mono Lake Committee, Lee Vining, CA. April 24, 1985 - progress report to Mono Lake Committee.

McPherson, Wallis. Long-time resident of Mono Basin, CA. Summary of interview with Emilie Strauss; April 29, 1989 - summary of interview with Ilene Mandelbaum; September 19, 1991, and October 28, 1992 - telephone conversations with Ted Beedy.

Menigan, Larry S. Wildlife specialist. U.S. Bureau of Land Management, Bishop, CA. July 29, 1976 - memorandum concerning Mono Lake inventory.

Murphy, Tom. Resident and coyote researcher at Mono Lake. Mono City, CA. February 1991 - meetings in the field.

Obst, Brian. Professor. University of California, Santa Barbara, Santa Barbara, CA. 1989-1990 - multiple conversations with Margaret Rubega.

Page, Gary. Shorebird biologist. Point Reyes Bird Observatory, Stinson Beach, CA. September 25, 1991 and February 14, 1992 - telephone conversations with Ted Beedy.

Preston, Jack. Long-time resident of Mono Basin, CA. April 21, 1986 - summary of interview with Ilene Mandelbaum.

Reid, Fritz. Biological supervisor for the Pacific Flyway. Ducks Unlimited, Sacramento, CA. December 14, 1992 - telephone conversation.

Rubega, Margaret. Graduate student. University of California, Irvine, Irvine, CA. March 1991-June 1992 - multiple conversations with Ted Beedy.

Sanders, Susan. Wildlife biologist. Woodlands, CA. December 14, 1992 - meeting with Ted Beedy.

Shivik, John. Graduate student and coyote researcher at Mono Lake. University of California, Berkeley, Berkeley, CA. July 1991 - meetings in the field.

Shuford, David W. Biologist. Point Reyes Bird Observatory, Stinson Beach, CA. May 1991-October 1992 - multiple meetings and telephone conversations with Ted Beedy.

Skorupa, Joe. Wildlife biologist. U.S. Fish and Wildlife Service, Pacific Coast Research Station, Davis, CA. December 10, 1991, and October 23, 1992 - telephone conversations with Ted Beedy.

Stine, Scott. Professor and geomorphology expert. California State University, Hayward, Hayward, CA. July 1991-June 1992 - multiple meetings and telephone conversations with Ted Beedy.

Strauss, Emilie. Biologist. Mono Lake Committee, Lee Vining, CA. May 1991-June 1992 - multiple telephone conversations and meetings with Ted Beedy.

Swanson, George A. Wildlife biologist. U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center, Jamestown, ND. December 5, 1991 - telephone conversation with Ted Beedy.

Swarth, Chris. Graduate student. California State University, Hayward, CA. 1976-1982 - multiple conversations with Ted Beedy.

Taylor, Tim. Wildlife biologist. June Lake, CA. Meeting and multiple telephone conversations during 1991 and 1992 with Ted Beedy.

Tillemans, Brian. Range and wildlife specialist. Aqueduct-Northern District, Los Angeles Department of Water and Power, Bishop, CA. June 1991-November 1992 - multiple conversations with Pete Rawlings and Ted Beedy.

Vestal, Eldon. Fisheries biologist (retired). California Department of Fish and Game, Napa, California. September 19, 1991, and October 29, 1992 - telephone conversations with Ted Beedy.

Winkler, David. Assistant Professor of Ornithology. Cornell University, Ithaca, NY. June 1991-October 1992 - multiple telephone conversations with Ted Beedy.

Yparraguirre, D. R. Waterfowl biologist. California Department of Fish and Game, Sacramento, CA. October 23, 1992 - telephone conversation with Ted Beedy.