Chapter 3D. Environmental Setting, Impacts, and Mitigation Measures - Fishery Resources

Mono Lake is a highly alkaline, saline lake that does not provide suitable habitat for fish. This condition has persisted over a long span of geologic time. The diversion of streamflow from the Mono Lake tributaries, however, potentially affects fishery resources not only in the diverted tributary reaches but throughout most of the length of the Owens River, as well (Figure 1-5). This chapter describes potentially affected fish populations and habitats in these river systems. The SWRCB process will not address instream flows in Mill and Wilson Creeks; DFG is currently preparing instream flow studies on Mill and Wilson Creeks, but completion dates are unknown. Instream flows in the Owens River gorge, which extends from Long Valley Dam to Pleasant Valley Reservoir, also are not addressed in this EIR; the alternatives do not affect flows in the gorge, and separate actions to determine appropriate flow conditions in the gorge are ongoing.

In this chapter, the Upper Owens River includes the headwaters of the river to Long Valley Dam, which impounds Lake Crowley reservoir. The Middle Owens River extends from Pleasant Valley Dam to Tinemaha Reservoir. The Lower Owens River extends from Tinemaha Reservoir to Owens Lake.

PREDIVERSION CONDITIONS

Sources of Information

Existing information on prehistoric habitat conditions in Mono Basin and the Owens River basin is limited and based on Deinstadt et al. (1985) and Moyle (1976).

To describe historic prediversion aquatic habitats and fish populations in Mono Basin, Trihey & Associates (1991) and Jones & Stokes Associates independently identified, compiled, and reviewed potential data sources. Published and unpublished scientific information is scarce, and definitive information is unavailable to quantitatively describe historic prediversion fish habitats or populations; however, the available information that was identified is presented below. Numerous physical attributes of historic prediversion conditions and related fishery resource values were estimated for Lee Vining and Rush Creeks by use of maps, ground and aerial photographs, and written and oral historic accounts (Trihey & Associates 1991, 1992a). Primary sources of information on prediversion conditions in the Owens River basin are Moyle (1976) and Smith and Needham (1935).

Prehistoric Conditions

Mono Basin

Habitat. Prehistoric Mono Lake tributaries mostly were characterized by relatively steep gradients (from 2% to 5%); rocky substrates; and turbulent, perennial flows (Deinstadt et al. 1985). Minimum flows occurred during winter, and ice formation was extensive at higher elevations and present at lower elevations. Peak flows were associated with snowmelt during late spring and early summer and occasionally were accentuated by summer thunderstorms. Common stream habitat types in tributaries included small pools, riffles, runs, rock gardens, and cascades. Dense riparian vegetation often consisted of several species of willows, black cottonwood, Jeffrey pine, and western birch, interspersed with sagebrush in drier areas. See Chapter 3C, "Vegetation", for a detailed description of plant communities and species.

Grant Lake is the northernmost, lowest lake in the June Lake Loop chain of glacial lakes. Grant Lake, which had a maximum surface area of 150 acres, had only slight annual changes in water surface elevations and received inflow from only one tributary stream, Rush Creek.

Fish Populations. Before the mid-1850s, streams and lakes in Mono Basin, including Lee Vining and Rush Creeks, were devoid of fish. Archeological finds of fish bones lying beneath volcanic ash, however, indicate that fish were once present in Mono Basin. Geologically recent volcanic eruptions may have eliminated these fish from the basin (Hubbs pers. comm. in Moyle 1976).

Owens River Basin

Habitat. Owens River tributaries provided habitats similar to those described above for Mono Lake tributaries. Owens River habitats varied considerably, as described below.

Originating in the upper reaches of Long Valley, the Owens River drains the eastern slope of the Sierra Nevada and, to a lesser extent, the western slope of the White and Inyo Mountains. The river forms as a result of tributary inflow from Deadman and Glass Creeks and spring inflow at Big Springs. Winding its way through extensive meadow areas in Long Valley, the Owens River is joined by smaller tributaries (such as Hot, Mammoth, and Convict Creeks) before entering the Owens River gorge. Within the gorge, the river has cut into the valley, forming high canyon walls as it drops 3,000 feet in approximately 16 miles. The steeper gradient and boulder fields produced pool habitats and short cascades unlike the run habitats characteristic of the highly meandering section in Long Valley.

Downstream of the gorge, the Owens River flows through unconsolidated alluvial deposits, again becoming a meandering channel with high sinuosity. Willows and cottonwoods lining the river formed a dense riparian corridor. Recent aerial photographs show remnant meander scars and oxbow lakes, suggesting that river meanders were highly migratory under unaltered conditions.

Fish Populations. The Owens River basin contained four native fish species: Owens sucker, Owens tui chub, Owens pupfish, and Owens speckled dace. Little is known about the ecology of these endemic species prior to habitat alteration and widespread introductions of exotic species. Moyle (1976) suggests that dace was the dominant species of headwater streams. At lower elevations, dace were common in riffles, while pupfish inhabited extensive marshes of the valley floor. Suckers and tui chubs dominated the Owens River and the slower moving, lower elevation reaches of tributary streams.

Historical Conditions

Mono Tributaries

Habitat. Lee Vining and Rush Creeks were lined by dense riparian growth, primarily cottonwood and willow at lower elevations and pine and cottonwood at higher elevations (see Chapter 3C, "Vegetation"). The stream channels were quite stable and contained large deposits of high-quality spawning gravel. Overall, the channel structure and riparian vegetation provided good to excellent habitat conditions for trout in Lee Vining and Rush Creeks (Trihey & Associates 1991).

Lee Vining Creek. Lee Vining Creek streamflows were unimpaired before 1860. Early settlers soon began to divert water from the creek for use in sawmills and for irrigation. Diversions for irrigation increased through the late 1800s and early 1900s (Aquatic Systems Research 1992). In 1923, the Poole Power Plant began operating at the foot of Lee Vining Creek Falls, and water was diverted above the falls to generate hydroelectric power. Habitat changes occurred seasonally downstream of diversion sites where summer streamflows were reduced. Subsequently, several small lakes in the watershed were enlarged to increase storage capacity, and a low-head hydroelectric plant was built at the U.S. Highway 395 (U.S. 395) crossing (Aquatic Systems Research 1992). Between 1930 and 1940, water was diverted from Lee Vining Creek primarily for irrigation and hydroelectric generation. Historical sources indicate that these diversions did not dewater Lee Vining Creek, although irrigation diversions significantly reduced late summer flow in drought periods (Trihey & Associates 1992a).

Before 1940, Lee Vining Creek below the U.S. 395 crossing was characterized by a multiple channel system consisting of a single main channel and several subsidiary channels. The main and subsidiary channels contained a diversity of aquatic habitats that supported all trout lifestages. Narrow channel widths and frequent meanders provided deep water habitat and promoted the development of undercut root wads and lateral scour pools. Dense riparian vegetation occurred along most of Lee Vining Creek, providing cover and shade over most of the stream width and stabilizing streambanks. Logs, root wads, and fallen trees contributed to trout habitat quality. Because of the higher summer flows, summer water temperatures were cooler than they are today. Trout spawning gravels were abundant in Lee Vining Creek, with the largest deposits probably located near the mouth (Trihey and Associates 1992a).

Aquatic Systems Research (1992) subdivided Lee Vining Creek into six study segments based on differences in gradient, geomorphology, and riparian vegetation (Figure 3D-1). Upper Lee Vining Creek, identified as Segment 1, is the portion of the stream from Poole Powerhouse to LADWP diversion dam; lower Lee Vining Creek was delineated into five segments between the LADWP diversion dam to Mono Lake. Trihey & Associates (1991) subdivided lower Lee Vining Creek into only three segments as a basis for describing historical habitat conditions in this reach. Existing stream segment boundaries are considered to be representative of segment boundaries under historic prediversion conditions, as described by Trihey & Associates (1991).

Segment 1 (0.8 mile), corresponding to Aquatic Systems Research's Segment 2, contained abundant high-quality spawning gravels. Dense riparian vegetation consisted of Jeffrey pine, lodgepole pine, white fir, water birch, quaking aspen, black cottonwood, and several willow species. The understory along this reach included brush willows, wild rose, and various species of grasses and other herbs. Most of the cover used by trout in Segment 1 was probably associated with undercut banks, protruding tree roots, and debris jams. (Trihey & Associates 1991.)

Segment 2 (1.3 miles), corresponding to Aquatic Systems Research's Segments 3 and 4, contained good-quality spawning gravels, but these gravels were less frequent than in Segment 1. The largest deposits of spawning gravels in this segment were located immediately upstream of U.S. 395 (Vestal 1990, Court Testimony, Volumes I and II). Riparian vegetation was similar to that in Segment 1, but large rocks and debris jams were more prevalent sources of trout cover in Segment 2. (Trihey & Associates 1991.)

Segment 3 (1.8 miles), corresponding to Aquatic Systems Research's Segments 5 and 6, contained good-quality, but increasingly less frequent spawning gravels. Large deposits of spawning gravels were located primarily near the mouth of Lee Vining Creek (Vestal 1990, Court Testimony, Volumes I and II). Vegetation was less diverse (though no less dense) in Segment 3, with black cottonwood, willows, and Jeffrey pine dominating. Grasses, wild rose, sagebrush, and bitterbrush constituted major elements of the understory. Cover used by trout was similar to that in Segment 1, probably consisting of undercut banks, protruding tree roots, and debris jams. (Trihey & Associates 1991.)

RushCreek. Between the 1860s and the late 1930s, water was diverted seasonally from Rush Creek for in-basin agricultural purposes. These diversions reduced summer streamflows in the areas immediately downstream of the diversion points, but tributary inflow and the tendency of some diverted water to return downstream through springs and seepage lessened the impacts of these diversions. (Beak Consultants 1991.) Major irrigation diversions began in the 1920s following the construction of an artificial dam that increased the storage capacity of Grant Lake (Stine 1992a).

Peak flows in Rush Creek during the snowmelt runoff period often reached a maximum of 175 cfs under the influence of Southern California Edison's (SCE's) reservoir operations, although flows of more than 300 cfs occurred in wet years. Late spring and early summer runoff from Parker and Walker Creeks typically contributed about 50 cfs of these flows (Jones & Stokes Associates 1993).

Rush Creek was divided into seven segments from Grant Lake Dam downstream to Mono Lake (Figure 3D-2). Habitat mapping surveys were conducted in 1984 (EA Engineering, Science, and Technology 1989), 1987 (Beak Consultants 1991), and 1990 (Trihey & Associates 1991) with minor differences resulting from each survey. Beak Consultants (1991) delineations primarily are used here because they provided the basis for the Rush Creek instream flow study and were most closely associated with boundaries established by Trihey & Associates (1991), which form the basis for existing aquatic and riparian habitat restoration efforts. Existing stream segment boundaries are generally representative of segment boundaries under historic prediversion conditions and are used to facilitate comparable discussions and analyses.

Segment 1 (1.4 miles), which was replaced with the return ditch when Grant Lake Dam was enlarged in 1939-1940, maintained abundant, good-quality gravels for trout spawning and insect production (Vestal 1990, Court Testimony, Volumes I and II). No other specific data are available to determine historic prediversion conditions.

Segment 2 (0.9 mile) is a relatively steep canyon characterized by a high channel gradient (3.18%), alternating cascades and pools, large substrate material (i.e., boulders), and a stand of riparian vegetation. Boulders and cobbles dominated the streambed materials, although pockets of gravels accumulated in many pools. Small clusters of Jeffrey pine grew along the stream corridor, and a continuous stand of cottonwood and willow extended along much of this reach. (Beak Consultants 1991, Trihey & Associates 1991.)

Segment 3 (3.2 miles) is the longest of the seven reaches, extending from Segment 2 downstream to a large bedrock formation known as "the narrows". The gradient is moderately flat (1.85%), and the terrain is relatively open. Aerial photographs taken in January 1930 indicate that the riparian corridor along the upper mile of Segment 3 consisted of dense willows interspersed with Jeffrey pine. Heavy bank cover of sagebrush, bitterbrush, willow, and rugosa wild rose was cited by Vestal (Vestal 1990, Court Testimony, Volumes I and II). Several cutoff meander bends and secondary channels were present and probably provided excellent habitat for young fish and, if influenced by groundwater, good overwintering habitat. In addition, the network of secondary channels probably contributed to a reduction in channel scour during periods of high runoff by shunting a portion of the flood peak out of the main channel and onto the floodplain. It appears that pool and/or low-velocity run habitats were present, and well-vegetated undercut streambanks contributed substantially to the general character of this reach. (Trihey & Associates 1991.)

The lower 2 miles of Segment 3 occupied a single channel. Clusters of pine accompanied a narrow band of cottonwoods and willow that lined the streambanks. Dense stands of cottonwood and willows extended across the floodplain above old U.S. 395. Logs and debris jams probably contributed to the diversity of instream habitat conditions, as did exposed roots along the streambank. Many large boulders were present in this reach, and gravel deposits reportedly were present immediately upstream of old U.S. 395 and near The Narrows. Habitat composition may have consisted primarily of riffles, but runs and small pools were common. (Trihey & Associates 1991.)

Segment 4 (0.05 mile), the narrows, has a relatively high gradient (2.86%) and largely is confined within vertical rock walls along both sides of the creek channel. Aquatic habitat consisted mainly of repeating cascade and plunge pool sequences over most of the reach. (Beak Consultants 1991.)

Segments 5-7 extend from the narrows to Mono Lake and are quite different from Segments 1-4 upstream. This area, called the Rush Creek bottomlands, supported a broad riparian forest throughout most of its length. The historic prediversion stream channel was quite sinuous and, in some places, the primary stream course consisted of parallel channels or meander bends with bypass channels. The quality of streambed gravels has been described as excellent for both trout spawning and aquatic insect production (Vestal 1990, Court Testimony, Volumes I and II). Exposed willow roots, a few fallen trees, and shoreline debris jams probably were the principal components of instream cover for fish. Habitat composition probably was dominated by riffles and runs; however, deep pools may have occurred at meander bends and with debris jams. (Trihey & Associates 1991.)

Segments 5 (1.8 miles) and 6 (1.6 miles) lie between the narrows and 0.4 mile above the county road and are similar (Beak Consultants 1991). The stream gradients are 1.39% and 0.49%, respectively; both segments were characterized by small substrate materials (Beak Consultants 1991). In these segments, Rush Creek flowed through a lush wet meadow bisected by numerous spring-fed channels augmented by irrigation return flow (e.g., Bohler Creek). The combined flow of these ancillary channels is estimated to have ranged from 18 to 52 cfs. The spring-fed flow resulted from the seasonal irrigation of approximately 1,500 acres on Cain Ranch and 600 acres in Pumice Valley with an annual average of 30,000 acre-feet (af) of water. These springs and the associated high water table in the meadows supported dense stands of cottonwood and willows covering more than 150 acres. The spring-fed channels must have provided ideal habitat conditions for trout. Water temperatures in these channels probably were very stable throughout the year, providing cool water temperatures during summer and ice-free habitat during winter. (Trihey & Associates 1991.)

Based on the gradient of the surrounding meadow and the sinuosity of these spring-fed channels, hydraulic conditions in Segments 5 and 6 would have favored relatively deep, slow-moving water associated with well-vegetated undercut streambanks. Vestal (1990, Court Testimony, Volumes I and II) has indicated that lush beds of watercress filled with aquatic insects grew in these channels. The abundant food and year-round growing conditions provided by these spring-fed channels supported a high-quality fishery in these reaches in the historic prediversion period. (Trihey & Associates 1991.)

The lowermost reach, Segment 7 (1.3 miles), extends from 0.4 mile upstream of county road to Mono Lake (Trihey & Associates 1991). Terrain and channel configurations were similar to those found in Segments 5 and 6, although little spring flow probably occurred in Segment 7. Dikes constructed along this reach, however, created freshwater ponds and marshy areas. Large trout were observed feeding in this area (Vestal 1990, Court Testimony, Volumes I and II), and the marsh may have been a highly productive wetland and a nursery area for young trout. Fine and coarse sands and fine gravels settled out at the mouth of Rush Creek to create a delta (Vestal 1954).

Parker and Walker Creeks. In the historic prediversion period, Parker and Walker Creeks were lined with meadows, and watercress existed at certain locations (McAfee 1990). Riparian vegetation on the lower reaches of both Parker and Walker Creeks (immediately upstream of the confluence with Rush Creek) consisted of dense willows, cottonwood, sagebrush, bitterbrush, and watercress adjacent to the springs (Vestal 1990, Court Testimony, Volumes I and II). Lower Parker and Walker Creeks contained suitable spawning gravels and may have been important spawning and rearing habitat for Rush Creek brown trout (Vestal pers. comm.).

No other published or unpublished information is available on historic prediversion habitat conditions of Parker and Walker Creeks. The smaller channel and flows in Parker and Walker Creeks, however, probably provided less habitat and supported smaller fish populations than did Lee Vining and Rush Creeks. Nonetheless, small streams like Parker and Walker Creeks can maintain significant fishery resources, especially if the creeks have reaches with perennial flows, stable channels, cover, and suitable spawning gravels, as these two creeks did. Such tributary streams also can be important in maintaining fish populations in downstream areas by providing important spawning, nursery, or juvenile-rearing habitat.

Fish Populations

Lee Vining Creek. At most eastern Sierra Nevada lakes and streams, including Lee Vining Creek, several trout species were introduced and became established in the late 1800s and early 1900s. The first trout were introduced into Lee Vining and Rush Creeks shortly after 1850, when freighters transporting goods along the eastern Sierra Nevada carried Lahontan cutthroat trout in water barrels over the Conway Summit from the East Walker River. These trout quickly colonized the streams, and an abundant cutthroat trout fishery developed by 1900. (Beak Consultants 1991.)

Plantings of hatchery-reared brown trout fingerlings and catchable rainbow trout occurred in the early 1900s in Lee Vining Creek until 1941 (Vestal 1990, Court Testimony, Volumes I and II). By 1940, brown trout was the most abundant trout species inhabiting Lee Vining Creek. Small populations of rainbow trout were present with rare occurrences of eastern brook and Lahontan cutthroat trout (McAfee 1990). Witness accounts indicated that 8- to 10-inch trout were abundant, with some trout reaching 13-15 inches (Trihey & Associates 1991). Information on the occurrence of nongame fish species in Lee Vining Creek before 1941 is not available.

Rush Creek. Trout were first introduced into Rush Creek simultaneous with introductions to Lee Vining Creek. Brown, rainbow, and eastern brook trout were stocked in Rush Creek from Fern Creek and Mount Whitney State Fish Hatcheries in the early 1900s (Beak Consultants 1991). Brown trout fingerlings were first introduced into Rush Creek approximately 15 miles upstream of Mono Lake in 1919, and plantings were continued until 1942 (Vestal 1954). Golden trout were planted in upper Rush Creek above Grant Lake in the 1920s and 1930s. In 1931 and 1932, eastern brook trout and Lahonton cutthroat trout were planted in Rush Creek and reportedly had little effect on the brown trout population, which had become well established. Threespine stickleback were incidentally introduced into the system when steelhead trout from the Ventura River were transported to Rush Creek (Vestal 1954).

By 1940, brown trout dominated the fishery, which also included a few rainbow and eastern brook trout. Only one quantitative estimate of trout populations before 1940 was made; trout population abundance in Rush Creek before 1935 was estimated to equal the abundance measured during the water spill from Grant Lake in 1970, when 50,000 adults were observed between the dam and Mono Lake. This estimate was based on personal observations of fall runs at the egg-taking station in 1938 and from hatchery records (Vestal pers. comm.). Fishing for brown trout reportedly was excellent in Rush Creek in the 1930s (Vestal 1954). On one occasion, trout even were observed to be present in Mono Lake, immediately within the freshwater inflow area below the mouth of Rush Creek (Vestal 1990, Court Testimony, Volumes I and II). Brown trout weighing 3/4 pound to 2 pounds were common and occasionally a 5- or 6-pound fish was caught (McPherson 1990 in Trihey & Associates 1991). During the Great Depression, trout from Rush Creek regularly supplemented the diets of local residents.

Parker and Walker Creeks. Existing information on the early fisheries of Parker and Walker Creeks is limited, but both of these creeks probably were planted with species similar to those planted throughout Mono Basin in the late 1800s and early 1900s, as reported by Vestal (1954). Eastern brook trout reportedly existed in Parker Creek in the 1920s, and anglers could catch a limit of 8- to 10-inch trout in 2-3 hours (McAfee 1990). Small stream size, reduced gradient, and prevalence of meadow habitat may have contributed to a larger proportion of brook trout comprising the overall fishery than in Lee Vining or Rush Creeks, but definitive information is nonexistent. Information on the occurrence of nongame fish species in Parker and Walker Creeks before 1941 was not found.

Management

Lee Vining Creek. Little information exists on historic prediversion management of Lee Vining Creek fishery resources. DFG hatchery records indicate that hatchery-reared trout were planted regularly in streams throughout the region. Reports (Vestal 1990, Court Testimony, Volumes I and II) indicate that hatchery-reared brown trout fingerlings and catchable rainbow trout were planted in Lee Vining Creek until 1941.

Rush Creek. Fish populations in Rush Creek were maintained through natural reproduction and hatchery plantings. No definitive account exists of how many fish were planted in Rush Creek and who planted them. The Rainbow Club of Bishop, an outdoor sportsmen's organization, helped stock Rush Creek beginning in the early 1920s.

An egg-collecting station was constructed in lower Rush Creek in 1925 and operated through 1953. Eggs were collected from each adult brown trout during the fall spawning migration. The destination of the fertilized eggs is uncertain; however, most eggs probably were shipped to the Mt. Whitney Hatchery (Vestal pers. comm.).

The Fern Creek Hatchery, located midway between Silver and Grant Lakes along the June Lake Loop, produced approximately 1 million fish per year (1928-1942), and some of these fish were planted into Rush Creek (Leitriz 1970).

Parker and Walker Creeks. Information on fishery management for Parker and Walker Creeks before 1940 is not available. Management practices probably consisted of planting hatchery-reared trout, which was the common practice throughout the region.

Grant Lake

Habitat. Information on preconstruction lake habitat was not found. In the late 1930s, however, LADWP increased Grant Lake's size and capacity by constructing the Grant Lake Dam and Mono Craters Tunnel. The surface area of Grant Lake was increased from 150 to 1,094 acres, and the capacity was increased to 47,525 af (Sada 1977). In addition, a second inlet stream to the lake was created with the construction of the Lee Vining conduit, which delivers water diverted from Lee Vining, Parker, and Walker Creeks.

Fish Populations. Grant Lake contained no post-Pleistocene native fishes (Hubbs and Miller 1948) until trout were introduced around 1880 (Vestal 1954). Little information has been published on the early fishery of Grant Lake, but Grant Lake probably contained species similar to those planted throughout Mono Basin in the late 1800s and early 1900s as reported by Vestal (1954). Smith and Needham (1935) determined that Lahontan cutthroat and brown trout were present in the lake. Information on the occurrence of nongame fish species in Grant Lake before 1940 was not found.

Management. Information is limited regarding Grant Lake fishery management before 1941. Management practices probably consisted of planting hatchery-reared trout to maintain trout populations and offset increasing fishing pressure.

Owens River Basin

Habitat. Habitat conditions in the Owens River before 1940 are not well documented. Conditions in 1940 probably were similar to prehistoric habitat conditions, although water diversions in the early 1900s significantly altered natural flows in the Lower Owens River below the Los Angeles Aqueduct intake enough to alter water surface elevations of Owens Lake. Tributaries in the Owens River basin usually were productive; Smith and Needham (1935) described Hot Creek as one of the richest trout streams they had ever encountered.

Upper Owens River. Limited information on Upper Owens River habitat conditions before 1941 indicates that the channel and streamflows near the present location of East Portal provided excellent trout habitat (Chapter 3J, "Recreation Resources"). Early settlers of the Owens River basin diverted water for irrigation, and streamflows probably were reduced seasonally in certain areas. Grazing also was known to occur in the area before 1941.

Lake Crowley Reservoir. Lake Crowley reservoir did not exist in 1940; Long Valley dam was completed in 1941. No information on preimpoundment fish habitat was available.

Owens River Gorge. Beginning in 1952, the Owens River gorge below Lake Crowley reservoir was substantially dewatered because of diversion of water by LADWP for hydroelectric power generation. The issue of flows in the Owens River gorge is the subject of a lawsuit filed in 1991 by Mono County against LADWP and the SWRCB. The parties are attempting to resolve the issues raised in the suit through settlement negotiations.

Middle Owens River. Flows in the Middle Owens River were nearly unimpaired before 1941. Habitat conditions in 1940 probably approached prehistoric habitat conditions except for grazing-related impacts and water diversions.

Lower Owens River. Habitat conditions in the Lower Owens River before LADWP diversions began in 1913 probably resembled prehistoric conditions except for changes associated with grazing and local agricultural diversions. After the diversion of the Lower Owens River at the Los Angeles Aqueduct intake structure in 1913, Lower Owens River flows below the intake were eliminated except during exceptionally wet years. Habitat conditions in the Lower Owens River were altered significantly below the Los Angeles Aqueduct intake as a result of LADWP diversions.

Pleasant Valley, Tinemaha, and Haiwee Reservoirs. Haiwee and Tinemaha Reservoirs were filled in 1913 and 1929, respectively, and provided warmwater lentic (lake) habitat. Owens River habitat conditions at the Tinemaha Reservoir site before reservoir filling probably resembled prehistoric conditions except for grazing-related changes. River flow was unimpaired along the entire reach of the Owens River above the aqueduct intake until the construction of Tinemaha Reservoir. Approximately 2 miles of Owens River habitat became inundated after dam closure.

Haiwee Reservoir, constructed in 1913 south of Lake Owens, is an offsite storage facility but does store water diverted from the Owens River. Water is diverted into the Los Angeles Aqueduct from the Owens River at the aqueduct intake structure and is conveyed to Haiwee Reservoir.

Pleasant Valley Reservoir did not exist in 1940; dam construction was completed in 1955.

Los Angeles Aqueduct and Irrigation Canals. The Los Angeles Aqueduct, constructed between 1908 and 1913, is an artificial channel designed and operated to convey water diverted from the Owens River. The aqueduct not only provided warmwater fish habitat in the channel but also was responsible for habitat losses in the Lower Owens River as described above. Irrigation canals provided intermittent fish habitat.

Fish Populations. Native Owens sucker, Owens tui chub, Owens pupfish, and Owens speckled dace comprised the Owens River fish community before exotic game and nongame species were introduced, flows regulated, and habitat extensively altered. By the 1930s, however, introductions of exotic species in Owens River basin had resulted in self-sustaining populations of brown trout, largemouth bass, catfish (brown bullhead), and carp in the Owens River (Smith and Needham 1935). These introduced species coexisted and competed with the native fish fauna.

Upper Owens River. In 1940, fish populations of the Upper Owens River probably consisted of native Owens sucker, tui chub, and speckled dace (Moyle 1976) and introduced brown, rainbow, cutthroat, and brook trout (Smith and Needham 1935). Owens suckers were collected by Smith and Needham during surveys of Convict Lake, indicating that suckers also may have been present in headwater streams. Tui chub were not collected during surveys of the Upper Owens River, but definitive information on the species' presence could not be found.

Middle Owens River. The primary game species in the Middle Owens River were brown trout (wild and planted) and planted rainbow trout. Also present in 1940 were self-sustaining but limited populations of largemouth bass and brown bullhead.

Native Owens tui chub and Owens speckled dace populations in the Middle Owens River apparently had declined by 1940 but were still present in the main river where somewhat stable populations of Owens sucker still occurred. Records of Owens pupfish do not exist from this period, but small populations persisted in isolated springs within the Owens Valley. Carp were abundant in the sluggish reaches of the valley floor.

Lower Owens River. Limited information exists concerning when the first non-native species were introduced into the Lower Owens River. Introductions probably occurred before 1941 because native populations were known to be declining by this time. As introduced species and water diversions increased, native species largely were displaced by introduced species. By 1940, fish populations in the Lower Owens River above the LA Aqueduct probably were similar to those identified for the Middle Owens River. Below the LA Aqueduct, the Lower Owens River was generally dry with extremely limited, if any, fish populations.

Pleasant Valley, Tinemaha, and Haiwee Reservoirs. Game and nongame species similar to those present in the Middle and Lower Owens River likely occurred in Tinemaha and Haiwee Reservoirs, as well. The warm and slower-moving waters of these reservoirs favored introduced warmwater species, such as largemouth bass, bluegill, carp, and mosquitofish, although some native species, Owens sucker and tui chub, probably were present.

Los Angeles Aqueduct and Irrigation Canals. Fish species inhabiting the Los Angeles Aqueduct and irrigation canals consisted of species found in the Lower Owens River above the aqueduct intake. Fish populations were maintained chiefly through natural reproduction and recruitment from upstream sources. Introduced species would have dominated species composition in these modified habitats.

Management. The principal management activity in Owens River basin before 1940 was the initial stocking of accessible lakes and streams with rainbow, golden, cutthroat, brook, and brown trout. Subsequent stocking was initiated annually to maintain trout populations in response to increasing pressure from anglers. Smith and Needham (1935) surveyed streams of Inyo and Mono National Forests and found that heavy fishing pressure was occurring throughout the region. Planting of the Upper Owens River also was conducted by resort owners eager to attract anglers to the area (Smith and Needham 1935). Fishery management in the Middle Owens River; Lower Owens River; and Pleasant Valley, Tinemaha, and Haiwee Reservoirs consisted of planting trout in response to the increasing fishing pressure.

ENVIRONMENTAL SETTING

This section describes the conditions of fishery resources at the point of reference in August 1989. Important changes in these resources between 1941 and 1989 also are described.

Sources of Information

The following is based on information derived from recent publications, agency data, and discussions with agency personnel. Available DFG fishery and instream needs investigations and Restoration Technical Committee reports provide the primary basis for this section.

Mono Basin

Overview

Habitats. Water diversions and impoundments constructed to meet downstream water demands have significantly altered the natural flows in every major stream in Mono Basin. Mono Basin streams, such as Lee Vining, Rush, Parker, and Walker Creeks, have experienced significantly reduced flows below LADWP diversions since 1941. These modified flows have reduced or eliminated available fish habitat in specific reaches of these streams. Since 1985-1986, however, court-ordered flows in Lee Vining and Rush Creeks have increased available fish habitat. Flows were restored in Parker and Walker Creeks in 1990.

Fish Populations. Moyle (1976) indicates that five game and four nongame species (all introduced) occur in Mono Basin (Table 3D-1). Recent trout population estimates conducted on Mono Basin tributaries such as Lee Vining and Rush Creeks indicate that brown trout is the dominant species, followed by rainbow trout (EA Engineering, Science, and Technology 1990b; Beak Consultants 1991). The threespine stickleback is the only nongame fish species reported to occur in Lee Vining, Rush, Parker, and Walker Creeks, although Owens sucker and a tui chub hybrid reportedly occur in Rush Creek above Grant Lake (Sada 1977). Mono Basin does not support any special-status species, except the introduced Owens sucker upstream of Grant Lake.

Management. Most of the streams and lakes in Mono Basin are heavily fished throughout the typical fishing season (May-October). In response to this fishing pressure, DFG has stocked most of the streams and lakes with rainbow, brown, eastern brook, and Lahontan cutthroat trout. Most of the trout planted are catchable size, but fingerling-, subcatchable-, and trophy-sized fish also are stocked. Trout populations are maintained by natural reproduction, intensive stocking, or both.

Lee Vining, Parker, and Walker Creeks below the conduit have been planted with fingerling brown trout since instream flows were restored; Rush Creek below Grant Lake has not been planted since flows were restored. DFG has not decided whether these streams will be managed for wild trout, hatchery trout, or a combination of wild and hatchery trout.

Fishing regulations target the intensive trout fishery; the open season is generally the last Saturday in April through October 31. A daily bag limit of five trout per day and a possession limit of ten trout are permitted. These regulations apply to all Mono Basin streams, lakes, and reservoirs. Exceptions include Rush Creek below Grant Lake and Parker and Walker Creeks below the Lee Vining conduit, where the maximum size limit is 10 inches and only artificial lures with barbless hooks may be used.

Habitat Restoration. The 1990 court order amending interim flows in Rush Creek and Lee Vining Creek included a provision requiring LADWP to consult with the affected parties and attempt to reach an agreement regarding "channel modification and any related actions that should be accomplished in Rush Creek and Lee Vining Creek to help reestablish the conditions which benefitted the fisheries which existed in them before DWP's diversions began in 1941".

A conceptual plan for restoring aquatic and riparian habitats in Rush and Lee Vining Creeks was drafted and revised on May 30, 1991 (Trihey & Associates 1991). The goal of the restoration program is to establish aquatic and riparian conditions and resource values equivalent to those which existed before 1941. A multidisciplinary planning team was assembled, and various technical and pre-restoration field studies were performed as part of the planning process. In addition, a multiple-year habitat and fish population monitoring program was developed to evaluate the success of the restoration program and guide future restoration efforts (Trihey & Associates 1991).

Lee Vining Creek

Instream Flows. The majority of upper Lee Vining Creek flows are regulated by the discharge from SCE's Poole powerhouse. SCE stores water in Saddlebag, Tioga, and Ellery Reservoirs (headwaters of Lee Vining Creek) during the spring runoff period, reducing downstream flows by as much as 25% (Aquatic Systems Research 1992). Substantial inflow from several small tributary streams contributes to upper Lee Vining Creek flows and often continues through the late spring runoff period into August. In upper Lee Vining Creek, peak flows (June) range from 40 to 350 cfs, while low flows (October-April) range from 20 to 30 cfs with an occasional minimum flow of 10 cfs (Jones & Stokes Associates 1993).

Increased diversions from lower Lee Vining Creek began in 1941 when LADWP constructed a diversion structure to export water south. Until 1947, only minor flow reductions occurred in lower Lee Vining Creek. After the 1947-1951 dry period, however, all runoff was diverted. After 1951, flows in lower Lee Vining Creek occurred only during periods of high runoff.

Court-mandated interim flows have been imposed to maintain the fishery resources that were reestablished in the mid-1980s. The minimum release flow at the point of reference into lower Lee Vining Creek below LADWP's diversion structure is a court-mandated 5 cfs. Higher flows occur only in spring in above-average water years and in all months during only the wettest years. Higher minimum-flow requirements were established in April 1991 to comply with a preliminary injunction requiring LADWP to maintain a minimum Mono Lake surface elevation of 6,377 feet.

General Habitat. The geomorphic, hydrologic, vegetative, and aquatic habitat conditions in lower Lee Vining Creek have changed dramatically since LADWP began diverting water in 1940. The greatest changes have occurred in the lowermost 1.5 miles of the creek from 1,500 feet below U.S. 395 to Mono Lake; little geomorphic and vegetative change has occurred upstream from U.S. 395 to the LADWP diversion dam (Stine 1992a).

Major water diversions by LADWP after 1947 resulted in dewatering of lower Lee Vining Creek except during periods of high runoff. The extensive riparian zone became dessicated and was destroyed by fire in the early 1950s. With the loss of riparian vegetation along lower Lee Vining Creek, floodflows in the late 1960s and early to mid-1980s caused significant streambank erosion and major changes in channel morphology and location. All channels occupied by the stream today are wider, straighter, and less physically complex than the former stream system. The length of subsidiary channels has been reduced 70%. In addition, the length of the former channel has increased 0.55 mile through the former Mono Lake delta because of receding lake levels since 1941 (Trihey & Associates 1992a).

Aquatic Systems Research (1992) identified six distinct study segments in Lee Vining Creek between the Poole Powerhouse and Mono Lake and further delineated these segments into individual habitat units as a basis for an IFIM study (Figure 3D-1). Segment boundaries below LADWP's diversion dam are generally consistent with those established for habitat restoration planning (Trihey & Associates 1991) and fish population sampling (EA Engineering, Science, and Technology 1989) but include further subdivisions of the segments identified below State Route (SR) 120. The following descriptions are adapted from Aquatic Systems Research (1992) and EA Engineering, Science, and Technology (1989).

Segment 1 (5 miles) extends from the Poole Powerhouse to LADWP's diversion dam. This low-gradient segment meanders through a meadow area and consists of pools, runs, and short riffles.

Segment 2 (0.8 mile) extends from LADWP's diversion dam to the head of a bedrock gorge immediately above SR 120. Like Segment 1, Segment 2 is a low-gradient, meandering segment consisting of pools, runs, and short riffles. It has a dense riparian community consisting mostly of pines, willows, and grasses. Habitat complexity is generally low. Suitable spawning substrate is present, but trout cover is limited. Springs and return flow from the O-Ditch occur along this segment.

Segment 3 (1.0 mile) extends from the head of a bedrock gorge to U.S. 395. This steep gradient segment is confined by a narrow canyon and consists mostly of cascades. The riparian community consists of pine, cottonwood, and wild rose. Habitat complexity is fairly high; a mixture of boulders, rubble, and cobbles provides cover for juvenile and adult trout, but provides little fry or spawning habitat.

Segment 4 (0.3 mile) extends from U.S. 395 to the end of the existing riparian tree cover. The upper boundary of Segment 4 marks the beginning of an alluvial fan that extends to Mono Lake. Downstream of U.S. 395, the creek splits into a large main channel and one to three smaller side channels. Cascades and riffles are the dominant macrohabitat types. Segment 4 has characteristics similar to those in downstream segments.

Segment 5 (1.5 miles) extends from the end of the riparian tree cover to the county road. This segment is largely devoid of riparian vegetation and consists of a broad, unstable and braided channel consisting largely of riffles. Because of the scarcity of pool habitat and instream cover, adult trout habitat and refuge habitat from high flows for all trout lifestages is limited. Segment 5 is the primary focus of habitat restoration planning.

Segment 6 (0.4 mile) extends from the county road to Mono Lake. Riffles and runs make up most of the habitat. This segment is influenced by fluctuations in Mono Lake levels.

Spawning Habitat. An instream flow study of upper Lee Vining Creek between the Poole Powerhouse and the LADWP diversion suggests that brown trout spawning habitat is limited to the lowermost segments and available only at flows exceeding 18 cubic feet per second (cfs) (Wesco 1981). Because brown trout had been reproducing successfully for many years in Lee Vining Creek, however, it was assumed that spawning habitat occurs in scattered localities throughout the stream at flows of 20-30 cfs.

Little suitable spawning gravels remain in Lee Vining Creek below the LADWP diversion dam (Aquatic Systems Research 1992, Trihey & Associates 1992). The results of population monitoring indicate that the Meadow segment (Segment 2) contains most of the spawning gravels in lower Lee Vining Creek and produced at least 75% of the young-of-the-year brown trout during 1987 and 1988 when streamflow releases were 4 cfs (EA Engineering, Science, and Technology 1989).

Fish Populations. Lee Vining Creek supports wild (self-sustaining) populations of brown trout and brook trout and stocked rainbow trout. Brown trout are the dominant fish species in both the upper and lower segments of Lee Vining Creek. Brook trout is the primary subdominant species in upper Lee Vining Creek, and rainbow trout is the primary subdominant species in lower Lee Vining Creek (Wesco 1981; EA Engineering, Science, and Technology 1989.)

Estimates of the brown trout population in upper Lee Vining Creek in the late 1970s and early 1980s ranged from 130 to 528 trout per mile (Wesco 1981). Similar populations probably exist today because flow releases and habitat conditions in upper Lee Vining Creek have been stable.

Most of the flow in lower Lee Vining Creek has been diverted by LADWP since 1947. For this reason, trout populations were extirpated in this segment from the 1950s through 1970s (Aquatic Systems Research 1992). Heavy snowfall and subsequent runoff in the early 1980s, however, resulted in uncontrolled flows past LADWP's diversion facility and helped reestablish fishery resources in lower Lee Vining Creek. Brown trout biomass in lower Lee Vining Creek has now increased and was estimated at 306, 355, and 224 pounds for 1988-1990, respectively (EA Engineering, Science, and Technology 1990b).

Nongame or special-status fish species are not known to exist in Lee Vining Creek (Wesco 1981).

Management. In the past, DFG stocked substantial numbers of catchable-sized rainbow trout in Lee Vining Creek throughout most of the fishing season (Wesco 1981). DFG currently stocks Lee

Vining Creek above the conduit with rainbow trout weekly during summer. The number of fish stocked is in excess of 50,000 catchables (Parnell pers. comm.).

Fisheries management objectives have not been established for Lee Vining Creek. Lee Vining Creek has the potential to be included under the DFG's Wild Trout Project if adequate habitat is maintained (Bontadelli pers. comm.).

Restoration. The focus of habitat restoration work in Lee Vining Creek is in Segments 5 and 6 where substantial habitat degradation has occurred. Completed habitat restoration treatments in Lee Vining Creek and the treated reach length (existing channel only) as of December 1992 (English pers. comm.) include:

- constructing five spawning beds, adding cover, and removing sediment in Segment 2 (800 feet);
- providing fish passage at the abandoned dam in Segment 2 (150 feet);
- constructing a fishway in the SR 120 culvert in Segment 3 (120 feet);
- constructing a series of jump pools in the channel at SCE's substation (225 feet);
- removing debris jam and defining and rewatering historical channels in Segment 5 (0 feet); and
- excavating or constructing pools and backwater complexes and adding object cover (i.e., woody debris and cobbles) and spawning gravels in Segments 5 and 6 (2,012 feet).

Rush Creek

Instream Flows. During the 1948-1951 dry period, offstream diversions significantly affected streamflow in lower Rush Creek. During this period, water releases from Grant Lake were eliminated and in-basin irrigation was reduced, which reduced summer base flows in the bottomlands from 24 cfs to 2 cfs in 1949 (Vestal 1954). Streamflow returned only in subsequent wet years.

Coupled with the decline in Mono Lake surface elevations from LADWP's diversions, flooding in 1967 caused major geomorphological changes in the Rush Creek bottomlands. Lower Rush Creek became steeper, straighter, and deeper (Stine 1992b).

In 1971, increases in Rush Creek and tributary diversions and termination of in-basin irrigation virtually dewatered lower Rush Creek in subsequent years, except during times of exceptionally high runoff. Riparian vegetation was degraded and fish populations were eliminated in lower Rush Creek.

Uncontrolled spills past Grant Lake dam and LADWP's diversion structure caused streamflow to return to lower Rush Creek during the wet years of the early 1980s. As a result, riparian vegetation and trout populations, in particular brown trout, became reestablished in lower Rush Creek.

Since 1982, average monthly streamflows immediately below Grant Lake have ranged from a low of 17 cfs to a high of 349 cfs. Streamflow losses occur, however, as water flows from Grant Lake reservoir toward Mono Lake, especially during dry summer months. Streamflow losses between Mono Gate #1 and Mono Lake ranged from 11 cfs to 13 cfs in summer and 4 cfs to 7 cfs in fall and winter (EA Engineering, Science, and Technology 1990c; Beak Consultants 1991).

Since 1985, and including the point of reference (1989), a court-imposed minimum flow of 19 cfs has been maintained, resulting in the reestablishment of riparian vegetation and brown trout populations. A December 1989 preliminary injunction required flows between 85 and 100 cfs to maintain a minimum Mono Lake surface elevation of 6,377 feet. In June 1990, the minimum flow requirements were amended to be 40 cfs in April-September and 28 cfs in October-March with a flushing flow requirement of 165 cfs for 3 days in below-normal runoff years and 30 days in normal to above-normal runoff years. An April 1991 preliminary injunction, which superseded the June 1990 order, requires LADWP to allow sufficient water to pass its diversion facilities to maintain Mono Lake at or above 6,377 feet.

General Habitat. Existing habitat was described and mapped from Grant Lake reservoir dam to Mono Lake in 1984 (EA Engineering, Science, and Technology 1990c) and from Grant Lake reservoir dam to the county road in 1987 (Beak Consultants 1991). While both studies basically identified the same habitat types (cascade, pool, riffle, run, and rock garden), some differences between segment boundaries occurred. As described under "Prediversion Conditions", segment delineations are primarily used in this report. Segment delineations were based on analysis of topographic maps, gradient profiles, tributary influences, riparian vegetation, surrounding topography, and direct observations.

Segment 1 (1.4 miles) consisted entirely of the low-gradient (0.25%), uniformly configured conveyance channel connecting Mono Gate #1 with the natural channel of lower Rush Creek. Detailed habitat mapping was not conducted because conveyance channel is artificial. This segment was not included in Beak Consultants' IFIM study.

In Segment 2 (0.9 mile), rock garden is the most abundant habitat type (over 50%), followed by pool (17.3%) and run (13.7%) habitats. Habitat is scarce for spawning or newly emerged trout. Segment 3 (3.2 miles) is dominated by riffle (45.3%) habitat, followed by rock garden (28.1%), run (17.1%), and pool (8.4%) habitat types. Segment 4 (0.05 mile) aquatic habitat mainly consists of repeating cascade (26.5%) and plunge pool types over the majority of the segment length. The aquatic habitat in Segment 5 (1.8 miles) is dominated by run (36.4%), riffle (greater than 20%), and pool (greater than 20%) habitat types. The small substrates provide good spawning and juvenile-rearing habitat, and the scattered pools with woody debris are used by adult trout for cover. Segment 6 (1.6 miles) aquatic habitat also is characterized by a repeating sequence of pool, riffle, and run habitats. Run habitat (49.8%) dominates the segment, followed by pool (greater than 20%) and riffle (greater than 20%) habitat types. Good spawning and juvenile-rearing habitat is present, and pools with woody debris provide cover for adult trout as in Segment 5. (EA Engineering, Science, and Technology 1990c.)

EA Engineering, Science, and Technology (1990c) conducted the only habitat mapping between the county road and Mono Lake. This 0.9-mile segment (Segment 7), has relatively low gradients and sandy substrates. Trout habitat is poor because of the high concentration of sand and numerous braided channels. Following the upstream diversions and the decline in Mono Lake water surface elevations, Rush Creek began to erode the delta region that existed prior to diversions. As a result, Rush Creek has incised 20-30 feet in the Delta segment and is now eroding laterally, creating a new floodplain (Stine 1992b).

Spawning Habitat. Spawning habitat, identified by the presence of redds (nests), was evaluated as a component of population studies conducted in 1985-1989. Fifty-five redds were found between Grant Lake dam and Mono Lake. The greatest density of observed redds (9.4 per mile) occurred in the uppermost 0.85 mile of Rush Creek below Grant Lake dam. No redds were located in the lower 2.2 miles above Mono Lake. (EA Engineering, Science, and Technology 1990c.)

Lower Parker and Walker Creeks also may be important spawning and rearing habitat for Rush Creek brown trout (Vestal 1990, Court Testimony, Volumes I and II).

Fish Populations. Brown trout is the most abundant species in Rush Creek, followed by rainbow trout. Lahontan cutthroat trout have not been observed in Rush Creek for many years (Beak Consultants 1991) and probably have been extirpated.

Creel returns from the Rush Creek Test Stream Study (see "Management" below) conducted from 1947 to 1951 indicated that 10% (6,573) of the angler catch was comprised of wild trout. Of this 10%, 87% (5,716) were brown trout, 12% (791) were rainbow trout, and 1% (66) was eastern brook trout (Vestal 1954). The catch of wild brown trout remained consistent each year of the study, and catches of wild rainbow and brook trout declined. A significant finding of the 5-year study was that wild brown trout were able to sustain a population despite heavy fishing pressure and continued competition for food and space with the large numbers of planted trout. DFG continued to plant trout in Rush Creek until 1967 (Pister pers. comm. in EA Engineering, Science, and Technology 1990c).

Trout populations in Rush Creek between Grant Lake dam and Mono Lake were eliminated when increased diversions by LADWP in 1971 eliminated downstream flows. Trout recolonized Rush Creek in the early 1980s after Grant Lake spilled, and subsequent flow releases maintained Rush Creek flows. Recent fish population surveys (1985-1989) have shown that the Rush Creek fish community now consists almost entirely of brown trout with only small populations of rainbow and brook trout. The average population abundance for brown trout from Grant Lake dam to Mono Lake was estimated to range from a low of 205 pounds per mile in 1989 to a high of 362 pounds per mile in 1988. (EA Engineering, Science, and Technology 1990c.)

Threespine stickleback was the only nongame fish species collected during electroshocking from 1985 to 1989 (EA Engineering, Science, and Technology 1990c).

Management. Annual plantings of catchable-sized rainbow trout replaced brown trout plantings in 1942 and were continued until 1947. DFG established a test section in lower Rush Creek and collected creel census and fish population data over a 9-year study period (1947-1956) to evaluate the effectiveness of fish-planting procedures (Vestal 1954). From 1947 through 1952, DFG annually planted marked, catchable-sized rainbow trout and obtained annual creel census data. From 1953 through 1956, DFG annually planted marked, catchable-sized brown trout and obtained creel census data (Kabel and Butler 1956). DFG continued to plant trout until 1967 (Pister pers. comm. in EA Engineering, Science, and Technology 1990c).

Currently, Rush Creek is not planted with hatchery-reared trout. The trout population is maintained primarily by natural reproduction in Rush Creek and its tributaries and, to a lesser extent, by immigration during uncontrolled spills at Grant Lake dam during exceptionally wet years.

Restoration. Completed habitat restoration treatments in Rush Creek and the treated reach length as of December 1992 (Dalton pers. comm.) include:

- excavating portions of the Mono Gate #1 return channel, placing 1,000 cubic yards of spawning gravels, and adding rock weirs and object cover;
- placing 200 cubic yards of spawning gravels in Segments 2 and 3;
- restoring and enlarging five existing side channels and associated backwater habitat in Segment 3 (819 feet);
- enlarging and deepening existing instream pools and adding object cover in Segment 3 (291 feet);
- stabilizing and protecting eroded banks with native sod and willows in Segment 5 (300 feet); and
- constructing a fishway at the U.S. 395 crossing.

Parker and Walker Creeks

Habitat. Parker and Walker Creeks were dry at the point of reference in 1989 and provided no fish habitat. Court-ordered flows commenced on October 9, 1990, and are currently 6 cfs from October

1 through March 31 and 9 cfs from April 1 through September 30 in Parker Creek, and 4.5 cfs from October 1 through March 31 and 6 cfs from April 1 through September 30 in Walker Creek. The court-ordered flow will nearly always exceed natural flows from September through May for Parker Creek and August through May for Walker Creek. LADWP diversions would generally occur only during snowmelt runoff in June and July of all water year types.

Court-ordered channel maintenance flows are also required: Flushing flows of 23 cfs in Parker Creek and 15 cfs in Walker Creek are required for 3 days in below-average runoff years and 30 days in above-average runoff years.

Fish Populations. DFG sampling surveys of Parker and Walker Creeks in 1986 revealed that brown and brook trout were present in both creeks during high flows (California Department of Fish and Game 1987). Rainbow trout were not collected at any of the sampling locations. Brown trout have spawned in the lower segments of Walker Creek (Morhardt 1990). At the point of reference, however, Parker and Walker Creeks were dry and devoid of fish.

No nongame fish species were collected during DFG sampling surveys of Walker and Parker Creeks in 1986 (California Department of Fish and Game 1987).

Management. Information is not available on fishery management for Parker and Walker Creeks until after 1989. For the first time in many years, permanent flows were reestablished in Parker and Walker Creeks in fall 1990. In November 1990, DFG marked and planted 1,667 catchable-sized brown trout and five rainbow trout from Fish Springs Hatchery into Parker and Walker Creeks from the Lee Vining Conduit downstream for approximately 1 mile. The objective was to augment natural recolonization and enhance recovery of these recently rewatered streams (Parmenter pers. comm.).

Restoration

Completed channel and habitat restoration treatments in Parker and Walker Creeks as of December 1992 (English pers. comm.) include:

- defining and reconstructing the natural channel and blocking old diversion channels,
- removing accumulated woody debris and brush from the channel,
- removing sod from the natural channel to expose the natural streambed,
- constructing sediment traps by connecting offstream ponds and enlarging instream pools,
- removing 20,000 cubic yards of gravel deposited in Parker Creek,

excavating 20 existing instream pools in Walker Creek, and

replacing the culvert on Walker Creek at the old county road.

Grant Lake

Habitat. Grant Lake inflows are provided by Rush and Lee Vining Creeks with smaller contributions from Parker and Walker Creeks. Despite diversions and controls on these inflows, Rush Creek and the Lee Vining conduit have flow regimes similar to natural conditions and are characterized by high flows in late spring and low flows in winter. Lake surface elevations are affected by LADWP demands, and low elevations occur in fall and winter and higher elevations during late spring runoff. As a result, Grant Lake reservoir exhibits vertical fluctuations of up to 30 feet in water surface elevations.

Most lake-dwelling brown trout spawn in Rush Creek above the point of slack water but within the lake inundation zone. When spring-time lake elevations are higher than the previous fall elevations, brown trout redds become inundated by the lake and mortality of eggs and recently hatched fry occurs. Some brown trout have been observed migrating up the Lee Vining conduit during spawning season, although these fish probably do not spawn successfully (Sada 1977).

Fish Populations. Little information has been published on Grant Lake fishery resources. Besides supporting a wild (self-sustaining) population of brown trout, Grant Lake may contain smaller populations of rainbow and eastern brook trout; DFG planted surplus brook trout and regularly planted many catchable-sized rainbow trout in Rush Creek above Grant Lake in the late 1970s to supplement angler catches (Pister pers. comm. in Sada 1977). DFG sampling in Rush Creek above Grant Lake from 1985 through 1986, however, revealed only brown and rainbow trout.

Several species of nongame fish have been introduced into, and reportedly occur, in the Grant Lake watershed. These species include the Owens sucker, threespined stickleback, and a hybridized form of tui chub (*Gila bicolor* ssp. *snyderi x* ssp. *pectinifer*). (Sada 1977.) Information on the occurrences of these species in Grant Lake is not available although some or all of these species may occur in the lake.

Management. Information on current fishery management for Grant Lake is not available. DFG hatchery records (California Department of Fish and Game [n.d.]) indicate that catchable-sized and broodstock rainbow, fingerling Lahontan cutthroat, and subcatchable-sized brown trout have been planted in Grant Lake. Catchable-sized rainbow trout are currently planted in Grant Lake; fingerling Lahontan cutthroat and subcatchable-sized brown trout are planted when available.

Owens River Basin

Overview

Habitat. Interbasin water conveyance in the Owens River, diversions, and impoundments (e.g., Lake Crowley reservoir, Pleasant Valley Reservoir, Tinemaha Reservoir, and Haiwee Reservoir) have been developed to meet downstream water demands and have significantly altered the natural flows in the Owens River. Diversion of the Lower Owens River (at the Los Angeles Aqueduct [LA Aqueduct]) dewaters approximately 100 miles of river habitat, including Owens Lake. Likewise, flow in the Owens River gorge below Lake Crowley reservoir was eliminated from 1940 to 1991 because of water diversions for power production. These diversions have significantly reduced or eliminated fish habitat and populations in these river segments. Flows in the Middle and Lower Owens River are regulated by Pleasant Valley Reservoir and Tinemaha Reservoir, respectively. Lake Crowley reservoir, the largest of the impoundments, inundates approximately 12 miles of Owens River habitat but provides a highly productive reservoir environment for trout.

Past and present practices of grazing and vegetation removal along many eastern Sierra Nevada streams have degraded riparian habitats and accelerated bank erosion. These degraded conditions are particularly evident on the Upper, Middle, and Lower Owens River. Combined with the effects of flow regulation, these impacts have resulted in a reduction in fish habitat quantity and quality compared to prehistoric conditions.

Fish Populations. Moyle (1976) indicates that 14 game (all introduced) and seven nongame species (three introduced and four native) exist in the Owens River basin (Table 3D-2). During 1983 surveys of 29 streams within the basin, brown trout were the numerically dominant game species, followed by brook, golden, rainbow, and cutthroat trout (Deinstadt et al. 1985). Of the nongame species, Owens sucker occupied the greatest number of sampled sections, followed by Owens tui chub, threespine stickleback, common carp, brown bullhead, largemouth bass, and bluegill. Nongame and warmwater game fish species largely are confined to the Middle and Lower Owens River, including Lake Crowley reservoir and Tinemaha Reservoir. Owens pupfish and speckled dace are no longer dominant species in major habitats of the Owens River. Nongame fish populations, except the Owens sucker, have been declining throughout their range as a result of the complex interactions between habitat alterations (e.g., water diversions, water impoundments, modified flow patterns, grazing) and competition from introduced species.

All four of the endemic fish species in the basin are recognized as special-status species: Owens sucker, Owens tui chub, Owens pupfish, and Owens speckled dace. Except for the Owens sucker, these species have experienced major declines in their historical ranges and abundances.

The Owens sucker is recognized as a state species of special concern. In general, species with this designation have declined in abundance and still occupy much of their natural range, but management is needed to prevent them from becoming threatened (Moyle et al. 1989). Owens sucker populations occur throughout the Owens Valley, including Lake Crowley reservoir, the Owens River gorge below Lake Crowley reservoir, and the Middle Owens River.

The Owens tui chub is listed as endangered by the state and USFWS. An endangered species designation means the species is in danger of extinction throughout all or a significant portion of its range. A major factor contributing to the Owens tui chub's endangered status is hybridization with the Lahontan tui chub, which probably was introduced into Lake Crowley reservoir and rapidly spread throughout the lower segments of the Owens River system. Pure populations of Owens tui chub are restricted to five isolated locations: the Hot Creek headsprings, the Owens River gorge downstream of Lake Crowley reservoir, springs and seeps along the west shore of Owens Lake, the Owens Valley Native Fish Sanctuary, and little Hot Creek. (McEwan 1990.) None of the pure populations are found in habitats that would be affected by the EIR alternatives.

Owens pupfish also is a federal- and state-listed endangered species. Owens pupfish once were present in the Owens River system from Fish Slough and its springs to Lone Pine. The species now occurs only in Warm Springs near Lone Pine and in the Owens Valley Native Fish Sanctuary (Moyle 1976). These habitats would not be affected by the EIR alternatives.

Owens speckled dace is designated a state species of special concern. Once common throughout the Owens River basin, Owens speckled dace now are known from a few springs and creeks in Long Valley and several small tributaries and irrigation ditches in the Owens Valley near Bishop, California. These habitats would not be affected by the EIR alternatives.

Management. Most of the streams and lakes in the Owens River basin are heavily fished throughout the typical fishing season (May through October). In response to fishing pressure, DFG stocks most of these streams and lakes with rainbow, brown, eastern brook, and Lahontan cutthroat trout. Most of the trout planted are catchable size, but fingerling-, subcatchable-, and catchable-sized, and trophy-sized fish also are stocked. Trout populations are maintained by natural reproduction, intensive stocking, or both.

Generally, fishing regulations in Mono Basin apply to the Owens River basin. Special regulations apply to certain other lakes and streams, including Lake Crowley reservoir and its tributaries and the Owens River between Pleasant Valley Dam and Five Bridges Road. (California Department of Fish and Game 1992c.)

DFG manages the 16-mile-long section of the Middle Owens River from Pleasant Valley Dam to Five Bridges Road as a component of the Wild Trout Program. Wild brown trout is the management species, and no trout are planted in this section of the Owens River. The fishing season is open all year, but the daily bag limit is two trout. Other streams in the region, including lower Rush Creek, also are managed for wild trout and are not planted with hatchery trout. Fish populations in streams managed as wild trout fisheries are maintained by a combination of natural reproduction and immigration from upstream or downstream areas.

In part of the agreement between the City of Los Angeles and the California Fish and Game Commission, the city granted the commission permanent use of the Hot Creek Hatchery site and contributed $25,000 toward construction of the hatchery in lieu of constructing fishways at Grant Lake and Long Valley Dams in 1940 (Leitritz 1970). Today, hatchery production is carried out at several DFG hatchery facilities in the Owens River basin, including Hot Creek, Fish Springs, and Mt. Whitney-Black Rock Hatcheries. Hot Creek Hatchery produces about 75% of all hatchery-planted fish in Inyo and Mono Counties.

Upper Owens River

Instream Flows. The Upper Owens River meanders through Long Valley for over 20 miles from Big Springs to its terminus at Lake Crowley reservoir (Figure 3D-3). The river is supplied by springs and snowmelt runoff, and by its major tributary, Hot Creek. Upper Owens River flows were augmented by water diversions from Mono Basin by LADWP beginning in 1941. Diversion flows from Mono Basin increased the annual average Upper Owens River flows by nearly 100 cfs, or approximately 120%, with substantial flow increases occurring in every month. Average annual flows for 1941-1989, as measured above and below East Portal, were 58 cfs and 168 cfs, respectively. Flows downstream of East Portal are subsequently modified by ungaged diversions for bypassing flow around portions of the main river or for irrigating adjacent pastures; however, the dominating characteristic of Upper Owens River flows remains the LADWP exports from Mono Basin. The resulting flows in the Upper Owens River have altered channel locations, current velocities, stream widths, streambanks, water temperatures, and sediment transport and sediment deposition. (EBASCO Environmental et al. 1993.)

These flow augmentations to the Upper Owens River were essentially the point-of-reference conditions in August 1989, with some reductions in the flows because of court-ordered instream flow requirements in Rush and Lee Vining Creeks that otherwise would have been exported into the Owens basin.

Instream flows in the Upper Owens River have been modified since August 1989 by additional court-ordered flows in Mono Basin. In 1990, the court ordered increased streamflows for Mono Basin tributaries downstream of LADWP's conduit. In 1991, LADWP was ordered by the court to maintain Mono Lake at 6,377 feet before diverting water from Mono Basin to the Upper Owens River. As a result of these orders and the absence of surplus waters because of the 1987-1992 drought, Upper Owens River flows have been at natural rates since 1991, although flows were augmented in October 1991 for the purpose of conducting an instream flow study. (EBASCO Environmental et al. 1993.)

Habitat. From East Portal to Lake Crowley reservoir (Figure 3D-3), the Upper Owens River is characterized by multiple channels and a sand and gravel bed. The river geomorphology can generally be defined as an interconnecting network of low-gradient, relatively deep and narrow, straight to sinuous channels with stable banks composed of fine-grained sediment and vegetation (Smith and Smith 1980 in EBASCO Environmental et al. 1993). Flood channels flank the sinuous main channel and have formed from historical overbank floods, which have increased in frequency and duration since Mono Basin exports began in 1941. Channel length and meander bends also have been reduced since 1944 by 3.6 miles of river channel, with most of this loss upstream of Hot Creek and attributed primarily to the Mono Basin exports. Despite geomorphic changes, adequate flushing flows exist in the Upper Owens River regardless of hydrologic condition or Mono Basin exports. (EBASCO Environmental et al. 1993.)

Woody riparian vegetation occurs sporadically along the Upper Owens River and is dominated by willows and a variety of herbaceous species. The upper portions of the Upper Owens River contain most of the riparian vegetation, and the lowermost sections contain little or no woody riparian vegetation. Historical accounts indicate that riparian vegetation was also lacking in 1925. Aquatic macrophytes also provide important cover and macroinvertebrate habitat in the Upper Owens River (EBASCO Environmental et al. 1993).

Water exports from Mono Basin into the Upper Owens River have eroded and widened the channel below the East Portal discharge. Fluctuations in Lake Crowley reservoir storage have periodically exposed or inundated the lowest portion of the Upper Owens River channel. Irrigation diversions have reduced flows along various reaches of the main channel. Livestock grazing has occurred all along the Upper Owens River and has reduced vegetative cover, compacted soils, and eroded streambanks. Streambank erosion and concomitant loss of streamside vegetation can affect fish populations by reducing undercut bank cover and availability of terrestrial insects. Livestock grazing enclosures constructed along portions of the Upper Owens River have increased herbaceous species diversity, density, and height within the enclosures, illustrating the adverse effects of grazing practices. (EBASCO Environmental et al. 1993.)

The Upper Owens River comprises three segments with differing hydrology, geomorphology, and land use practices (Figure 3D-3). Segment 1 extends from East Portal to the most downstream major water diversion and is characterized by bypass channels or diversions of varying capacity and less than 20% shaded riverine conditions. Segment 2 extends to the Hot Creek confluence and is characterized by lower mean flows, an absence of major diversions, and less than 20% shaded riverine conditions. Segment 3 extends to Lake Crowley reservoir and is characterized by decreased pool habitats, higher average flows than other reaches due to the contribution of Hot Creek, and no shaded riverine conditions. Glides and runs provide the greatest habitat types in each segment, followed by riffles, and then pools. Only four pools were defined in Segment 3 in 1990. (EBASCO Environmental et al. 1993.)

Arsenic concentrations are relatively high near Benton Crossing because of Hot Creek and a nearby active geothermal area, and impacts on fish may be occurring. Effects from elevated arsenic concentrations should be considered tentative, however, until further data are developed. (EBASCO Environmental et al. 1993.)

Fish Populations. Native fish species of the Upper Owens River include Owens tui chub and Owens sucker (Moyle 1976). The Owens tui chub was observed only in Hot Creek recently, while the Owens sucker was observed in Hot Creek and in the Upper Owens River. Three introduced species are known to occur in the Upper Owens River: brown trout, rainbow trout, and threespine stickleback. (Deinstadt et al. 1986 in EBASCO Environmental et al. 1993.) Lahontan cutthroat trout probably inhabit the Upper Owens River because they were planted there during 1987 and 1989 (Pickard pers. comm.). Fish planting practices in Lake Crowley reservoir also affect fish populations in the Upper Owens River. (EBASCO Environmental et al. 1993.)

Brown and rainbow trout density estimates were highest in Segment 1 and lowest in Segment 3 during 1990 sampling. Mean brown trout biomass estimates were 249, 53, and 22 pounds per acre in Segments 1, 2, and 3, respectively. Mean rainbow trout biomass estimates were 97, 38, and 49 pounds per acre in Segments 1, 2, and 3, respectively. Total trout biomass estimates of 346, 91, and 71 pounds per acre for Segments 1, 2, and 3, respectively, are comparable to or higher than estimates for the Upper Owens River in previous studies and for other Sierra Nevada streams. Gerstung (1973 in EBASCO Environmental et al. 1993) reported a mean biomass of 41 pounds per acre for 278 northern Sierra Nevada stream sections and a mean biomass of 37 pounds per acre for 65 south Sierra Nevada stream sections. A mean of 73 pounds per acre was estimated for 73 selected streams in the Sierra Forest Ecoregion (Platts and McHenry 1988 in EBASCO Environmental et al. 1993).

Catchable trout populations are larger in the Upper Owens River than estimated for other Sierra Nevada streams; brown and rainbow trout up to 18-20 inches in length are present in the fishery. Trout growth rates and condition generally exceed average values reported for other Sierra Nevada streams. Aquatic macroinvertebrate populations are relatively large and diverse, and food production does not appear to be a limiting factor to trout production. The Upper Owens River, therefore, contains large trout populations and maintains an excellent fishery, particularly in Segment 1. (EBASCO Environmental et al. 1993.) The excellent fishery is maintained in part by controlled access and catch-and-release regulations on private land.

Major migrating periods of brown and rainbow trout from Lake Crowley reservoir into the Upper Owens River occur primarily in October and November for fall-run brown trout and March through May for the spring-run rainbow trout (Milliron pers. comm.). Fall-run rainbow trout make up a much smaller spawning run in late summer and fall. No instream barriers exist from just below East Portal downstream, and successful upstream migration can be achieved at low lake levels with river discharges exceeding 20 cfs (EBASCO Environmental et al. 1993). Consequently, Lake Crowley reservoir trout have spawning habitat available to them throughout the Upper Owens River under a range of hydrologic conditions.

Management. DFG routinely plants catchable- and subcatchable-sized rainbow trout in the Upper Owens River (Pickard pers. comm.) During 1985-1987 and 1989-1991, an average of 221,206 rainbow trout were planted annually in the Upper Owens River near Benton Crossing. An average of 42,501 per year were of catchable size. During this same period, an average of 4,577 catchable-sized rainbow trout were planted upstream near Big Springs. Additionally, 122,304 subcatchable-sized

Lahontan cutthroat trout were planted in the Owens River near Benton Crossing. During 1987 and 1989, a total of 200,052 subcatchable-sized Lahontan cutthroat trout were planted near Big Springs. (EBASCO Environmental et al. 1993.)

Lake Crowley Reservoir and Tributaries

Habitat. Lake Crowley reservoir is highly productive compared to other eastern Sierra Nevada lakes because of its high alkalinity, moderate lake level fluctuations, and shallow depth. The initial filling of the reservoir inundated extensive meadowland and sagebrush flats, which now provide productive habitat for bottom-dwelling chironomid larvae, a principal prey species for trout.

Trout growth in Lake Crowley reservoir is excellent compared to growth in other eastern Sierra Nevada lakes. Differences in overwinter growth of subcatchable-sized trout appear to be related to the severity of winter conditions (i.e., extent of ice cover) and the reservoir operations, which determine the amount of productive shoal area (Pister 1965). The summer diet of trout mainly consists of chironomid pupae, cladocera (*Daphnia* sp.), and fish (Sacramento perch, tui chub) (Pister 1965, Loudermilk pers. comm.). Recent food habit studies also have been conducted to examine potential effects of algal control practices (e.g., copper sulfate treatment) on zooplankton populations and potential secondary effects on fish growth (Loudermilk pers. comm.).

The Upper Owens River and Hot, Convict, McGee, Hilton, Whiskey, and Crooked Creeks provide spawning habitat for lake-dwelling brown and rainbow trout. Significant spawning habitat is located in the Upper Owens River and Hot, Convict, and McGee Creeks, but high water temperatures can reduce egg and alevin survival in Hot Creek, especially after runoff (Wong pers. comm.). Juvenile trout produced naturally occur in the Upper Owens River and Convict Creek, but the extent of stream or lake rearing is unknown.

Fish Populations. Game fish populations in Lake Crowley reservoir and its tributaries are the result of past introductions and an intensive stocking program. Rainbow trout of different strains is the most abundant game species, followed by brown trout, Sacramento perch, and Lahontan cutthroat trout. The principal nongame species are Owens sucker and Owens tui chub, which provide important forage for the trout.

Spawning rainbow and brown trout occur in virtually all Lake Crowley reservoir tributaries, including the Upper Owens River and Hot, Convict, McGee, Hilton, Whiskey, and Crooked Creeks. Spring and fall spawning runs of rainbow trout in the Upper Owens River may consist of planted rainbow trout or wild trout representing a mixture of any of the strains planted in the past. Planted and wild brown trout contribute to fall spawning runs in the Upper Owens River and Lake Crowley tributaries. The contribution of natural spawning to the lake or tributary trout populations is unknown. (Wong pers. comm.)

Management. Lake Crowley reservoir supports one of the largest trout fisheries in California. Since the opening of the reservoir to angling in 1941, reservoir fishery management has focused on the annual stocking of many hatchery-reared trout to meet increasing public demand for angling. Early management practices primarily consisted of annual plants of fingerling brown and rainbow trout. Since 1951, stocking practices have shifted increasingly toward summer and fall (end of season) plants of subcatchable-sized rainbow trout, which has increased angler success considerably (Pister 1965). Since 1975, the reservoir has received annual plants of 200,000-450,000 subcatchable- and catchable-sized rainbow trout of a variety of strains and 100,000 subcatchable-sized brown trout. In addition, surplus broodstock and fingerling rainbow, brown, and Lahontan cutthroat trout are planted periodically (Pister 1965).

Catch rates in the reservoir are generally high early in the season (May) but then gradually decline throughout the remainder of the season (June-July). DFG has sought to improve late season fishery through an experimental planting program designed to evaluate the long-term survival and growth qualities of various rainbow trout strains. Current management goals emphasize maintaining a high-yield early season fishery and providing opportunities to catch trophy-sized fish. In 1985, a trophy trout season with restrictions on size, fishing gear, and bag limit was established from August 1 through October 31. Larger trout are important to sustain spawning runs and tributary fisheries.

Lake Crowley reservoir management practices have been evaluated by conducting a creel census program, primarily on weekends, throughout the angling season. In recent years, angler surveys have been conducted the opening weekend or periodically during the season. Evaluations are based on angler use and catch rates from season to season and the returns of marked subcatchable-sized trout planted in previous years. Angler surveys and trapping studies have been initiated on reservoir tributaries to evaluate existing angling regulations relative to angler use and success, and run timing and composition (Wong pers. comm.).

Middle Owens River

Instream Flows. Water diversions from Mono Basin, together with the creation and operation of Lake Crowley reservoir, have changed the Middle Owens River flow regime considerably. After the completion of the Mono Craters Tunnel and Long Valley Dam, the average annual flow increased from 245 to 366 cfs; flows were higher than preproject levels throughout the year and peak monthly flows averaging between 400 and 500 cfs extended through the summer months during 1948-1970. In 1971, export capacity increased by nearly 50%, thus increasing the average annual flow to 436 cfs during 1971-1976. Peak monthly flows exceeded 500 cfs during summer.

Minimum instream flow releases below Pleasant Valley Dam were established in 1961 at 75 cfs. LADWP notifies DFG when flows below Pleasant Valley Reservoir drop below 100 cfs (Pickard pers. comm.). In March 1966, DFG recommended that a constant, or gradually fluctuating, flow of at least 200 cfs be maintained from October 15 through April 15 to provide suitable spawning flows and protect developing eggs and young in the gravel (Wong pers. comm.). Flows up to 500 cfs were appropriate during this period only if increases were made gradually. The 75-cfs minimum flow standard and DFG's recommendations remain unchanged at present.

Sustained high flows ranging from 400 cfs to 600 cfs from November through March 1978 were identified as potentially limiting brown trout recruitment in 1979 (Deinstadt and Wong 1980b). These flows apparently formed a complete barrier to upstream migrating adults at culverts below the Pleasant Valley spawning channel during the November-December spawning period. In addition, high water current velocities during the spawning and early rearing period may have restricted the amount of usable spawning and fry habitat in the main channel of the Owens River.

Habitat. Since 1948, increased flows in the Middle Owens River below Pleasant Valley Dam have resulted in increased mean width of the channel and loss of undercut banks. Since 1967, accelerated bank erosion rates along the Owens River below Pleasant Valley Dam have been attributed to increases in the flow regime (Ponder and Deinstadt 1978). Also contributing to increased erosion and loss of bank cover along the Middle Owens River was the removal, spraying, and burning of riparian vegetation by agricultural and grazing interests from the 1950s to 1970s (Ponder and Deinstadt 1978).

Since Pleasant Valley Dam was completed in 1954, downstream gravel movements from upper portions of the drainage have been blocked. The reduced gravel supply, combined with higher flows below the dam, has reduced the quantity and quality of suitable spawning gravels, degraded the streambed, and armored the streambed with coarser substrate. These changes have continued downstream, and observations in 1977 indicated that the process may have affected approximately half of the wild trout segment (Williams 1975). Fish migration from the Middle Owens River to spawning habitat located in the lower segments of Pine and Rock Creeks also was eliminated following dam construction. To compensate for the lost spawning habitat, an artificial spawning channel was constructed downstream of the dam (see "Management" below).

Brown trout spawn primarily in the gravel-bottom runs of the Middle Owens River within the wild trout management area. A survey of the entire Middle Owens River in November and December 1990 revealed the presence of redds from Pleasant Valley Dam to Big Pine canal, with most redds concentrated in the upper one-third of the wild trout segment.

Existing habitat in the Middle Owens River reflects the generally low river gradient and erodible nature of the Owens Valley floor, and sinuosity prevails throughout the segment. Observed changes in general channel features from Pleasant Valley Dam to Tinemaha Reservoir include a gradual decrease in stream gradient (approximately 0.4% to less than 0.1%), increased channel width, and increasing proportions of fine sediment. Actively eroding banks are common along the outside of meander bends, especially along the segment below Laws Creek ditch. Detailed information on habitat characteristics of the Middle Owens River are presented in Jones & Stokes Associates (1992).

Water Quality. Water quality problems in Pleasant Valley Reservoir have affected the Middle Owens River below Pleasant Valley Dam. In August 1974, an algae bloom and several days of cloud cover without wind reduced dissolved oxygen to less than 0.5 parts per million (ppm) in Pleasant Valley Reservoir and caused a complete fish kill in the Middle Owens River from the dam to Pleasant Valley campground. A similar event in 1977 resulted in a "near fish kill" (Ponder and Deinstadt 1978). An aerating device was subsequently installed at Pleasant Valley Dam to overcome future oxygen depletion problems in the river below Pleasant Valley Reservoir (Ponder and Deinstadt 1978).

Fish Populations. Introduced game fish in the Middle Owens River include brown trout, rainbow trout, brown bullhead, largemouth bass, and bluegill. Brown trout are the dominant game fish in the wild trout management section, a 16-mile segment immediately below Pleasant Valley Reservoir. Recent surveys and tagging studies indicate that the river 1.5 miles downstream of Pleasant Valley Dam, including the river channels within the existing campground, contains the highest brown trout densities within the wild trout segment (Worthley pers. comm.). Below the wild trout segment, catchable-sized rainbow trout are seasonally abundant in areas where DFG continues to plant these fish.

DFG brown trout surveys in fall 1977 and 1979 detected reduced trout abundance and biomass in 1979, which was attributed primarily to poor recruitment of subyearling trout (Deinstadt and Wong 1980a, 1980b).

Nongame species in the Middle Owens River include carp, threespine stickleback, Owens sucker, and Owens tui chub. Recent surveys indicate that Owens pupfish are present only in a few isolated springs, while speckled dace occur in small tributaries and irrigation ditches in the Owens Valley near Bishop, California. Tui chubs are present in the main river, but their numbers have declined (Moyle 1976). In contrast, Owens suckers have maintained relatively large populations in the Middle Owens River.

Management

Wild Trout Management Area. Before 1968, the Middle Owens River supported a predominantly put-and-take fishery maintained by annual plants of hatchery-reared rainbow trout from several state hatcheries. Following an evaluation of the trout fishery in 1967 and 1968, DFG discontinued stocking of hatchery-reared rainbow trout and began managing the 16-mile segment between Pleasant Valley Dam and Five Bridges Road bridge as a wild brown trout fishery (Segment 2, Figure 3D-4). In 1972, the segment was included under the newly created wild trout management program. The primary purpose of the program is to preserve high-quality trout fisheries sustained by naturally produced wild trout strains. The wild trout reach has become California's top brown trout stream in terms of angler use and number of trout harvested (Deinstadt and Wong 1980a).

DFG's general management recommendations for the wild trout area, as outlined in the Lower Owens River Management Plan (Ponder and Deinstadt 1978), include:

maintaining angling opportunities and harvest levels attractive to wild trout anglers;

providing optimal flow, water quality, and physical habitat conditions;

providing for recreational use of wild trout while minimizing uses not compatible with wild trout angling; and

preserving or restoring the natural character of the streamside environment.

Additional recommendations include coordinating with LADWP to continue policies and operations beneficial to the fishery, continuing efforts to correct conditions recognized as detrimental to the trout population and fishery, and attempting to define more clearly the changes that could improve brown trout production (Ponder and Deinstadt 1978).

DFG initiated monitoring of the Owens River brown trout fishery in 1967. Creel surveys within the wild trout management area revealed a decline in angler use and catch between 1967 and 1976 (Deinstadt and Wong 1980a). During this period, catch rate (catch per angler hour) and age structure of creeled brown trout fluctuated but without apparent trends (Ponder and Deinstadt 1978). Creel surveys in 1981, 1985, and 1988 indicated that use increased slightly from the previous levels. The proportion of fly anglers and fish released also has increased (Deinstadt 1988).

Angling in the Middle Owens River is open year round. Before 1980, regulations within the wild trout area included a 10-trout limit during the general season and a five-trout limit in winter with no gear restrictions. In 1980, the limit was reduced to two fish year round with no gear restriction. The river section from Five Bridges Road bridge to the U.S. Highway 6 bridge is being considered for inclusion in the wild trout management area (Deinstadt pers. comm.).

Pleasant Valley Spawning Channel. The Pleasant Valley Spawning Channel, located approximately 0.5 mile downstream from Pleasant Valley Reservoir, was constructed by LADWP in 1962 with guidance from DFG. The purpose of the artificial spawning channel is to compensate for inundated trout spawning areas above Pleasant Valley Dam and provide a supplementary spawning area for resident trout below the dam. The spawning channel essentially is a diversion loop of the main stream with structures that regulate channel flows and prevent upstream migrating brown trout from bypassing the channel.

Periodic monitoring of brown trout spawning and channel maintenance has been performed by LADWP with DFG guidance. An estimated 200 to 500 spawning brown trout entered the spawning channel annually between 1967 and 1972. DFG recognized the Pleasant Valley spawning channel as an increasingly important spawning area for upstream migrants because of reduced suitable spawning areas in the main channel of the river. Based on a 1961 agreement between LADWP and DFG, a minimum flow release of 75 cfs from Pleasant Valley Dam was established for proper operation of the spawning channel.

Lower Owens River

Habitat. Before 1986, the Lower Owens River channel was dry because of LA Aqueduct operations. Since June 1986, a continuous flow in the Lower Owens River has been reestablished through cooperative efforts of Inyo County and the City of Los Angeles to implement the existing habitat management plan, which was drafted in 1988. A formal agreement between Inyo County and the City of Los Angeles has not yet been reached. (Tillemans pers. comm.)

Fish Populations. The Lower Owens River below Tinemaha Reservoir supports limited populations of warmwater game fish, including largemouth bass, smallmouth bass, bluegill, channel catfish, brown bullhead, and possibly redear sunfish. Coldwater game fish include brown trout and planted rainbow trout; nongame fish include carp and mosquitofish (Milliron pers. comm.).

Management. The current focus of fisheries management in the Lower Owens River is to enhance existing warmwater fisheries through implementation of the Lower Owens River Habitat Management Plan. A key element of the proposed plan is to provide a continuous, but seasonally variable, flow in the normally dry portion of the Owens River between Blackrock Springs and Owens Lake (Tillemans pers. comm.). The objectives of the plan are to improve existing fisheries and waterfowl habitats and create additional recreational opportunities in the southern Owens Valley.

The coldwater fishery in the Lower Owens River is maintained largely by plantings of catchable-sized rainbow trout downstream of Tinemaha Reservoir (Lipp pers. comm.).

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

Habitat. Pleasant Valley Reservoir receives inflows from the Owens River, which flows out of LADWP's powerhouse approximately 0.75 mile upstream of Pleasant Valley Reservoir. Inflows are mostly controlled and can vary daily from releases for power production, while uncontrolled tributary inflows from Rock and Pine Creeks during spring also can cause brief seasonal variations in flow. Reservoir surface elevations are relatively stable because Pleasant Valley Reservoir is relatively small and is not operated as a water-storage facility; rather, it is operated as a reregulating reservoir to control releases from LADWP's powerhouse. The Owens River below LADWP's powerhouse and tributary streams, such as Rock and Pine Creeks, provide spawning habitat for Pleasant Valley Reservoir brown and rainbow trout.

The initial filling of Tinemaha Reservoir inundated several miles of riparian and sagebrush habitats. Tinemaha Reservoir is relatively shallow, provides short-term regulation of Owens River flows, and experiences daily fluctuations. Recent earthquake safety concerns have further limited the usable storage of the reservoir. Tinemaha Reservoir receives inflow from the Middle Owens River and Tinemaha Creek.

Haiwee Reservoir consists of two connected reservoirs: North and South Haiwee. Haiwee Reservoir receives inflow from the LA Aqueduct and is operated in similar fashion as Tinemaha Reservoir and therefore experiences daily water surface fluctuations. Recent earthquake concerns have limited the usable storage of Haiwee Reservoir. LADWP has treated Haiwee Reservoir with copper sulfate since the 1950s to control taste and odor problems (White pers. comm.).

Fish Populations. Based on unpublished DFG file memoranda, Pleasant Valley Reservoir contains brown trout, rainbow trout, largemouth bass, catfish (bullhead), Sacramento perch, tui chub, Owens sucker, and carp.

Tinemaha Reservoir supports a limited fishery comprised primarily of largemouth bass, bluegill, and bullhead (Milliron pers. comm.).

North Haiwee Reservoir supports known populations of smallmouth bass, largemouth bass, rainbow trout, bluegill, and carp. Brown trout, channel catfish, bullhead, tui chub, and mosquitofish also may occur. Fish species in South Haiwee Reservoir probably are similar to those found in North Haiwee Reservoir (Pickard pers. comm.).

Management. The fishery in Pleasant Valley Reservoir is maintained largely by plants of catchable-sized rainbow trout. During the 1950s, DFG planted brown trout in Rock Creek to maintain the tributary fishery. Brown trout are nearly self-sustaining and form a small percentage of the total catch in Pleasant Valley Reservoir.

Los Angeles Aqueduct and Irrigation Canals

Habitat. The portion of the LA Aqueduct from the intake structure near Aberdeen to the Alabama spillgate near Lone Pine consists of an unlined, incised ditch. Below the Alabama spillgate, the aqueduct is a lined canal. Riparian vegetation along the unlined portion of the aqueduct is limited because of the steep banks. Consequently, instream and overhead cover is limited to areas with instream vegetation and to areas where willows have become established along the margins of the aqueduct.

Fish Populations. The unlined portion of the LA Aqueduct supports limited populations of warmwater and coldwater species, including largemouth bass, smallmouth bass, carp, channel catfish, bullhead, bluegill, brown trout, and rainbow trout (Lipp and Tillemans pers. comms.). Fish populations are maintained through natural reproduction and recruitment from upstream sources. Rainbow and brown trout populations probably are maintained by natural reproduction in the creeks that drain the east side of the Sierra Nevada (Tillemans pers. comm.). The aqueduct captures many of these creeks as it winds along the western edge of the Owens Valley.

Management. Currently, no fish are planted in the unlined portion of the LA Aqueduct. Fish populations are maintained through natural reproduction and recruitment from upstream and downstream sources. Fishing is limited; however, several places along the aqueduct are popular with anglers and locally are used intensively.

IMPACT ASSESSMENT METHODOLOGY

The LAAMP model output provides the primary quantitative basis from which to develop response variables, analytical frameworks, and assessment models to assess fisheries impacts of each Mono Basin EIR alternative. Each alternative manifests its effects on the aquatic ecosystem by changing instream flows, as simulated by the LAAMP model. Consequently, response variables that vary with streamflow were identified, and relationships between these response variables and streamflow were developed when possible to most effectively evaluate impacts to fishery resources.

Optimal design of an environmental impact assessment methodology and integration approach for the Mono Basin EIR involves developing consistent response variables, analytical frameworks, assessment models, and ranges of impact thresholds. Unfortunately, the databases available for each of the streams and reservoirs vary widely, despite attempts to develop relatively consistent databases since initial instream flow studies began on Rush Creek in 1987. Most importantly, models used to determine the effects of streamflow changes on fish response variables are unavailable, provide only limited use, or may be affected by a combination of the 1987-1992 drought, ongoing habitat restoration efforts, and channel disequilibrium from relatively recent stream rewatering. For these reasons, the fisheries impact assessment for the Mono Basin EIR primarily consists of qualitative interpretations of the complex relationships between available quantitative fisheries data and LAAMP model output. Only the habitat-based models and specific hydrologic variables known to affect fisheries resources were developed sufficiently for quantitative impact assessments methodologies to be conducted.

Several examples are cited to indicate the problems associated with developing standard methodologies for fisheries impact assessments for the Mono Basin EIR. Parker and Walker Creeks underwent channel modifications (woody debris removal), flow modifications (rewatering), and fish plantings in fall 1990; consequently, the stream channels and fish populations have not developed a dynamic equilibrium, and data and models relating fisheries habitat or populations to flow are nonexistent. Extensive fisheries studies have been conducted on Rush and Lee Vining Creeks, but recent and proposed habitat restoration efforts may limit the usefulness of these assessment models and results, particularly during future management efforts. In addition, the results of the instream flow investigations on Lee Vining Creek and the Upper Owens River were still subject to revision during the EIR analysis phase. Data on fisheries resources and instream flows in the Upper and Middle Owens River have only recently become available, and multiyear data collection efforts on these rivers are limited.

Impact Prediction Methodology

Physical Habitat

Tennant Method. Quantitative relationships between physical habitat and discharge do not exist for Parker and Walker Creeks, and the Tennant Method was used to evaluate habitat conditions, since it requires limited data and has been applied to a broad range of streams throughout the United States (Wesche and Rechard 1980). The Tennant Method is based on a simple relationship between general aquatic habitat conditions and the magnitude of the base flow expressed as a percentage of average annual discharge for a given stream. According to this method, 10% of the average annual flow provides only short-term survival conditions for most aquatic life forms, 30% of the average flow provides good aquatic habitat conditions, and 60% of the average flow provides excellent to outstanding habitat conditions (Tennant 1975). Tennant provides two sets of criteria, adjusted for seasonal differences in flow ratings, and these criteria were applied to Parker and Walker Creeks based on average annual historical discharge in these two creeks (Table 3D-3).

Using LAAMP results for each alternative (Jones & Stokes Associates 1993), habitat conditions were rated for dry (20%), normal (50%), and wet (80%) hydrologic conditions for each month based on the Tennant criteria in Table 3D-3. Tennant qualitative habitat descriptions were then assigned numeric values ranging from 0 for flows associated with severely degraded conditions to 5 for optimum conditions. All monthly values were averaged to generate a single value representing the average habitat conditions for dry, normal, and wet hydrologic conditions under each alternative.

Instream Flow Incremental Methodology. The Instream Flow Incremental Methodology (IFIM) uses an index of habitat (weighted usable area [WUA]) to quantify habitat available to selected aquatic species and life stages under various flow regimes (Bovee 1982). IFIM habitat-discharge relationships for Rush Creek (Beak Consultants 1991), Lee Vining Creek (Aquatic Systems Research 1992), the Upper Owens River (EBASCO Environmental et al. 1993), and the Middle Owens River (Jones & Stokes Associates 1992) were used to predict physical habitat under simulated hydrology (Jones & Stokes Associates 1993) for each alternative. Impact analyses based on the habitat-discharge relationships focused on specific stream segments and brown trout lifestages generally limiting fish populations.

Rush Creek. Impact predictions were limited to Segments 3, 5, and 6 of lower Rush Creek because these segments contain most of the brown trout spawning, fry, juvenile, and adult habitat in lower Rush Creek (Beak Consultants 1991). Segment 1 was excluded because it is a deep, uniform artificial channel with little habitat diversity. Segment 2 was excluded because it is a relatively short, steep gradient reach contributing only a small portion (less than 10%) to the total available habitat and exhibiting only minor habitat change over a broad flow range. Segment 4 was excluded because it is a very short reach contributing little (less than 2%) to total fish habitat.

Lee Vining Creek. Impact predictions were limited to Segments 2, 5, and 6 of lower Lee Vining Creek. Segment 1 was excluded because it is located upstream of the LADWP diversion and was not included in DFG's IFIM study (Aquatic Systems Research 1992). Segment 3 was excluded because of unrealistic hydraulic simulations resulting from turbulence, air entrainment, and transect placement restrictions (Aquatic Systems Research 1992). Segment 4 was also excluded because of its small contribution (less than 10%) to total habitat values.

Segment 2 is the primary source of brown trout production and recruitment in lower Lee Vining Creek because of the scarcity of adult and spawning habitat in Segments 5 and 6 (Aquatic Systems Research 1992; EA Engineering, Science, and Technology 1989). In comparison, fry habitat in these lower segments is abundant and does not currently limit brown trout populations in this portion of the creek. Consequently, habitat evaluations for Lee Vining Creek focused on Segment 2, and Segments 5 and 6 were considered only with respect to impacts on juvenile, adult, and spawning habitat. Habitat restoration efforts were implemented after the IFIM study was conducted but have not significantly altered the habitat-discharge relationships (Aquatic Systems Research 1992).

Upper Owens River. Impact predictions for brown trout and rainbow trout were developed for all three segments identified for the Upper Owens River.

Middle Owens River. Impact analyses for the Middle Owens River were limited to Segments 1, 2, and 3, which account for most of the wild brown trout production in the Middle Owens River. Habitat evaluations for aquatic invertebrates were also limited to these segments because of their importance as food for brown trout. Largemouth bass habitat was evaluated only in Segment 4, where historical habitat conditions have been most suitable for largemouth bass production. Native fish species in the Middle Owens River were not evaluated because few, if any, data exist on their habitat preferences and sampling their populations would be extremely difficult.

Impact Prediction Methods. Impact assessments for brown and rainbow trout spawning and fry stages were limited to the principal spawning and fry rearing periods in each stream. The seasonal occurrence of each trout life stage was determined from the most relevant literature and modified according to any observed temperature-related differences in the timing of various life stages in each stream (Table 3D-4). Although fall-spawning rainbow trout occur in the Upper Owens River, it was assumed that the dominant rainbow trout life history pattern is characterized by spring spawning. Brown trout juveniles and adults are present throughout the year, but WUA was determined only for April-October because underlying habitat suitability criteria were developed from observations during this period and may not be applicable to winter conditions. The April-October period is also more important for brown trout growth than are winter months, and competition for food and space is probably greatest during spring and summer.

Under some alternatives, simulated flows in lower Rush Creek and Lee Vining Creek exceeded the flow range used for habitat simulation in the IFIM studies. Consequently, WUA predictions for brown trout life stages could not be quantified in these cases. Habitat-discharge relationships for each life stage and stream indicate that WUA was generally constant at the highest modeled flows; therefore, monthly flows outside the range of the IFIM for a specific life stage were given a WUA value equal to that associated with the maximum simulated flows in each IFIM study (100 cfs for both Rush and Lee Vining Creeks). This rule was applied in all cases to maintain consistency and facilitate comparisons among alternatives. The uncertainty of the effects of higher flows on physical habitat was considered when interpreting results, especially when flows greatly exceeded the modeled range.

Habitat time series for each alternative were constructed by integrating habitat-discharge relationships with the monthly flow simulations generated by the LAAMP model for the 1940-1989 hydrologic period (Jones & Stokes Associates 1993). Monthly WUA values for each life stage were first computed for each selected segment. Because flows vary longitudinally, WUA predictions for each segment, and sometimes within subsegments, were based on their respective flows after adjustments were made for any known streamflow gains and losses. Accordingly, the resulting WUA values were weighted by the respective length of each segment or subsegment, then summed to yield the corrected prediction of total WUA.

Monthly WUA values for each segment and life stage were averaged and summed to obtain a single WUA value representing the average amount of habitat available in a given year. These values were graphed as a time series of annual WUA values for each alternative to examine annual differences in available habitat over time. Annual changes in WUA were presented graphically for each alternative and summarized for each life stage as the overall average WUA over the 1940-1989 hydrologic period. WUA predictions for the Upper Owens River were restricted to monthly 20%, 50%, and 80% flows developed from the 1940-1989 hydrologic period.

Water Temperature, Water Quality, and Icing

Fisheries impacts associated with water temperature, water quality, and icing were integrated with available physical habitat and other data to assess alternatives. These factors are affected by flow and generally act to limit the extent and distribution of suitable habitat along a given stream length.

Water Temperature. Water temperature impacts associated with each alternative were assessed using water temperature modeling results on Rush Creek (Beak Consultants 1991), Lee Vining Creek (Aquatic Systems Research 1992), the Upper Owens River (EBASCO Environmental et al. 1993), and the Middle Owens River (Jones & Stokes Associates 1992), with water temperature suitability criteria for brown trout reported by Raleigh et al. (1986) (Table 3D-5). Water temperature modeling for Rush Creek, Lee Vining Creek, and the Upper Owens River evaluated the effect of streamflow on daily water temperatures during summer when fish would most likely experience stress associated with high stream temperatures. Graphs representing summer water temperatures as a function of flow for various locations in Rush Creek, Lee Vining Creek, and the Upper Owens River were used to determine the relative effect of each alternative on the frequency of optimum, suboptimum, and lethal water temperatures for brown trout, fry, juveniles, and adults.

The Middle Owens River water temperature model was developed specifically to assess fisheries impacts related to each of the proposed alternatives. Accordingly, LAAMP hydrologic simulations served as input to the water temperature model. Water temperature simulations were conducted for representative dry (20%), normal (50%), and wet (80%) hydrologic conditions for April, June, August, and October. These months were selected because they encompass the period when water temperatures are most likely to affect brown trout production. Mean, maximum, and minimum daily water temperature predictions were generated monthly, assuming constant daily flow regimes within each month and daily meteorologic conditions that were the same as those measured in 1991. Three stations were selected to characterize longitudinal changes in water temperature: Owens River at Five Bridges Road, Owens River at Big Pine Canal, and Owens River near Big Pine (Figure 3D-4).

Water Quality. Existing water quality conditions in the streams potentially affected by flow alterations are expected to remain within acceptable limits over the range of alternatives. Arsenic levels were identified as a concern in the Upper Owens River (EBASCO Environmental et al. 1993) and potential impacts were addressed qualitatively. No further analyses were necessary.

Icing. Information on winter ice formation and potential fisheries impacts is based largely on field observations and is primarily qualitative. Observations and measurements of winter ice formation in Lee Vining Creek and the potential risks to trout were discussed in relation to flow, weather, and stream gradient (Aquatic Systems Research 1992). This information was used to assess potential impacts on brown trout populations in relation to the magnitude of winter flows in Lee Vining, Parker, and Walker Creeks under each alternative. Ice formation does not appear to adversely affect trout populations in Rush Creek or the Owens River.

Channel Morphology and Spawning Gravel Characteristics

Channel maintenance and flushing flow requirements are important considerations for evaluating alternative flow regimes because such flows are often critical for long-term maintenance of stream habitat quality and diversity. Potential fishery benefits and impacts of peak spring flows on channel stability, sediment transport, and spawning gravel distribution and quality were assessed using geomorphic study results developed for Rush, Lee Vining, Parker, and Walker Creeks, and the Upper and Middle Owens River. These studies provide insight on the approximate magnitude of flows necessary to maintain channel structure and mobilize streambed substrate, including gravels within the suitable size range for brown trout spawning.

Fish Population Characteristics

The potential response of brown trout populations to flow and habitat changes associated with each alternative was assessed based on available evidence of direct and indirect effects of flow on trout abundance, distribution, survival, growth, and reproduction. Information sources included recent brown trout population monitoring in Rush Creek (EA Engineering, Science, and Technology 1990c, 1991; Beak Consultants 1991) and Lee Vining Creek (EA Engineering, Science, and Technology 1989, 1990a, 1990b; Aquatic Systems Research 1992), 1990 population sampling in the Upper Owens River (EBASCO Environmental et al. 1993), and past population sampling (Deinstadt and Wong 1980a) and direct observations (Jones & Stokes Associates 1992) in the Middle Owens River. Potential changes in population interactions including competition, predation, stocking, and harvest were also considered.

Reservoir Productivity and Fluctuations

Alternative operations represent the primary source of potential impacts on reservoir fishery resources. Consequently, reservoir hydrologic modeling is critical for impact assessment. The basic approach was to develop criteria based on scientific literature regarding habitat requirements of key species and on discussions with biologists familiar with conditions of Grant Lake reservoir and Lake Crowley reservoir. Habitat requirements or conditions were then interfaced with hydrologic modeling results to determine project impacts relative to the point of reference and between alternatives. These analyses focused on changes to or impacts on the reservoir fishery relative to the point of reference and on relative differences between alternatives. Impacts on reservoir fisheries were determined through separate analyses of fish productivity (relative to reservoir levels) and spawning success (dependent on rising reservoir water surface elevations). Fisheries impacts in Pleasant Valley, Tinemaha, and Haiwee Reservoirs were treated qualitatively based on expected changes in reservoir surface area and the timing and magnitude of reservoir fluctuations.

Reservoir Productivity. Operational changes associated with each alternative could change the pattern and amplitude of Grant Lake reservoir and Lake Crowley reservoir levels. Greater reservoir areas and less fluctuations generally increase fish populations and productivity. Potential impacts from each alternative were assessed by comparing average reservoir surface areas with point-of-reference conditions.

Average monthly reservoir surface areas were computed based on end-of-month (EOM) reservoir water surface elevations simulated by the LAAMP model for the 1940-1989 hydrologic period. A total average reservoir surface area was then calculated for each alternative by averaging all monthly values occurring within the April-October growing season. For Lake Crowley reservoir, a total average reservoir surface area was also computed for the November-March period to evaluate over-winter conditions, which have been shown to affect fish productivity in Lake Crowley reservoir (Pister 1965); in general, higher reservoir levels and reduced fluctuations increased productive shoal area and fish growth.

Reservoir Fluctuations. Alternative operations could change the pattern and amplitude of Grant Lake reservoir fluctuations and adversely affect brown trout spawning success. Sada (1977) provides evidence that brown trout redds constructed in Rush Creek upstream of the reservoir can be adversely affected by rising winter and spring reservoir levels. These potential impacts were assessed by comparing simulated winter and spring (October-June) reservoir water surface elevations for each alternative with simulated reservoir elevations for the point of reference. A time series of EOM water surface elevations simulated by the LAAMP model for the 1940-1989 hydrologic period was initially developed. Monthly changes in water surface elevation were determined by computing the difference in EOM water surface elevations for each month during the October-June period. For each alternative, results were then ranked within each month to determine water surface elevations exceeded 20%, 50%, and 80% of the time.

The effects of Lake Crowley reservoir fluctuations on spawning success were not analyzed because Lake Crowley reservoir fish primarily spawn in the Owens River and other tributaries upstream of the reservoir inundation zone.

Criteria for Determining Significance

Physical Habitat

Tennant Method. Changes in aquatic habitat conditions in Parker and Walker Creeks under each alternative were considered significant if the difference in the average Tennant score between alternatives for dry, normal, and wet hydrologic conditions equaled or exceeded 1. For example, a change in the average Tennant score from 3 (i.e., good habitat conditions) under one alternative to 2 (i.e., fair habitat conditions) under another alternative was considered a significant adverse impact.

Instream Flow Incremental Methodology. Changes in WUA for each alternative were considered significant if the affected habitat would potentially limit populations based on an understanding of all relevant data, and if the average WUA over the 1940-1989 hydrologic period would increase or decrease by more than 10% relative to the average WUA under point-of-reference conditions. A 10% change in habitat conditions was considered significant because it corresponds to the minimum change in fish populations that could reasonably be detected over time given the precision of existing measurement techniques.

Water Temperature, Water Quality, and Icing

Water temperature modeling for Rush Creek, Lee Vining Creek, the Upper Owens River, and the Middle Owens River indicate that water temperatures associated with each of the alternatives fall within the tolerance range for brown trout under most weather conditions; alternatives differ mainly with respect to the frequency of optimum and suboptimum water temperatures. Raleigh et al. (1986) present optimal temperature ranges and tolerance limits for brown trout life stages, but criteria for evaluating sublethal effects based on the frequency, magnitude, and duration of exposure to suboptimal water temperatures are not defined. Therefore, specific threshold criteria for determining significant impacts could not be defined, and temperature impacts associated with each alternative were assessed based on the magnitude, frequency, and duration of suboptimal water temperatures and whether such exposure would reasonably cause significant, long-term changes in fish abundance or biomass.

Water quality conditions in the affected stream are expected to remain at acceptable levels under all alternatives. Because significance criteria could not be defined, potential risks of winter ice formation to brown trout in Lee Vining Creek were compared, for each alternative, with those associated with point-of-reference conditions. For other streams, information on ice-related impacts was unavailable or ice formation was not considered to be a limiting factor.

Channel Morphology and Spawning Gravel Characteristics

Sediment transport studies and analyses on Rush Creek, Lee Vining Creek, and the Middle Owens River provided information on flows necessary to mobilize streambed or bank materials. To the extent possible, these threshold flows were used to determine the adequacy of peak spring or summer flows in maintaining favorable spawning gravel and channel conditions in the affected streams. Significant adverse impacts on spawning gravels, aquatic invertebrate habitat, and channel structure were predicted when the frequency of such flows was reduced relative to point-of-reference conditions. More frequent high flows would have variable effects, depending on existing channel conditions and sediment budgets in each of the streams; benefits might be expected in relatively stable reaches while less stable reaches might experience excessive bank erosion and loss of cover, even at natural, unimpaired flows. These potential impacts were also considered in evaluating the frequency and magnitude of high spring and summer flows associated with each alternative. No information was available to evaluate effects related to the duration of channel maintenance and flushing flows.

Fish Population Characteristics

Changes in trout populations resulting from alternative flow regimes were expressed qualitatively based on evidence derived from population monitoring studies, observed habitat relationships, and trout population data from eastern Sierra Nevada streams. The principal evaluation criteria were general abundance and standing crop of adult trout; the effects of flow and habitat changes on survival, growth, and reproductive success were considered in terms of their probable effects on adult trout abundance and standing crop. Where possible, impact analyses focused on specific habitats or life stages that potentially limit adult populations. Existing data were inadequate for developing accurate population-habitat models to provide quantitative estimates of fish populations and therefore apply quantitative significance criteria.

Potential effects of food abundance on trout growth and survival were also considered. A general habitat-discharge relationship developed for aquatic invertebrates was used to assess potential consequences of habitat changes on food abundance or availability in the Middle Owens River, and any change greater than 25% was used as the significance criterion because of the more general nature of the invertebrate habitat suitability criteria used in the IFIM compared to the fish habitat suitability criteria.

The determination of impacts related to fish population interactions, such as competition, predation, stocking, and harvest, was largely speculative and based on indirect evidence from population monitoring studies and general literature on the behavior and ecological requirements of the species present.

Reservoir Productivity and Fluctuations

Reservoir Productivity. Adverse impacts on lake productivity could occur if alternative operations reduce reservoir surface area relative to point-of-reference conditions. Reductions in reservoir surface area were considered to have a significant effect on fish productivity if total reservoir surface area was reduced by 10% or more. A 10% reduction in reservoir surface area would likely have a measurable, adverse effect on reservoir fish production over time.

Reservoir Fluctuations. Adverse impacts on brown trout spawning could occur when alternative operations increase reservoir water surface elevations during winter and spring (October-June) relative to the point of reference. Under normal and dry water years, impacts were considered to be significant if rising reservoir levels increased the amount of inundation of potential spawning habitat by 517 linear feet or more relative to the point of reference (517 feet is 10% of the total potential spawning habitat available to brown trout under point-of-reference conditions). In wet water years, significant impacts would occur if 133 feet (10%) of potential spawning habitat were inundated; significance thresholds for wet water years are lower because total potential spawning habitat available to brown trout at the onset of the spawning season would be reduced as a result of higher initial reservoir levels.

SUMMARY COMPARISON OF BENEFITS AND IMPACTS OF THE ALTERNATIVES

Summary comparisons of benefits and impacts of the alternatives are presented in Tables 3D-6, 3D-7, and 3D-8.

Summary Consideration of Pre-1941 Fishery Standards Set by Court Order

In addition to meeting its responsibilities under CEQA, SWRCB must also meet specific criteria established in court orders addressing fisheries resources in Mono Lake tributaries. The court has directed SWRCB to exercise its ministerial duty to amend LADWP's water right licenses for appropriation of the Mono Lake tributaries to include conditions in accordance with California Fish and Game Code Sections 5937 and 5946. Most importantly, the court further specified that licenses require LADWP to "release sufficient water into the streams from its dams to reestablish and maintain the fisheries that existed in them prior to its diversion of water". This standard has an overriding influence on the evaluation and selection of alternative lake levels, as described at the end of this chapter.

Several factors limit reestablishing pre-1941 fishery conditions in the Mono Lake tributary streams. Pre-1941 fishery conditions cannot be accurately described and, consequently, it would be difficult to ascertain whether the objective of reestablishing the pre-1941 conditions was ever met. It was recognized early in the habitat restoration program ordered by the court that existing conditions may preclude restoration of some specific pre-1941 physical conditions. The Restoration Technical Committee therefore agreed to and adopted the goal of developing and implementing programs to establish aquatic and riparian conditions and resource values equivalent to those existing in the streams prior to 1941 as an acceptable substitute for the overall goal of reestablishing the conditions which benefited the fisheries that existed in the creeks prior to 1941. Establishing even equivalent conditions that benefited the pre-1941 fishery is impossible in the short term and possible in the long term only if aggressive and substantial habitat restoration programs, in concert with major instream flow releases, are undertaken.

Compared to the 1989 point of reference, all alternatives would have substantial fishery benefits in the Mono Lake tributaries. Compared to the pre-1941 conditions, however, significant cumulative impacts were identified for all alternatives. Similarly, none of the alternatives can restore and maintain pre-1941 fishery conditions for at least 50 or more years. Major geomorphic alterations are simply too great to allow restoration of the complex habitat functions present in lower Rush and Lee Vining Creeks in the pre-1941 period. Successful restoration efforts now will require greater short-term control of high flows while channel and habitat conditions are stabilized and restored.

DFG Stream Evaluation Reports provide fishery protection flows and other measures to optimize fishery conditions in Mono Lake tributaries. It is unclear whether these reports represent DFG's formal recommendations for each stream or are consultants' recommendations only. Nonetheless, the Stream Evaluation Reports represent the best available information provided by DFG for establishing conditions that approach, to the greatest degree possible, the pre-1941 habitat conditions desired by the court.

Based on aqueduct model simulations using preliminary Stream Evaluation Report instream flow recommendations, the implications of possible fisheries instream flow requirements were evaluated. The recommended flows would cause the surface elevation of Mono Lake to rise to an average elevation of 6,381 feet, using a maximum Rush Creek flow of 60 cfs, or to 6,385 feet using a maximum Rush Creek flow of 100 cfs. Uncontrolled spills would not likely occur in the Mono Basin tributaries under the conditions specified. Minimum instream flow recommendations for Rush Creek would be met in most years, but available flows in Lee Vining, Parker, and Walker Creeks would often be insufficient to meet the specified minimum instream flows in dry and normal runoff years.

These simulated lake level ranges, when compared to the lake level regimes described for each alternative, indicate the degree to which each alternative is capable of meeting the pending DFG instream flow recommendations for protection of fishery resources. The 6,383.5-Ft Alternative is the nearest alternative that satisfies preliminary DFG recommendations developed to optimize fisheries conditions. The average lake level (6,385) based on the 6,383.5-Ft Alternative would meet DFG's pending instream flow requirements.

Effects in Mono Basin

The No-Restriction Alternative results in significant adverse and unmitigable effects in Rush, Lee Vining, Parker, and Walker Creeks.

Rush Creek brown trout habitat would increase substantially with increasing lake levels from point-of-reference conditions. Beginning with the 6,377-Ft Alternative, however, peak average monthly flows in Rush Creek would significantly exceed DFG's recommended maximum flow of 100 cfs and contribute to streambank erosion and channel meandering in Segments 5 and 6 and to spawning gravel losses in Segments 2 and 3. These impacts are considered significant, and mitigation measures are identified to reduce these impacts to less-than-significant levels.

Lee Vining Creek brown trout habitat would increase substantially with increasing lake levels from point-of-reference conditions. Beginning with the 6,377-Ft Alternative, however, peak average monthly flows would adversely affect habitat restoration efforts, gradually reduce available spawning gravels, and increase mortality rates of brown trout susceptible to downstream displacement at high flows. These impacts are considered significant, and mitigation measures are identified to reduce these impacts to less-than-significant levels.

Parker and Walker Creek fishery resources benefit substantially with increasing lake levels from point-of-reference (dewatered) conditions. Average monthly flows associated with the No-Diversion Alternative, however, would cause adverse impacts on unstable channel reaches, but the net result compared to point-of-reference conditions would remain a substantial benefit to fishery resources.

Grant Lake reservoir fishery resources would experience less-than-significant adverse effects from the No-Restriction Alternative. Slight benefits to trout spawning success would occur at all lake levels above point-of-reference conditions. At the 6,383.5-Ft, 6,390-Ft, and 6,410-Ft Alternatives, however, reservoir surface area is reduced significantly, which would reduce fish productivity significantly. The slight benefits to spawning success and DFG's stocking of Grant Lake reservoir offset the reduced surface area, and the net effect on Grant Lake reservoir fishery resources would be a less-than-significant adverse impact. Substantial benefits to fisheries of Grant Lake reservoir would occur with the No-Diversion Alternative.

Effects in Owens River Basin

Upper Owens River fishery resources would experience slight benefits under the No-Restriction Alternative. Net less-than-significant impacts would occur at the 6,372-Ft Alternative; the 21% reduction in brown trout spawning habitat is minimized because spawning habitat is not limiting brown trout production in the Upper Owens River. Substantial decreases in instream flows, however, would cause significant adverse impacts to both brown and rainbow trout adult habitat at Mono Lake levels of 6,377 feet and higher, with impacts exacerbated as lake levels increase and Upper Owens River instream flows decline. In addition, water temperature increases and water quality degradation below the Hot Creek confluence become significant adverse factors at Mono Lake levels of 6,383.5 feet and higher, again with impacts exacerbated as lake levels increase and Upper Owens River instream flows decline. Mitigation measures are proposed to reduce these impacts to less-than-significant levels.

Lake Crowley reservoir fishery resources would experience slight improvements under the No-Restriction Alternative and less-than-significant impacts under all other alternatives. The alternatives have only slight effects on Lake Crowley reservoir surface area and water surface elevations.

Middle Owens River fishery resources would experience less-than-significant adverse effects with the No-Restriction Alternative and slight benefits under all other alternatives. Fry habitat is the primary limiting factor for brown trout production in the Middle Owens River, and fry habitat is stable over the range of alternatives. Brown trout spawning habitat and aquatic invertebrate habitat increase substantially for the 6,372-Ft Alternative and higher lake-level alternatives, but these factors are not considered to limit brown trout production in the Middle Owens River.

Pleasant Valley, Tinemaha, and Haiwee Reservoirs; the LA Aqueduct; and irrigation canal fishery resources would not experience any significant changes under any of the alternatives.

Cumulative Impacts

Significant cumulative impacts associated with all alternatives are:

- long-term and short-term LADWP operations on geomorphology and fish populations in Rush, Lee Vining, Parker, and Walker Creeks;
- effects of LADWP diversion facilities on gravel recruitment in Rush, Lee Vining, Parker, and Walker Creeks;
- effects of road crossing and LADWP diversion facilities on migrating trout populations in Rush, Lee Vining, Parker, and Walker Creeks; and
- effects of water diversions, impoundments, modified flow patterns, grazing, and competition from introduced species on Owens tui chub and Owens speckled dace in the Middle Owens River.

A significant cumulative impact associated with lake level alternatives from the 6,377-Ft Alternative to the No-Diversion Alternative is:

- reduced LADWP exports on fish populations in the Upper Owens River.

A significant cumulative benefit associated with the No-Restriction Alternative is:

- continued high LADWP exports on fish populations in the Upper Owens River.

All significant cumulative impacts can be reasonably mitigated with the exception of long-term LADWP operational effects in Rush, Lee Vining, Parker, and Walker Creeks, and the effects of multiple and interrelated factors on Owens tui chub and Owens speckled dace in the Middle Owens River.

IMPACTS AND MITIGATION MEASURES FOR THE NO-RESTRICTION ALTERNATIVE

Changes in Resource Condition

Rush Creek

Under the No-Restriction Alternative, aquatic habitat and fisheries resources would be eliminated or severely degraded relative to point-of-reference conditions. Diversions would dewater lower Rush Creek in all but the wettest years (highest 10% of flows) or during periods of high spring and summer runoff when Grant Lake releases exceed the diversion capacity or the reservoir spills (see Chapter 3A, "Hydrology"). Springs and irrigation return flow would maintain a small baseflow in Segment 5, but this flow would be insufficient to maintain fishery resources. The absence or severe reduction in aquatic habitat in most years under this alternative (Figures 3D-5 through 3D-8) is reflected in the 67-79% reductions in average WUA for brown trout spawning, fry, juvenile, and adult life stages relative to point-of-reference values (Tables 3D-9 through 3D-12).

Lee Vining Creek

Under the No-Restriction Alternative, aquatic habitat and fisheries resources would be eliminated or severely degraded relative to point-of-reference conditions. Diversions would dewater lower Lee Vining Creek in all but the wettest years (highest 10% flows) or during periods of high spring and summer runoff when flows exceed the diversion capacity (see Chapter 3A, "Hydrology"). The absence or severe reduction in aquatic habitat in most years (Figures 3D-9 through 3D-12) under this alternative is reflected in the 55-72% reductions in average WUA for brown trout spawning, fry, juvenile, and adult life stages relative to point-of-reference values (Tables 3D-13 through 3D-16).

Parker and Walker Creeks

The No-Restriction Alternative would not affect aquatic habitat conditions and fisheries resources in Parker and Walker Creeks relative to point-of-reference conditions. Parker and Walker Creeks were dry under 1989 point-of-reference conditions and would remain so under the No-Restriction Alternative (see Chapter 3A, "Hydrology").

Habitat impact analyses based on the Tennant Method indicate severe aquatic habitat conditions (Table 3D-17 and Appendix O, Table O-1); diversions of all Parker and Walker Creek flows to the Lee Vining conduit would severely degrade and eliminate aquatic habitat and resources downstream to their confluences with Rush Creek. Seasonal occurrences of irrigation releases or spills from the conduit dam would continue, but the intermittent nature of these flows would prevent the maintenance of aquatic habitat to sustain fisheries resources.

Grant Lake Reservoir

Reservoir Fluctuation. Under the No-Restriction Alternative, LAAMP-simulated reservoir levels indicate that brown trout redd inundation from increasing reservoir elevations during the spawning and egg incubation period (October-June) would not occur in dry water years; there would be no adverse effects on spawning success.

Under normal water year conditions, the No-Restriction Alternative would adversely affect brown trout spawning success in June because reservoir elevations would increase by 1 foot relative to point-of-reference conditions (Table 3D-18). Although this 1-foot increase in reservoir elevation would inundate approximately 167 feet of potential Rush Creek spawning habitat, impacts would be less than significant because the amount of potential spawning habitat that would be inundated represents only 3.2% of the total Rush Creek spawning habitat available to Grant Lake brown trout.

In wet water years, reservoir fluctuations during the spawning and egg incubation period would occur with greater frequency and magnitude relative to point-of-reference conditions. Brown trout spawning success would be adversely affected in all months that these fluctuations occurred, except for June, when fluctuations in reservoir elevations would be less than those occurring under point-of-reference conditions. These fluctuations would increase reservoir elevations relative to point-of-reference conditions by 1-6 feet and would cause an additional 167-916 feet of potential spawning habitat to be inundated.

Reservoir Productivity. Grant Lake reservoir operations under the No-Restriction Alternative would increase average monthly water surface elevations for the April-October period by 2 feet and cause average reservoir surface area to increase by approximately 15 acres relative to point-of-reference conditions (Table 3D-19). The No-Restriction Alternative would have slight beneficial effects on reservoir fish populations from increased reservoir surface area because reservoir surface area would increase only 1.7% relative to point-of-reference conditions.

Upper Owens River

Physical Habitat

Brown Trout. The No-Restriction Alternative would increase physical habitat available to adult brown trout by 6-7% in dry and normal water year types, and reduce the amount of habitat by 2% in wet years compared to point-of-reference levels (Table 3D-20). Brown trout spawning habitat would increase 14% in dry years, decrease by 6% in normal years, and decrease by 9% in wet years (Table 3D-

20). Consequently, the No-Restriction Alternative would have slight beneficial effects or less-than-significant adverse impacts on physical habitat.

Rainbow Trout. Changes in adult rainbow trout habitat would be less than 10% in dry, normal, and wet years (Table 3D-20). Spawning habitat would be nearly the same in dry years but would decrease by 9% in normal and wet years relative to point-of-reference levels (Table 3D-20). All impacts would be less than significant.

Water Temperature. Water temperature simulations indicate that average daily water temperatures along most of the Upper Owens River between East Portal and Lake Crowley reservoir can be kept below 68°F by maintaining summer flows below East Portal above 75-100 cfs, depending on the initial water temperature (EBASCO Environmental et al. 1993). At lower summer flows, exposure to suboptimum water temperatures would increase, particularly below Hot Creek where water temperatures are elevated by Hot Creek inflows. Flows above 75-100 cfs in the Owens River below East Portal would reduce critically high summer temperatures in this section of the river primarily in July and August (EBASCO Environmental et al. 1993).

The 68°F temperature level exceeds the maximum optimum temperature of 66°F identified for brown trout juveniles and adults by Raleigh et al. (1986), which served as a basis for evaluating temperature impacts in this EIR, and exceeds the maximum optimum temperature of 64°F reported for rainbow trout juveniles and adults (Raleigh et al. 1984). Consequently, temperature impacts based on these criteria would be somewhat greater than that based on the 68°F analysis. Nevertheless, recommended minimum summer flows of 75-100 cfs would maintain suitable water temperatures in the Upper Owens River downstream to Hot Creek and reduce the frequency and magnitude of stressful summer water temperatures below Hot Creek.

Under point-of-reference conditions, monthly Owens River flows below East Portal during June through September would nearly always exceed 75 cfs except in the driest years (lowest 10% flows during the 1940-1989 hydrologic period) (Jones & Stokes Associates 1993). Consequently, suitable summer water temperatures would occur most of the time, and trout would likely be subject to only short-term, localized stress in the reach below Hot Creek. Because the frequency of flows less than 75 cfs would be similar under the No-Restriction Alternative, no measurable temperature-related impacts on fish populations would occur.

Water Quality. Elevated concentrations of arsenic and other trace metals have been identified as a potential water quality problem in the Upper Owens River. Of the trace metals measured in 1991, only arsenic was detected at levels that could adversely affect aquatic life, although the degree of toxicity is unknown (EBASCO Environmental et al. 1993). Potentially harmful levels were measured in the segment below the confluence of Hot Creek, a major source of arsenic in the Upper Owens River basin.

Water diverted from Mono Basin improves water quality downstream of the Hot Creek confluence by diluting high concentrations of arsenic and other trace metals. Mineral concentrations are generally highest during periods of low flow or no Mono Basin diversions (EBASCO Environmental et al. 1993). Potential water quality benefits, therefore, would be expected as Mono Basin exports increase. Increased exports may also benefit aquatic production in the Upper Owens River by providing an additional source of nitrogen, which is known to limit algae growth in eastern Sierra Nevada streams (EBASCO Environmental et al. 1993). Mono Basin exports may adversely affect water quality by reducing hardness levels, thereby increasing the toxicity potential for trace metals like arsenic (EBASCO Environmental et al. 1993). The significance of these factors to aquatic production in the Upper Owens River is unknown.

Under point-of-reference conditions, concentrations of arsenic and other trace metals downstream of the Hot Creek confluence would be reduced substantially under relatively high Mono Basin exports. Water quality under the No-Restriction Alternative would be very similar to point-of-reference conditions.

Channel Morphology and Spawning Gravel Characteristics. Channel morphology of the Upper Owens River has changed in response to historical flow augmentation by Mono Basin exports, but the channel appears to have adjusted to the higher flow regime and there are no significant problems related to channel stability or flushing flows (EBASCO Environmental et al. 1993). Hydraulic and sediment transport studies on the Upper Owens River indicate that flows between 20 and 200 cfs (measured below East Portal) provide favorable conditions for maintaining gravel recruitment and spawning gravel quality while preventing the frequent occurrence of overbank flows that probably cause meander bend flooding, erosion, and cutoff, and associated losses of trout habitat (EBASCO Environmental et al. 1993).

Under the No-Restriction Alternative, minimum monthly flows would be within the optimum range of 20-200 cfs, but potential erosion-inducing flows exceeding 200 cfs would occur as much as 70% of the time in April during the 1940-1989 hydrologic period (see Chapter 3A, "Hydrology"). Because the flow regime would be similar to point-of-reference conditions, no significant impacts on channel and streambed conditions would occur under this alternative.

Fish Population Characteristics. Trout populations sampled in 1990 had been experiencing flows of about 40 cfs (combined Big Springs flow and East Portal tunnel accretion) over a 12-month period before sampling was conducted. Food availability, water temperature, water quality, and fishing pressure were not likely limiting trout populations in Segments 1 (Inaja site) and 2 (Hot Creek site) under these conditions, and trout biomass was likely a function of available habitat as indicated by positive correlations between adult trout biomass and weighted usable area. Spawning habitat in the Upper Owens River was sufficient to support existing spawning populations and was not considered limiting to trout production. (EBASCO Environmental et al. 1993.)

Past population surveys revealed that young-of-the-year trout abundance in the Upper Owens River is variable, indicating that recruitment may be influenced by habitat conditions (e.g., instream flows and water temperatures) during the spawning, incubation, and fry rearing periods. The Upper Owens River IFIM did not address trout fry (<2-inch trout) habitat requirements in the Upper Owens River (EBASCO

Environmental et al. 1993). However, potential limitations on available fry habitat imposed by higher flows may be similar to those described below for the Middle Owens River. Generally, reductions in fry habitat would be expected under the higher flow regimes associated with lower lake level alternatives. The importance of numerous secondary channels along the Upper Owens River in providing fry habitat at higher flows is unknown, but may be significant.

Brown and rainbow trout populations under the No-Restriction Alternative would experience a flow and temperature regime similar to that occurring under point-of-reference conditions. Because little change in physical habitat, water temperature, water quality, and food abundance would be expected, trout populations would not differ significantly under the No-Restriction Alternative.

Lake Crowley Reservoir

Lake Crowley reservoir operations under the No-Restriction Alternative would increase average monthly water surface elevations during the April-October period and cause average reservoir surface area to increase by approximately 33 acres (0.75%) relative to point-of-reference conditions (Table 3D-21). Similarly, average surface area for the November-March period would increase by approximately 52 acres (1.2%) compared to point-of-reference conditions (Table 3D-21). Greater reservoir surface areas would have slight beneficial effects on fish productivity in Lake Crowley reservoir. Compared to point-of-reference conditions, the No-Restriction Alternative would provide slightly better conditions for fish productivity because average monthly reservoir levels would be relatively stable and reservoir surface area would be slightly greater.

Middle Owens River

Physical Habitat

Brown Trout. Under the No-Restriction Alternative, physical habitat available to spawning, fry, juvenile, and adult brown trout would be nearly equal to point-of-reference levels (Figures 3D-13 through 3D-16); changes in average WUA for each life stage would be less than 3% (Tables 3D-22 through 3D-25). WUA values at individual spawning transects would also show little change (Table 3D-26).

Aquatic Invertebrates. Under the No-Restriction Alternative, aquatic invertebrate habitat would be reduced by 18% relative to point-of-reference levels (Figure 3D-17, Table 3D-27). Because of the generalized nature of the aquatic invertebrate habitat suitability criteria used in the Middle Owens River IFIM, this reduction is not considered to be significant.

Largemouth Bass. Higher spring and summer flows under the No-Restriction Alternative would significantly reduce largemouth bass spawning habitat relative to point-of-reference levels (Figures 3D-18 through 3D-21); average WUA would be reduced by 17% under this alternative (Tables 3D-28 through 3D-31). Little change in fry, juvenile, and adult habitat availability would occur.

Water Temperature. Middle Owens River flows would be at their lowest levels under the No-Diversion Alternative compared to other alternatives, which allow various levels of Mono Basin exports. Consequently, potential fisheries impacts related to high water temperatures would be greatest under the No-Diversion Alternative during the spring and summer months. Water temperature simulations for the No-Diversion Alternative indicated that maximum daily water temperatures would remain well below the upper tolerance limit for brown trout at Five Bridges Road during the spring and summer, peaking at 72°F for several days in August under the 20% flow (Figure 3D-22). Therefore, potential impacts over the range of alternatives would be minor as measured by the frequency (i.e., number of days) that mean daily water temperatures would exceed the optimum temperature range. Relative impacts for all other alternatives were determined from the water temperature simulations for the No-Diversion Alternative and the point-of-reference scenario (Tables 3D-32 and 3D-33).

Under point-of-reference conditions, mean daily water temperatures at Five Bridges Road would exceed the optimum range for brown trout for 2 days in April (based on fry criteria), 24 days in June (based on fry criteria), and 11 days in August (based on juvenile and adult criteria) (Tables 3D-32 and 3D-33). Under the No-Restriction Alternative, flows in the Middle Owens River would be slightly higher than those occurring under point-of-reference conditions, and optimum water temperatures would occur slightly more frequently. Based on the changes in the frequency of optimum and suboptimum temperatures with respect to flow (Tables 3D-32 and 3D-33), the difference in frequency would be minimal (1-2 days per month). In October, the frequency of water temperatures within the optimum range for brown trout spawning and incubation would be virtually unchanged (Table 3D-30). No measurable or significant impacts on brown trout reproduction, growth, or survival would occur.

Water temperatures would frequently fall below the reported optimum ranges for largemouth bass spawning, incubation, and growth during the spring and summer months. Over the range of alternatives represented by the No-Diversion Alternative and the point of reference, mean daily water temperatures near Big Pine Canal, even under the warmest weather conditions (August), would remain below the optimum range (Figure 3D-23). The frequency and magnitude of water temperatures under the No-Restriction Alternative would be similar to those under point-of-reference conditions.

Channel Morphology and Spawning Gravel Characteristics. Specific channel maintenance and flushing flows have not been identified for the Middle Owens River, but flows exceeding 600-800 cfs may cause excessive bank erosion. Sediment transport studies in Segments 1 and 2 of the Middle Owens River indicate that the primary source of coarse and fine sediment is the streambed and banks. The streambanks are likely the major sediment source at high flows (Hickson and Hecht 1992). Sediment transport rates increase sharply at flows above 600-800 cfs (Hickson and Hecht 1992). Flows of this magnitude may cause disproportionate bank erosion rates, potentially widening channels and degrading trout habitat quality through changes in channel form and loss of undercut banks and woody cover.

Under the No-Restriction Alternative, peak annual Pleasant Valley Reservoir releases in July would be similar in frequency and magnitude to point-of-reference conditions; mean monthly outflows above 600 cfs would occur in approximately 40% of the years under historical hydrologic conditions (see Chapter 3A, "Hydrology"). Consequently, channel and streambed conditions under the No-Restriction Alternative would be similar to those occurring under the point-of-reference conditions.

Fish Population Characteristics

Brown Trout. Under the No-Restriction Alternative, aquatic invertebrate habitat reductions may indirectly affect brown trout growth by potentially reducing food abundance. Potential effects include reduced growth of brown trout, especially for fry and juvenile brown trout, which rely to a greater extent on invertebrate prey than adult brown trout. This impact on the fish population is less than significant.

Largemouth Bass. The significant reduction in largemouth bass spawning habitat in Segment 4 could adversely affect reproductive success and recruitment if spawning habitat within the Middle Owens River channel is a limiting factor. Largemouth bass production, however, may be limited by water temperatures that are frequently lower than the reported optimal range for reproduction and growth throughout much of the Middle Owens River. Largemouth bass production may also largely depend on conditions outside the active channel, such as the extent and availability of backwater habitat (e.g., river oxbows) or littoral habitat in Tinemaha Reservoir. Given the uncertainty of largemouth bass population ecology and limiting factors in the Middle Owens River, the impact on largemouth bass populations is considered to be less than significant.

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

Pleasant Valley Reservoir operations under the No-Restriction Alternative would not affect reservoir volumes; reservoir volumes would remain relatively constant during each month. Impacts on fishery resources would not be expected to occur because the timing and magnitude of reservoir fluctuations and surface areas would not change relative to point-of-reference conditions.

Daily operation of Tinemaha and Haiwee Reservoirs would not be affected under the No-Restriction Alternative, and the timing and magnitude of reservoir fluctuations and reservoir surface area would not change relative to point-of-reference conditions. Fishery resources within these reservoirs would not be significantly affected.

Los Angeles Aqueduct and Irrigation Canals

Under the No-Restriction Alternative, exports to Los Angeles would increase slightly relative to point-of-reference conditions and would increase flows in the LA Aqueduct. Minor effects on fishery resources would likely occur because habitat conditions within the canal are less than optimal for most fish life stages and because LA Aqueduct flows would change slightly during the April-September period, when the effects on rearing fish would be the greatest (Los Angeles export targets are set at aqueduct capacity during the April-September period regardless of alternative).

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

Rush Creek

- Eliminates or severely degrades fish habitat and resources.

Mitigation Measures. Providing permanent and adequate flows necessary to maintain aquatic resources is infeasible under this alternative; the impact cannot be mitigated.

Lee Vining Creek

- Eliminates or severely degrades fish habitat and resources.

Mitigation Measures. Providing permanent and adequate flows necessary to maintain aquatic resources is infeasible under this alternative; the impact cannot be mitigated.

Parker and Walker Creeks

- Continues to severely degrade fish habitat conditions. Point-of-reference dewatered conditions would prevail.

Mitigation Measures. None are required because no additional impacts would occur over point-of-reference conditions.

Upper Owens River

- # Maintains brown and rainbow trout adult and spawning habitat.
- # Maintains water temperature, water quality, channel, and streambed conditions.
- # Maintains fish populations.

Grant Lake Reservoir

- # Reduces brown trout spawning success by increasing lake level fluctuations (generally 0-9%).

- # Slightly increases fish productivity (2% increase in reservoir surface area).

Lake Crowley Reservoir

- # Slightly increases fish productivity (less than 2% increase in reservoir surface area).

Middle Owens River

- # Maintains brown trout physical habitat similar to point-of-reference conditions.

- # Reduces aquatic invertebrate habitat but at a less-than-significant level (-18%).

- # Significantly reduces largemouth bass spawning habitat (-17%), but not to a level limiting bass population.

Mitigation Measures. Mitigation measures are not required because largemouth bass production is likely limited by low water temperatures throughout much of the Middle Owens River and spawning may be partially or primarily dependent on habitats outside the main channel.

- # Causes no measurable temperature-related changes in fish populations.

- # Maintains channel and streambed conditions similar to point-of-reference conditions.

- # Potentially reduces brown trout growth, but not significantly, because of decreased aquatic invertebrate habitat and production.

- # Adversely affects largemouth bass production by reducing spawning habitat, but population limited by low water temperatures and conditions outside main channel, so effect is less than significant.

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

- # Causes no significant changes in fish productivity.

Los Angeles Aqueduct and Irrigation Canals

- # Causes no significant changes in fish habitat.

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

Changes in Resource Condition

Rush Creek

Physical Habitat. Higher flows in lower Rush Creek under the 6,372-Ft Alternative would significantly increase the amount of physical habitat for brown trout spawning, juvenile, and adult life stages and significantly reduce the amount of fry habitat relative to point-of-reference levels (Figures 3D-5 through 3D-8). Average WUA for brown trout spawning, juvenile, and adult life stages would be increased by 69%, 22%, and 16%, respectively, while fry WUA would be reduced by 20% (Tables 3D-9 through 3D-12).

Water Temperature. Compared to point-of-reference conditions, higher summer flows under the 6,372-Ft Alternative would maintain lower summer water temperatures and prevent water temperatures from exceeding the upper tolerance limit for brown trout. Potential benefits include reduced exposure to near-lethal water temperatures, although measurable increases in survival and growth are not likely.

Channel Morphology and Spawning Gravel Characteristics. Sediment transport modeling (Beak Consultants 1991) indicates that flows exceeding 60 cfs in lower Rush Creek would potentially cause uncompensated losses of spawning gravel in Segments 2 and 3, and flows exceeding 100 cfs would likely induce streambank erosion and channel meandering in Segments 5 and 6 where the Rush Creek channel is unstable and subject to continued habitat degradation associated with high flow events; 100 cfs was recommended as an upper flow limit under normal and wet hydrologic conditions and in association with gravel augmentation measures (Gibbons pers. comm.). It should be noted, however, that this recommendation did not consider inflows from Parker and Walker Creeks.

Under existing channel conditions, a flow of 100 cfs is a minimum threshold for mobilizing spawning-size substrate in Segments 5 and 6, although periodic events of higher magnitude appear to be needed to loosen cemented gravels or expose uncompacted gravels suitable for spawning. Spawning gravel surveys conducted in April 1987 indicated that most gravel accumulations in lower Rush Creek were cemented and unsuitable for spawning and that brown trout redds were limited to small pockets of uncompacted gravels (EA Engineering, Science, and Technology 1990c). The cemented condition of the gravels was identified as a possible mechanism reducing juvenile brown trout recruitment in five of six year classes monitored from 1985 through 1990. Flows as high as 250 cfs may also benefit channel building processes in Segment 5 (Trihey pers. comm.).

Under point-of-reference conditions, average monthly flows in July would exceed 100 cfs in roughly 30% of the years under historical hydrologic conditions; average monthly flows of 250 cfs or greater would occur in wet years only (highest 20% flows) (see Chapter 3A, "Hydrology"). July flows under the 6,372-Ft Alternative would exceed 100 cfs only in the wettest years (highest 10% flows), and flows of 250 cfs or greater would occur less frequently. This is considered a short-term benefit because it would reduce erosion impacts and facilitate habitat restoration efforts in Segments 5 and 6. Over the long term, however, the reduced frequency of channel maintenance and flushing flows would degrade spawning gravel quality and overall habitat conditions.

Fish Population Characteristics. Under the 6,372-Ft Alternative, juvenile brown trout abundance in lower Rush Creek would potentially increase in response to additional spawning and rearing habitat, relative to point-of-reference conditions. Fry habitat reductions would not affect brown trout production because available fry habitat appears sufficient to accommodate potential increases in recruitment resulting from additional spawning habitat. However, the gradual reduction in spawning gravel quality associated with infrequent flushing flows may reduce the benefits of increased spawning habitat by reducing overall spawning success. In addition, adult brown trout abundance may continue to be limited by the extent of pool habitat with woody cover, despite flow-related increases in available habitat; significant positive relationships were found between catchable trout (greater than 8 inches long) abundance and the amount of pool habitat with woody cover in lower Rush Creek from 1985 to 1990 (EA Engineering, Science, and Technology 1991).

A dramatic decrease in brown trout growth rates during a period of increased brown trout abundance suggested that competition for food may limit brown trout production in lower Rush Creek (EA Engineering, Science, and Technology 1991). Under the 6,372-Ft Alternative, increased physical habitat may reduce competition during years of high population densities.

Lee Vining Creek

Physical Habitat. Higher flows under the 6,372-Ft Alternative would significantly increase physical habitat for brown trout spawning, juvenile, and adult life stages relative to point-of-reference conditions (Figures 3D-9 through 3D-12). Average WUA (Segments 3, 5, and 6 combined) for spawning, juvenile, and adult life stages would increase by 209%, 61%, and 91%, respectively (Tables 3D-13 through 3D-16). Higher winter flows would provide additional winter habitat relative to the point-of-reference flow of 5 cfs.

Mean monthly flows during October and November would be near optimum for brown trout spawning in Segment 2, and flows from October through June would maintain suitable incubation conditions. The 13% reduction in fry habitat associated with higher spring and summer flows is not considered significant because fry habitat would remain abundant relative to the amount of available spawning habitat.

Water Temperature and Icing. Under the 6,372-Ft Alternative, summer water temperatures in lower Lee Vining Creek would remain within the optimum range for brown trout, and no measurable benefits or adverse impacts would occur relative to point-of-reference conditions; the 5-cfs point-of-reference flow maintains optimum water temperatures throughout most of the affected reach even under extreme summer weather conditions (Aquatic Systems Research 1992).

Stable winter flows of about 19 cfs under the 6,372-Ft Alternative fall within the flow range (15-20 cfs) recommended to avoid potential risks to aquatic fauna associated with anchor ice formation and ice dislodging (Aquatic Systems Research 1992). No information is available to determine differences in trout mortality that may occur at winter flows of 19 cfs compared with 5 cfs.

Channel Morphology and Spawning Gravel Characteristics. Bed material transport was observed in lower Lee Vining Creek following sluicing activities at the LADWP diversion dam that caused a sudden flow increase from about 58 to 112 cfs in May 1990, although such flows were not of sufficient magnitude or duration to effectively transport large quantities of entrained sand (Aquatic Systems Research 1992). Partial gravel mobility was also observed following experimental flow releases attaining an instantaneous maximum of 179 cfs and a daily mean of 164 cfs during a 19-day period in June 1991 (Aquatic Systems Research 1992). Aquatic Systems Research (1992) recommended a channel maintenance flow of 160 cfs for 30 days in wet years (highest 20% flows) and 160 cfs for 3 days in normal and dry years.

Average monthly flows in lower Lee Vining Creek under point-of-reference conditions would equal or exceed 160 cfs in June or July in 30% of the years, but such flows would occur only in extremely wet years (highest 10% flows) under the 6,372-Ft Alternative (see Chapter 3A, "Hydrology"). This is considered a short-term benefit under existing channel conditions because high flows would potentially disrupt or reverse the progress of habitat restoration efforts in Segments 5 and 6 and cause adverse impacts on the brown trout population. Over the long term, however, the reduced frequency of channel maintenance and flushing flows would degrade spawning gravel quality and overall habitat conditions.

Fish Population Characteristics. Increases in spawning, juvenile, and adult brown trout habitat under the 6,372-Ft Alternative would be expected to increase brown trout populations above levels that would occur under point-of-reference conditions. Specific benefits associated with increased spawning habitat availability in Segment 2, however, would likely be limited over time by infrequent channel maintenance and flushing flows.

Parker and Walker Creeks

Under the 6,372-Ft Alternative, Parker and Walker Creeks would be rewatered, and flows necessary to maintain aquatic habitat and resources would be restored. Permanent and continuous flows would be maintained throughout the year, and average monthly flows would be nearly identical during all water-year types (see Chapter 3A, "Hydrology"). Habitat impact analyses based on the Tennant Method indicate overall good aquatic habitat conditions (Table 3D-17) with poor habitat conditions occurring in April and September of all water-year types (Appendix O, Table O-1). Water temperatures in Parker and Walker Creeks would primarily fall within the optimum temperature range for brown trout of 54-56ºF (Raleigh et al. 1986), based on 1991 data (EBASCO Environmental and Water Engineering and Technology 1991b, 1991c).

Restoring permanent flows to Parker and Walker Creeks under this alternative would promote the natural recolonization of these creeks by wild brown trout and the long-term maintenance of the fishery through natural production or hatchery stocking. The 6,372-Ft Alternative would provide flow regimes in Parker and Walker Creeks similar to flow regimes occurring since rewatering of these streams in October 1990. Brown trout have been successfully planted in the two creeks since rewatering, but the specific fish population levels that will be maintained under the current conditions or under the 6,372-Ft Alternative are unknown.

Recommended flushing flows for Parker and Walker Creeks are 25.2 and 15 cfs, respectively, using the Tennant Method, 23 and 15 cfs using court-ordered flows, and 25-40 and 15-30 cfs using DFG recommendations (EBASCO Environmental and Water Engineering and Technology 1991b, 1991c). None of these flushing flows would be achieved under this alternative in any water years. Without appropriate flushing flows, the improved habitat conditions predicted for Parker and Walker Creeks under the 6,372-Ft Alternative would be reduced over time, primarily by increased sediment deposition and gravel cementation. Despite reduced habitat quality over time, aquatic habitat conditions would nonetheless benefit significantly under the 6,372-Ft Alternative when compared to point-of-reference conditions.

Grant Lake Reservoir

Reservoir Fluctuations. The 6,372-Ft Alternative would not adversely affect brown trout spawning success relative to point-of-reference conditions under any water year. Under wet water years, spawning success would improve relative to point-of-reference conditions because the magnitude of fluctuations in reservoir elevation during the spawning and egg incubation period would be reduced (Table 3D-18). Under normal and dry water years, the 6,372-Ft Alternative would not increase Grant Lake reservoir elevations in any of the months during the spawning and egg incubation period relative to point-of-reference conditions (Table 3D-18) and would have no impact on brown trout spawning success.

Reservoir Productivity. Grant Lake reservoir operations under the conditions of the 6,372-Ft Alternative would decrease average monthly water surface elevations for the April-October period by 4 feet and decrease average monthly reservoir surface area by approximately 55 acres relative to point-of-reference conditions (Table 3D-19). Impacts would be less than significant because reservoir surface area would decrease by only 6.2% relative to point-of-reference conditions. The 6,372-Ft Alternative would provide slightly worse conditions for fish productivity than the No-Restriction Alternative.

Upper Owens River

Physical Habitat

Brown Trout. Under the 6,372-Ft Alternative, brown trout adult habitat would be reduced 14% in dry years, but exhibit negligible change in normal and wet years relative to point-of-reference levels (Table 3D-20). Brown trout spawning habitat would be reduced by 5% in normal years, 14% in dry years, and 44% in wet years (Table 3D-20). Impacts on adult brown trout habitat during dry years and spawning habitat in dry and wet years are considered significant adverse impacts.

Rainbow Trout. Adult rainbow trout habitat would be reduced by 13% in dry years but would exhibit negligible change in normal and wet years relative to point-of-reference levels (Table 3D-20). Rainbow trout spawning habitat would increase 5% in dry years, 12% in normal years, and 15% in wet years (Table 3D-20). The overall effect of the 6,372-Ft Alternative on adult rainbow trout habitat in dry years would be significant.

Water Temperature. Under the 6,372-Ft Alternative, flows less than 75 cfs during June through September would be limited to dry years only but would include flows as low as 32 cfs in July (see Chapter 3A, "Hydrology"). Additional temperature impacts would occur at this flow, particularly in Segment 3 below Hot Creek, but significant fisheries impacts relative to point-of-reference conditions are not expected because of the relatively rare occurrence and short duration of low flows.

Water Quality. Water quality conditions under the 6,372-Ft Alternative would be degraded relative to point-of-reference conditions, but would likely not significantly affect fishery resources, although definitive information is lacking. Mono Basin exports would be reduced relative to point-of-reference conditions but would continue to augment natural flows and reduce elevated concentrations of arsenic and other trace metals in many years, particularly below Hot Creek (Segment 3). Water quality impacts would probably be limited to dry years and therefore would not cause significant long-term fisheries impacts relative to point-of-reference conditions.

Channel Morphology and Spawning Gravel Characteristics. Channel and streambed conditions under the 6,372-Ft Alternative would be similar to those occurring under the No-Restriction Alternative.

Fish Population Characteristics. Under the 6,372-Ft Alternative, brown and rainbow trout adult populations would not change significantly relative to point-of-reference levels. Significant reductions in adult trout habitat in dry years and associated high water temperatures may periodically reduce adult trout abundance, but significant long-term effects on the populations are unlikely. Significant changes in the amount of available brown and rainbow trout spawning habitat under this alternative would probably have no significant effects on trout populations because spawning habitat does not appear to be limiting trout production in the Upper Owens River. Higher fall flows in wet years, however, would reduce brown trout spawning habitat by 44%, which may be sufficient to significantly reduce brown trout production in these years. Impacts of this magnitude, however, would be limited to wet years and would not likely cause significant long-term reductions in trout populations.

Lake Crowley Reservoir

Changes in lake productivity associated with the 6,372-Ft Alternative would be nearly identical to those associated with the No-Restriction Alternative, except that reservoir surface area during the November-March period would be slightly lower than reservoir surface area under the No-Restriction Alternative (Table 3D-21). Fish productivity would benefit slightly under the 6,372-Ft Alternative relative to point-of-reference conditions.

Middle Owens River

Physical Habitat

Brown Trout. Under the 6,372-Ft Alternative, the amount of physical habitat available to spawning, fry, juvenile, and adult brown trout would not change significantly from point-of-reference levels (Figures 3D-13 through 3D-16). Increases in average WUA ranged from 1% for fry habitat to 8% for spawning habitat (Tables 3D-22 through 3D-25). Changes in WUA at individual spawning transects ranged from a 10% decrease to a 4% increase (Table 3D-26).

Aquatic Invertebrates. Aquatic invertebrate habitat available under the 6,372-Ft Alternative would be substantially increased (36%) over point-of-reference conditions (Figure 3D-17, Table 3D-27).

Largemouth Bass. Reduced spring and summer flows under the 6,372-Ft Alternative would significantly increase (34%) largemouth bass spawning habitat over point-of-reference conditions (Figure 3D-17, Table 3D-28). Little change in fry, juvenile, and adult habitat availability would occur.

Water Temperature. Water temperatures under the 6,372-Ft Alternative would be similar in frequency and magnitude to those occurring under point-of-reference conditions.

Channel Morphology and Spawning Gravel Characteristics. Channel and streambed conditions under the 6,372-Ft Alternative would be similar to those occurring under point-of-reference conditions.

Fish Population Characteristics

Brown Trout. Increased aquatic invertebrate habitat under the 6,372-Ft Alternative may indirectly affect the brown trout population by potentially increasing food abundance. Potential effects include increased growth of brown trout, with fry and juvenile brown trout receiving the greatest potential benefit. Food, however, is not considered a major limiting factor over the range of alternatives.

Largemouth Bass. A substantial increase in largemouth bass spawning habitat in Segment 4 would potentially improve reproductive success and recruitment if spawning habitat in the main channel is in limited supply. As discussed earlier, largemouth bass production in the Middle Owens River is probably limited by low water temperatures throughout much of its length, and populations may largely depend on conditions outside the main river channel.

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

Impacts on fishery resources under the 6,372-Ft Alternative would be the same as those described above under the No-Restriction Alternative.

Los Angeles Aqueduct and Irrigation Canals

Under the 6,372-Ft Alternative, exports to Los Angeles would be slightly reduced relative to point-of-reference conditions, resulting in slightly reduced flows in the LA Aqueduct. Less-than-significant effects on fishery resources would be expected because little change in LA Aqueduct flows is expected during the April-September period, when impacts on rearing fish would be the greatest (Los Angeles export targets would be set at aqueduct capacity during the April-September period).

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

Rush Creek

Creates additional brown trout spawning (69%), juvenile (22%), and adult (16%) physical habitat.

Reduces exposure to near-lethal water temperatures.

Reduces impacts on bank stability and habitat restoration, but degrades aquatic habitat and spawning gravel quality over time.

Mitigation Measures. Mitigation measures include periodic scarification of existing streambed gravels or adding spawning gravel of appropriate size and quantity. A fisheries biologist should be consulted to identify treatment areas, methods, and schedules for gravel scarification or placement. Surveys of brown trout redd distribution and spawning gravel quality should be continued to assess spawning conditions. With increases in bank stability in the future, the frequency of channel maintenance and flushing flows should be increased to maintain overall aquatic habitat conditions. The need for scarification or adding spawning gravel to the stream should be reevaluated at that time. These mitigation measures should be coordinated and integrated with current or proposed habitat restoration efforts.

Increases brown trout abundance and biomass (although populations are still limited by lack of suitable cover) and reduces spawning gravel quality over time.

Lee Vining Creek

Substantially increases brown trout spawning (209%), juvenile (61%), and adult (91%) physical habitat.

Causes no changes in water temperature and ice-related risks relative to point-of-reference conditions.

Reduces impacts on habitat restoration efforts, but degrades aquatic habitat and spawning gravel quality over time.

Mitigation Measures. Mitigation measures would be identical to those specified for Rush Creek under this alternative.

Increases brown trout abundance and biomass (although populations are still limited by lack of suitable cover) and reduces spawning gravel quality over time.

Parker and Walker Creeks

Creates good fish habitat that would be gradually degraded without flushing flows.

Mitigation Measures. Providing adequate flushing flows is infeasible under this alternative. Adding gravel to the stream periodically would be unsuccessful mitigation because flows would remain inadequate to distribute gravels throughout Parker and Walker Creeks. Aquatic invertebrate habitat and overall fisheries habitat would continue to decline over time.

Grant Lake Reservoir

Improves brown trout spawning success by decreasing lake level fluctuations.
Reduces fish productivity (7% decrease in reservoir surface area).

Upper Owens River

Significantly reduces brown trout adult habitat in dry years (-14%) and spawning habitat in dry (-14%) and wet (-44%) years.

Mitigation Measures. Mitigation measures are not required because habitat changes are not expected to cause significant long-term reductions in trout populations.

Significantly reduces rainbow trout adult habitat in dry years (-13%), and increases spawning habitat in normal (12%) and wet (15%) years.

Mitigation Measures. Mitigation measures are not required because habitat changes are not expected to cause significant long-term reductions in trout populations.

Adversely affects water temperature conditions in dry years, but impacts on fisheries production considered to be less than significant.

Degrades water quality conditions in dry years, but impacts on fisheries production considered less than significant.

Maintains channel and streambed conditions.

Periodically reduces fish populations but impacts considered less than significant.

Lake Crowley Reservoir

Slightly reduces fish productivity (less than 1%).

Middle Owens River

Causes no significant change in brown trout spawning, fry, juvenile, and adult habitat from point-of-reference levels.

Increases aquatic invertebrate habitat (36%).

Increases largemouth bass spawning habitat (34%) but spawning habitat is not a limiting factor.

Causes no measurable temperature-related effects on fish populations.

Causes channel and streambed conditions similar to those under point-of-reference conditions.

Potentially improves brown trout growth by increasing aquatic invertebrate production.

Maintains largemouth bass population.

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

Causes no significant changes in fish productivity.

Los Angeles Aqueduct and Irrigation Canals

Reduces fisheries habitat by less-than-significant levels.

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

Changes in Resource Conditions

Rush Creek

Physical Habitat. Average monthly flows in lower Rush Creek under the 6,377-Ft Alternative would be nearly identical in magnitude and frequency to flows under the 6,372-Ft Alternative except for higher June flows (see Chapter 3A, "Hydrology"). Based on WUA predictions, physical habitat would increase for spawning (73%), juvenile (23%), and adult (17%) brown trout relative to point-of-reference levels and would be nearly equal to that occurring under the 6,372-Ft Alternative (Tables 3D-9 through 3D-12, Figures 3D-5 through 3D-8). Fry habitat would increase relative to the 6,372-Ft Alternative (10%) but still would be less than that available under point-of-reference conditions (-12%).

Water Temperature. Water temperatures under the 6,377-Ft Alternative would be nearly identical in magnitude and frequency to temperatures under the 6,372-Ft Alternative except for cooler temperatures associated with higher June flows. Like the 6,372-Ft Alternative, the 6,377-Ft Alternative would provide higher summer flows and more favorable water temperatures relative to point-of-reference conditions.

Channel Morphology and Spawning Gravel Characteristics. Under the 6,377-Ft Alternative, peak average monthly flows would exceed 100 cfs in about 80% of the years compared with the 30% frequency under point-of-reference conditions (see Chapter 3A, "Hydrology"). Consequently, the frequency of events causing streambank erosion and channel meandering in Segment 6 and spawning gravel losses in Segments 2 and 3 would be substantially increased relative to point-of-reference conditions. In addition, progress toward achieving habitat restoration objectives in Segment 6 would be reduced under this flow regime. Flows equal to or exceeding 250 cfs would occur with the same frequency as under the 6,372-Ft Alternative.

Fish Population Characteristics. Brown trout populations would likely be similar to those occurring under the 6,372-Ft Alternative (see page 3D-58). Adverse impacts on brown trout fry and juveniles from flows exceeding 100 cfs have not been documented, although high flows averaging 261 cfs from March to August 1986 and 100-110 cfs from September 1989 to August 1990 did not affect survival or growth of trout up to 2 years old relative to survival and growth of these age classes during nearly constant 19-cfs releases (EA Engineering, Science, and Technology 1991).

Lee Vining Creek

Physical Habitat. Average monthly flows in lower Lee Vining Creek under the 6,377-Ft Alternative would be nearly identical in magnitude and frequency to flows under the 6,372-Ft Alternative except for higher June flows. Habitat availability under the 6,377-Ft Alternative would be significantly greater than point-of-reference levels for spawning (218%), juvenile (62%), and adult (93%) brown trout lifestages and would be similar to that under the 6,372-Ft Alternative (Tables 3D-13 through 3D-16, Figures 3D-9 through 3D-12).

Water Temperature and Icing. Water temperatures under the 6,377-Ft Alternative would be nearly identical in magnitude and frequency to temperatures under the 6,372-Ft Alternative except for slightly cooler temperatures associated with higher June flows. Relative to point-of-reference conditions, no measurable changes in growth would be expected based solely on water temperature effects. Potential risks related to winter ice formation would not change relative to point-of-reference conditions.

Channel Morphology and Spawning Gravel Characteristics. Under the 6,377-Ft Alternative, the frequency of channel maintenance and flushing flows would be significantly increased relative to the 6,372-Ft Alternative and point-of-reference conditions. Average June flows equal to or exceeding 160 cfs would occur in 60% of the years compared with less than 10% of the years under the 6,372-Ft Alternative and 30% of the years under point-of-reference conditions (see Chapter 3A, "Hydrology"). Aquatic habitat and spawning gravel quality would be improved in many years relative to these alternatives, but frequent high flows would adversely affect habitat restoration efforts and gradually reduce available spawning gravels from Segment 2 because gravels from upstream sources would be trapped by the LADWP diversion dam. Significant impacts on spawning and habitat restoration would occur.

Fish Population Characteristics. Brown trout are susceptible to downstream displacement and higher mortality rates during periods of high flow because of limited refuge habitat in lower Lee Vining Creek (EA Engineering, Science, and Technology 1990b; Aquatic Systems Research 1992). Significant numbers of dead or stressed trout with signs of physical injury were observed following a series of rapid flow fluctuations (from near 0 cfs to 112 cfs) associated with sluicing operations at the LADWP diversion dam in May 1990 (Aquatic Systems Research 1992). Additional downstream displacement of trout may have occurred during releases of 115-203 cfs in June 1991, although no direct losses were observed. All brown trout life stages within the lower reaches below Highway 120 (Segments 3-6) are vulnerable to being washed downstream or into Mono Lake during high spring flows because of a lack of adequate refuge habitat (Aquatic Systems Research 1992).

Under the 6,377-Ft Alternative, frequent spring flows exceeding 100 cfs would significantly increase the incidence of downstream displacement of brown trout fry, juveniles, and adults relative to point-of-reference conditions. In many years, significant numbers of trout may be displaced downstream from the major trout production area (Segment 2) to lower reaches (Segments 3-6) where production is currently limited by a scarcity of suitable adult habitat and spawning gravel. The loss of trout from Segment 2 to downstream reaches or Mono Lake would adversely affect the brown trout population in many years despite increases in available habitat under this alternative.

Parker and Walker Creeks

Average monthly flows in Parker and Walker Creeks under the 6,377-Ft Alternative would be identical in magnitude and frequency to flows under the 6,372-Ft Alternative except for the occurrence of higher flows in June (see Chapter 3A, "Hydrology"). These higher June flows reduce habitat quality in both creeks slightly, with habitat conditions remaining as good in Parker Creek but being reduced to the fair rating in wet and normal years in Walker Creek (Table 3D-17). Similar to the 6,372-Ft Alternative, the 6,377-Ft Alternative would substantially benefit aquatic habitats and resources over the severely degraded conditions present at the point of reference.

In approximately 2 of every 3 years, the 6,377-Ft Alternative would exceed Tennant's recommended flushing and channel maintenance flow requirement during June. Consequently, habitat conditions would not be reduced over time under the 6,377-Ft Alternative and would therefore provide better overall aquatic habitat conditions than would the 6,370-Ft Alternative, which would not meet flushing flow requirements.

Grant Lake Reservoir

Reservoir Fluctuations. Changes in spawning success associated with the 6,377-Ft Alternative would be nearly identical to those associated with the 6,372-Ft Alternative (see page 3D-60). Compared to the 6,372-Ft Alternative, the 6,377-Ft Alternative would have slightly greater beneficial effects on brown trout spawning success during normal and wet water years (Table 3D-18).

Reservoir Productivity. Operation of Grant Lake reservoir under the conditions of the 6,377-Ft Alternative would decrease average monthly water surface elevations for the April-October period by 5 feet and cause average monthly reservoir surface area to decrease by approximately 77 acres, relative to point-of-reference conditions (Table 3D-19). Impacts on fish productivity would be less than significant because reservoir surface area would decrease by only 9% relative to point-of-reference conditions.

Upper Owens River

Physical Habitat

Brown Trout. Under the 6,377-Ft Alternative, brown trout adult habitat would be reduced 28% in dry years and 10% in normal years and would exhibit negligible change in wet years relative to point-of-reference levels (Table 3D-20). Brown trout spawning habitat would be reduced 19% in dry years, 6% in normal years, and 20% in wet years (Table 3D-20).

Rainbow Trout. Adult rainbow trout habitat would be reduced 26% in dry years and 10% in dry years and would exhibit negligible change in wet years relative to point-of-reference levels (Table 3D-20). Rainbow trout spawning habitat would increase 3% in dry years, 19% in normal years, and 18% in wet years (Table 3D-20).

Water Temperature. Under the 6,377-Ft Alternative, monthly flows less than 75 cfs during June through September would occur more frequently than under point-of-reference or the 6,372-Ft Alternative conditions but would still be limited to dry years (lowest 20% flows) (see Chapter 3A, "Hydrology"). Temperature impacts would be similar to those under the 6,372-Ft Alternative.

Water Quality. Under the 6,377-Ft Alternative, potential water quality impacts would be similar to those under the 6372-Ft Alternative (see page 3D-61).

Channel Morphology and Spawning Gravel Characteristics. Under the 6,377-Ft Alternative, monthly flows exceeding 200 cfs would occur 50% of the time (July) compared to 80% of the time (April) under point-of-reference conditions (see Chapter 3A, "Hydrology). The frequency of overbank flows and potential erosion impacts would decrease accordingly. Potential habitat degradation would be avoided in some years, but general channel and substrate conditions would not change significantly.

Fish Population Characteristics. Under the 6,377-Ft Alternative, brown and rainbow trout adult populations may be reduced significantly in response to significant reductions in adult brown trout and rainbow trout habitat in dry and normal water years (Table 3D-20). Significant changes in the amount of available brown and rainbow trout spawning habitat under this alternative would probably have no significant effects on trout populations because spawning habitat does not appear to be limiting production in the Upper Owens River.

Lake Crowley Reservoir

Operation of Lake Crowley reservoir under the conditions of the 6,377-Ft Alternative would decrease average monthly water surface elevations during the April-October period and cause average reservoir surface area to decrease by approximately 33 acres (less than 1%) relative to the point of reference (Table 3D-21). Similarly, average surface area during the November-March period would decrease by approximately 21 acres (less than 1%) compared to the point of reference (Table 3D-21). No significant impacts on fish productivity would occur under the 6,377-Ft Alternative because surface areas would be reduced by less than 1% relative to the point of reference. The 6,377-Ft Alternative would slightly reduce fish productivity in Lake Crowley reservoir compared to the alternatives discussed earlier.

Middle Owens River

Physical Habitat

Brown Trout. The 6,377-Ft Alternative would significantly increase overall brown trout spawning habitat in Segments 1-3 relative to the point-of-reference level (Figures 3D-13 through 3D-16). Average spawning WUA increased from 7% in Segment 1 to 18% in Segment 2 (Tables 3D-22 through 3D-25). Changes in WUA at individual spawning transects ranged from a 12% reduction to a 6% increase (Table 3D-26).

Aquatic Invertebrates. Aquatic invertebrate habitat under the 6,377-Ft Alternative would be increased relative to the 6,372-Ft Alternative (Figure 3D-17). Average WUA would be substantially greater (53%) than the point-of-reference level (Table 3D-27).

Largemouth Bass. A further reduction in spring and summer flows under the 6,377-Ft Alternative would increase largemouth bass spawning habitat relative to the 6,372-Ft Alternative (Figures 3D-18 through 3D-21); average spawning WUA would be increased substantially (53%) relative to the point-of-reference level (Table 3D-28). Little change in fry, juvenile, and adult habitat availability would occur.

Water Temperature. Under the 6,377-Ft Alternative, lower flows would result in a maximum of 2-3 additional days per month (June and August) in which the mean daily water temperature at Five

Bridges Road would exceed the optimum range for brown trout relative to the 6,372-Ft Alternative (see page 3D-62). Maximum daily water temperatures would remain below 72°F throughout the summer. In October, the number of days with mean daily water temperatures within the optimum range for brown trout spawning and incubation would be increased by 1-2 days. No measurable impacts on brown trout reproduction, growth, or survival would be expected from these small changes.

Lower flows in Segment 4 would slightly improve water temperatures for largemouth bass production relative to point-of-reference conditions, but the changes in frequency and magnitude of water temperatures would not be sufficient to provide measurable benefits.

Channel Morphology and Spawning Gravel Characteristics. Channel and streambed conditions under the 6,377-Ft Alternative would be similar to those occurring under point-of-reference conditions.

Fish Population Characteristics

Brown Trout. Potential changes in the brown trout population would be similar to those described for the 6,372-Ft Alternative (see page 3D-63).

Largemouth Bass. Potential changes in the largemouth bass population would be similar to those described for the 6,372-Ft Alternative (see page 3D-63).

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

Impacts on fishery resources under the 6,377-Ft Alternative would be the same as those described above under the No-Restriction Alternative (see page 3D-54).

Los Angeles Aqueduct and Irrigation Canals

Impacts on fishery resources under the 6,377-Ft Alternative would be similar to those under the 6,372-Ft Alternative (see page 3D-63).

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

Rush Creek

- Causes resource changes similar to those of the 6,372-Ft Alternative (see page 3D-63), except for increased streambank erosion, habitat restoration impacts, and spawning gravel losses.

Mitigation Measures. The frequency of flows exceeding 100 cfs in June should be reduced by increasing diversions and limiting flows to a maximum of 80 cfs, as measured at Mono Gate #1, except in years when the need for a flushing and channel maintenance flow is identified. The 80-cfs recommendation considers expected Parker and Walker Creek inflows, which were not considered in DFG's 100 cfs recommendation. Spawning gravels should be added periodically to Segments 2 and 3 to offset gravel losses. The quantities, locations, and timing of spawning gravel placement should be determined by a fisheries biologist.

Proposed habitat restoration work in lower Rush Creek includes the use of current deflectors, woody debris, and vegetation to protect and stabilize eroding streambanks and the use of diversions and secondary channels to limit the effect of high flows on unstable channel reaches (Trihey & Associates 1991). These measures are consistent with the mitigation requirements for protecting Segment 6 from increased erosion, but reducing the frequency of high flows under this alternative is critical for the short-term and long-term success of habitat restoration efforts.

Lee Vining Creek

- Increases brown trout spawning (218%), juvenile (62%), and adult (93%) physical habitat.

- Causes no significant changes in water temperature and ice-related effects on fisheries resources.

- Improves aquatic habitat and spawning gravel quality, but increases spawning gravel losses from Segment 2 and increases adverse impacts on habitat restoration.

Mitigation Measures. Habitat restoration impacts should be minimized by limiting peak flows to 100 cfs and determining the need for channel maintenance and flushing flows through periodic spawning gravel surveys. This mitigation measure would reduce the loss of gravels from Segment 2, although continued gravel replenishment may be necessary. Spawning gravel surveys should be continued to monitor gravel quality, quantity, and distribution in the affected reaches. If additional spawning gravel is needed, the quantities, locations, and timing of gravel placement should be determined by a fisheries biologist.

- Reduces brown trout abundance and biomass through downstream displacement and loss of trout from major spawning area.

Mitigation Measures. Recommended mitigation is to reduce the frequency, magnitude, and duration of high spring and summer flows by exporting additional flow when possible and avoiding rapid flow fluctuations associated with operation and maintenance of the LADWP diversion dam. To reduce significant impacts on the brown trout population, flows in lower Lee Vining Creek during the spring and summer runoff period should not exceed 100 cfs except in wet years when the diversion capacity cannot physically meet this requirement or when periodic channel maintenance flows are required. Under this flow regime, sluicing activities at the LADWP diversion dam should be discontinued and other means of removing sand from the diversion pond should be sought. Ramping rates during flow changes should not exceed the unimpaired historical rates observed above the LADWP diversion dam.

Additional mitigation measures include constructing adequate refuge habitat, such as pools, backwaters, and overflow channels, in combination with overhead cover, to allow the stream to reoccupy former channels and to restore channel and bank stability in the reach below Highway 395. These measures are currently being implemented as part of a stream habitat and riparian restoration plan developed for Rush and Lee Vining Creeks (Trihey & Associates 1991). The success of habitat restoration efforts in the future will determine the degree to which flows can be increased above 100 cfs.

Parker and Walker Creeks

Creates and maintains good fish habitat. Resource conditions would benefit substantially as described for the 6,372-Ft Alternative (see page 3D-64) but would not degrade over time because of inadequate flushing flows.

Grant Lake Reservoir

Improves brown trout spawning success by decreasing lake level fluctuations.
Reduces fish productivity (9% decrease in reservoir surface area).

Upper Owens River

Significantly reduces brown trout adult habitat in dry (-28%) and normal (-10%) years and spawning habitat in dry (-19%) and wet (-20%) years

Mitigation Measures. Expected brown trout habitat losses should be minimized by modifying LADWP operations of Grant Lake reservoir and the Mono Craters tunnel to augment Upper Owens River flows within the context of balancing other water and resource needs. Based on projected water supply, an annual operation strategy should be developed and implemented each year to provide nearly constant year-round East Portal releases that maximize Upper Owens River flows; flows should not exceed 200 cfs below East Portal or 270 cfs below the Hot Creek confluence (EBASCO Environmental et al. 1993). Maximizing Upper Owens River flows would be most important during dry and normal water years and may be partially accomplished by using carry-over storage in Grant Lake reservoir (e.g., storing water in wet years and releasing it to the Upper Owens River in dry or normal years). The magnitude of flow augmentation should be determined by April 1 and releases should be started by July 1 and continue for one year. Depending on specific operational schedules, this mitigation measure may partially or totally mitigate for reduced physical habitat under this alternative.

Fixed minimum instream flows were identified that would reduce the adult brown trout habitat impacts to less-than-significant levels (allowing for a 9% reduction from point-of-reference conditions). Spawning habitat is not considered to be a limiting factor under most conditions and was considered in establishing minimum flows to reduce significant impacts. Minimum flows of approximately 150 cfs in Segment 1 (below East Portal), 135 cfs in Segment 2 (above Hot Creek), and 180 cfs in Segment 3 (below Hot Creek) would reduce impacts to less-than-significant levels for brown trout.

- Significantly reduces rainbow trout adult habitat in dry (-26%) and normal (-10%) years, and increases spawning habitat in normal (19%) and wet (18%) years.

Mitigation Measures. Mitigation measures identified above for reduced brown trout habitat generally apply to impacts on rainbow trout habitat. Minimum flows of approximately 150 cfs in Segment 1 (below East Portal), 135 cfs in Segment 2 (above Hot Creek), and 170 cfs in Segment 3 (below Hot Creek) would reduce impacts to less-than-significant levels for rainbow trout.

- Adversely affects water temperature conditions in dry years similar to the 6,370-Ft Alternative, but impacts on fisheries production are considered less than significant.
- Degrades water quality conditions but impacts on fisheries production considered less than significant.
- Maintains channel and streambed conditions.
- Significantly reduces adult brown and rainbow trout abundance.

Mitigation Measures. Mitigation measures identified above for reduced physical habitat apply to impacts on trout abundance.

Lake Crowley Reservoir

- Slightly decreases fish productivity (less than 1%).

Middle Owens River

- Aquatic habitat and resources would not differ significantly from the 6,372-Ft Alternative (see page 3D-65).

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

- Maintains fish productivity.

Los Angeles Aqueduct and Irrigation Canals

- Reduces fisheries habitat by less-than-significant levels.

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

Changes in Resource Conditions

Rush Creek

Changes in resource conditions under the 6,383.5-Ft Alternative would be similar to those occurring under the 6,377-Ft Alternative (see page 3D-66) except for increased severity of streambank erosion, habitat restoration impacts, and loss of spawning gravels. Flows equal to or exceeding 250 cfs would occur with the same frequency under the point of reference.

Lee Vining Creek

Changes in resource conditions under the 6,383.5-Ft Alternative would be similar to those occurring under the 6,377-Ft Alternative (see page 3D-67).

Parker and Walker Creeks

Changes in resource conditions associated with the 6,383.5-Ft Alternative would be similar to those associated with the 6,377-Ft Alternative (see page 3D-68).

Grant Lake Reservoir

Reservoir Fluctuations. Changes associated with the 6,383.5-Ft Alternative would be similar to those associated with the 6,377-Ft Alternative (see page 3D-69).

Reservoir Productivity. Average monthly reservoir elevations for the April-October period under the 6,383.5-Ft Alternative would be reduced by 6 feet relative to point-of-reference levels. Lower average monthly reservoir levels would reduce average monthly reservoir surface area by 93 acres (11%). During the 1940-1989 hydrologic period, reservoir simulations indicate there would be approximately 23 years with significant impacts on fish production. The 6,383.5-Ft Alternative would have significant impacts on fish productivity in Grant Lake reservoir.

Upper Owens River

Physical Habitat

Brown Trout. Under the 6,383.5-Ft Alternative, brown trout adult habitat would be reduced 33% in dry years, 26% in normal years, and 3% in wet years relative to point-of-reference levels (Table 3D-20). Brown trout spawning habitat would be reduced 21% in dry years, 5% in normal years, and increased 40% in wet years (Table 3D-20).

Rainbow Trout. Adult rainbow trout habitat would be reduced by 32% in dry years, 25% in normal years, and 3% in wet years relative to point-of-reference levels (Table 3D-20). The amount of rainbow trout spawning habitat would be nearly the same in dry years, but would be increased 24% in normal years and 35% in wet years (Table 3D-20).

Water Temperature. Under the 6,383.5-Ft Alternative, the frequency of monthly flows less than 75 cfs during June through September would occur in 20-30% of the years compared to less than 10% of the years under the point of reference (see Chapter 3A, "Hydrology"). A corresponding increase in the frequency of suboptimum water temperatures would reduce the amount of suitable habitat in the lower reaches of the Upper Owens River, especially in the reach below the Hot Creek confluence. Significant impacts on trout populations, particularly below Hot Creek, may occur during summer months.

Water Quality. Water quality conditions under the 6,383.5-Ft Alternative would be further degraded relative to the 6,372-Ft Alternative (see page 3D-61). The increased frequency of low flows under the 6,383.5-Ft Alternative may cause significant impacts on fisheries in Segment 3 relative to point-of-reference conditions.

Channel Morphology and Spawning Gravel Characteristics. Under the 6,383.5-Ft Alternative, the frequency of flows exceeding 200 cfs would be decreased further (30% of the time) relative to the 6,377-Ft Alternative (see Chapter 3A, "Hydrology"), and potential habitat losses associated with increased bank erosion and meander cutoffs would be avoided in a greater number of years. Changes in channel and substrate conditions are not expected to change significantly from point-of-reference conditions.

Fish Population Characteristics. Further reductions in flows under the 6,383.5-Ft Alternative would significantly reduce adult brown trout and rainbow trout habitat in dry and normal water years, potentially reducing adult populations in many years relative to point-of-reference levels. Significant changes in the amount of available brown and rainbow trout spawning habitat under this alternative would probably have no significant effects on trout populations because spawning habitat does not appear to be limiting production in the Upper Owens River. Trout populations in Segment 3 also would be adversely affected by increased exposure to high summer water temperatures and poor water quality during periods of low flow.

Lake Crowley Reservoir

Lake Crowley reservoir operations under the 6,383.5-Ft Alternative would decrease average monthly water surface elevations during the April-October period and cause average reservoir surface area to decrease by approximately 108 acres (2%) relative to the point of reference (Table 3D-21). Similarly, average surface area during the November-March period would decrease by approximately 77 acres (2%) compared to point-of-reference levels (Table 3D-21). Lower reservoir elevations under the 6,383.5-Ft Alternative during either period would adversely affect fish productivity in Lake Crowley reservoir because of reduced reservoir surface areas. No significant impacts would occur under the 6,383.5-Ft Alternative because surface area would be reduced relative to the point of reference by less than the 10% significance criterion in both the summer and winter periods. The 6,383.5-Ft Alternative would have slightly greater impacts on fish productivity in Lake Crowley reservoir than would the alternatives discussed earlier.

Middle Owens River

Physical Habitat

Brown Trout. Under the 6,383.5-Ft Alternative, brown trout spawning habitat would be significantly increased relative to point-of-reference levels (Figures 3D-13 through 3D-16). Increases in spawning WUA would range from 12% in Segment 1 to 23% in Segment 2 (Tables 3D-22 through 3D-25), and changes in WUA at individual spawning transects would range from an 8% decrease in Segment 3 to a 10% increase in Segment 2 (Table 3D-26). Changes in fry, juvenile, and adult WUA would not be significant.

Aquatic Invertebrates. Aquatic invertebrate habitat under the 6,383.5-Ft Alternative would be increased relative to the 6,377-Ft Alternative (Figure 3D-17); average WUA would be substantially greater (66%) than the point-of-reference level (Table 3D-27).

Largemouth Bass. Under the 6,383.5-Ft Alternative, largemouth bass spawning habitat would be increased relative to the 6,377-Ft Alternative; average spawning WUA would be substantially greater (73%) than the point-of-reference level (Table 3D-28). Changes in fry, juvenile, and adult WUA would be less than 9%.

Water Temperature. The magnitude and frequency of water temperatures under the 6,383.5-Ft Alternative would be similar to those occurring under the 6,377-Ft Alternative (see page 3D-70).

Channel Morphology and Spawning Gravel Characteristics. Under the 6,383.5-Ft Alternative, mean monthly Pleasant Valley Reservoir releases above 600 cfs would occur less frequently (approximately 30% of the years) than under the point-of-reference (approximately 40% of the years) (see Chapter 3A, "Hydrology"). No substantial changes in channel and streambed conditions would be expected.

Fish Population Characteristics

Brown Trout. Substantial increases in brown trout spawning habitat under the 6,383.5-Ft Alternative would potentially increase brown trout fry production and recruitment relative to point-of-reference levels. However, fry abundance and subsequent abundance of older age classes may frequently be limited by the amount of suitable fry habitat, which would remain virtually unchanged over the range of alternatives, and not spawning habitat. The Middle Owens River channel in the principal brown trout rearing area is generally confined between steep banks, and shallow-water habitat with low water velocities is scarce over a broad flow range; during direct observation surveys at flows between 100 cfs and 200 cfs in May 1991, brown trout fry were found only in a several locations where such habitat was present (Jones & Stokes Associates 1992). Limited fry habitat was also identified as a potential cause of exceptionally low brown trout recruitment in 1979 (Deinstadt and Wong 1980b). Consequently, measurable increases in brown trout populations under the 6,383.5-Ft Alternative would not be expected; potential changes in the brown trout population would be similar to those described for the 6,372-Ft Alternative (see page 3D-63).

Largemouth Bass. Potential changes in the largemouth bass population would be similar to those described for the 6,372-Ft Alternative (see page 3D-63).

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

Impacts on fishery resources under the 6,383.5-Ft Alternative would be the same as those described for the No-Restriction Alternative (see page 3D-54).

Los Angeles Aqueduct and Irrigation Canals

Impacts on fishery resources under the 6,383.5-Ft Alternative would be similar to those under the 6,372-Ft Alternative (see page 3D-63).

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

Rush Creek

- # Causes resource changes similar to those of the 6,377-Ft Alternative (see page 3D-71), except for increased severity of streambank erosion, habitat restoration impacts, and spawning gravel losses.

Mitigation Measures. Mitigation measures are identical to those specified for the 6,377-Ft Alternative (see page 3D-72).

Lee Vining Creek

- # Causes resource changes similar to those of the 6,377-Ft Alternative (see page 3D-72).

Mitigation Measures. Mitigation measures are identical to those specified for the 6,377-Ft Alternative (see page 3D-72).

Parker and Walker Creeks

- # Creates and maintains good fish habitat. Substantial benefits to resource conditions under the 6,383.5-Ft Alternative would be identical to those associated with the 6,377-Ft Alternative (see page 3D-73).

Grant Lake Reservoir

- # Improves brown trout spawning success by decreasing lake level fluctuations.
- # Significantly reduces fish productivity (11%).

Mitigation Measures. Declines in Grant Lake reservoir surface elevation would average about 11% under the 6,383.5-Ft Alternative. Impacts on fish productivity could be lessened by the improved brown trout spawning success, however, if spawning habitat is limiting Grant Lake reservoir fish populations. Grant Lake reservoir also is presently stocked by DFG, and this stocking program partially mitigates the effects of lower water surface elevations. Given these factors, the overall impact on Grant Lake reservoir fishery resources is less than significant and mitigation is not required. Establishing a specific minimum pool, while decreasing the flexibility for managing water resources for instream or out-of-stream beneficial uses, could be used to enhance Grant Lake reservoir fishery resources.

A fish stocking program could be developed, negotiated, and implemented for Grant Lake reservoir by LADWP and DFG. The details of a fish stocking program would require that success criteria be established, such as number or weight of annual trout yield to anglers, to maintain game fish populations at point-of-reference levels. Some considerations for a fish stocking program include:

estimated point-of-reference annual trout yield;
size of fish to be stocked (fingerling, subcatchable, or catchable);
strain of trout to be stocked (rainbow and brown trout);
stocking density, frequency, and duration of season; and
existing California Fish and Game Commission fish planting policies.

Upper Owens River

Significantly reduces brown trout adult habitat in dry (-33%) and normal (-26%) years and spawning habitat in dry years (-21%), and increases spawning habitat in wet years (40%).

Mitigation Measures. Mitigation measures are identical to those specified for the 6,377-Ft Alternative (see page 3D-73).

Significantly reduces rainbow trout adult habitat in dry (-26%) and normal (-10%) years, and increases spawning habitat in normal (19%) and wet (18%) years.

Mitigation Measures. Mitigation measures are identical to those specified for the 6,377-Ft Alternative (see page 3D-74).

Significantly degrades water temperature conditions below the Hot Creek confluence.

Mitigation Measures. Maintaining a minimum flow of 75 cfs, as measured below East Portal, would mitigate this impact to a less-than-significant level. Maintaining a minimum flow of approximately 150 cfs, as measured below East Portal, would mitigate this impact completely, assuming current diversion rates in the Upper Owens River.

Significantly degrades water quality conditions below the Hot Creek confluence.

Mitigation Measures. Impacts from increased arsenic concentrations below Hot Creek are difficult to accurately assess and mitigate without further study. The minimum flow of 75 cfs, as measured below East Portal and recommended above to mitigate water temperature impacts to less-than-significant levels, would likely be satisfactory mitigation to reduce water quality impacts to less-than-significant levels, assuming current diversion rates in the Upper Owens River. Maintaining a minimum flow of approximately 150 cfs, as measured below East Portal, would likely mitigate these impacts completely, assuming current diversion rates in the Upper Owens River.

- # Maintains channel and streambed conditions.
- # Significantly reduces adult brown and rainbow trout abundance.

Mitigation Measures. Mitigation measures identified above for reduced physical habitat, increased water temperatures, and reduced water quality apply to impacts on trout abundance.

Lake Crowley Reservoir

- # Decreases fish productivity by less than 3%.

Middle Owens River

- # Causes resource changes similar to those of the 6,372-Ft Alternative (see page 3D-65).

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

- # Causes no significant changes in fish productivity.

Los Angeles Aqueduct and Irrigation Canals

- # Reduces fisheries habitat by less-than-significant levels.

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

Changes in Resource Conditions

Rush Creek

Changes in resource conditions under the 6,390-Ft Alternative would be similar to those occurring under the 6,377-Ft Alternative (see page 3D-66), except for increased severity of streambank erosion, habitat restoration impacts, and spawning gravel losses.

Lee Vining Creek

Changes in resource conditions under the 6,390-Ft Alternative would be similar to those occurring under the 6,377-Ft Alternative (see page 3D-67).

Parker and Walker Creeks

Changes in resource conditions associated with the 6,390-Ft Alternative would be similar to those associated with the 6,377-Ft Alternative (see page 3D-68).

Grant Lake Reservoir

Reservoir Fluctuation. Changes associated with the 6,390-Ft Alternative would be similar to those associated with the 6,377-Ft Alternative (see page 3D-69).

Reservoir Productivity. Changes in fish productivity associated with the 6,390-Ft Alternative would be nearly identical to those associated with the 6,383.5-Ft Alternative (see page 3D-75). Average monthly reservoir elevations for the April-October period under the 6,390-Ft Alternative would be reduced by 6 feet relative to point-of-reference levels. Lower average monthly reservoir levels would reduce average monthly reservoir surface area by 100 acres (11%). Reservoir simulations for the 1940-1989 hydrologic period indicate there would be approximately 25 years with significant impacts on fish production.

Upper Owens River

Physical Habitat

Brown Trout. Under the 6,390-Ft Alternative, brown trout adult habitat would be reduced 37% in dry years, 31% in normal years, and 9% in wet years relative to point-of-reference levels (Table 3D-20). Brown trout spawning habitat would be reduced 26% in dry years and 5% in normal years and increased 40% in wet years (Table 3D-20).

Rainbow Trout. Adult rainbow trout habitat would be reduced 35% in dry years, 29% in normal years, and 9% in wet years relative to point-of-reference levels (Table 3D-20). Rainbow trout spawning habitat would be reduced 5% in dry years, increased by 23% in normal years, and increased by 45% in wet years (Table 3D-20).

Water Temperature. Under the 6,390-Ft Alternative, the frequency of monthly flows less than 75 cfs during June through September would occur in 30-40% of the years compared to less than 10% of the years under the point of reference (see Chapter 3A, "Hydrology"). Water temperature conditions, particularly in the reach below Hot Creek, would be further degraded relative to the 6,383.5-Ft Alternative. The increased frequency of low flows would significantly increase fisheries impacts, especially below the Hot Creek confluence, during summer months.

Water Quality. Water quality conditions under the 6,390-Ft Alternative would be further degraded relative to the 6,383.5-Ft Alternative (see page 3D-76). Significant impacts on fisheries may occur in Segment 3 relative to point-of-reference conditions.

Channel Morphology and Spawning Gravel Characteristics. Channel and streambed conditions under the 6,390-Ft Alternative would be similar to those occurring under the 6,383-Ft Alternative (see page 3D-76).

Fish Population Characteristics. Under the 6,390-Ft Alternative, adverse impacts to adult brown and rainbow trout abundance would be similar to those under the 6,383.5-Ft Alternative (see page 3D-76), but somewhat exacerbated.

Lake Crowley Reservoir

Changes associated with the 6,390-Ft Alternative would be identical to those associated with the 6,383.5-Ft Alternative (see page 3D-77).

Middle Owens River

Physical Habitat

Brown Trout. Changes in the amount of physical habitat available to brown trout life stages would be similar to those occurring under the 6,383.5-Ft Alternative (Figures 3D-13 through 3D-16). Relative to the point of reference, spawning WUA would increase by 13% in Segment 1 and by 26% in Segment 2 (Tables 3D-22 through 3D-25), and WUA changes at individual spawning transects would range from a 6% decrease to a 12% increase relative to the point of reference (Table 3D-26).

Aquatic Invertebrates. Aquatic invertebrate habitat available under the 6,390-Ft Alternative would be increased relative to the 6,383.5-Ft Alternative (Figure 3D-17); average WUA would be substantially greater (74%) than the point-of-reference level (Table 3D-27).

Largemouth Bass. Under the 6,390-Ft Alternative, largemouth bass spawning habitat would be increased relative to the 6,383.5-Ft Alternative; average spawning WUA would be substantially greater (78%) than the point-of-reference level (Table 3D-28). Changes in fry, juvenile, and adult WUA would be less than 10%.

Water Temperature. The frequency of suboptimum water temperatures under the 6,390-Ft Alternative would be increased slightly relative to the 6,377-Ft Alternative (see page 3D-70). Mean daily water temperatures at Five Bridges Road would exceed the optimum range for brown trout more frequently in June and August (4-5 more days per month) compared to the point of reference. Maximum daily water temperatures would remain below the upper tolerance limit at all times in the principal brown trout rearing area. The frequency and magnitude of water temperatures in October would be similar to those occurring under the 6,377-Ft Alternative. No measurable impacts on brown trout reproduction, growth, or survival would be expected.

Under the 6,390-Ft Alternative, water temperatures would be slightly improved for largemouth bass relative to the 6,377-Ft Alternative (see page 3D-70) but would remain below optimum ranges during the spring and summer months. No measurable benefits would be expected.

Channel Morphology and Spawning Gravel Characteristics. Under the 6,390-Ft Alternative, mean monthly Pleasant Valley Reservoir releases above 600 cfs would occur less frequently (30% of the years) than under the point of reference (40% of the years) (see Chapter 3A, "Hydrology"). No substantial changes in channel and streambed conditions would be expected.

Fish Population Characteristics

Brown Trout. Potential changes in the brown trout population under the 6,390-Ft Alternative would be similar to those described under the 6,372-Ft Alternative (see page 3D-63).

Largemouth Bass. Potential changes in the largemouth bass population would be similar to those described for the 6,372-Ft Alternative (see page 3D-63).

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

Impacts on fishery resources under the 6,390-Ft Alternative would be the same as those described for the No-Restriction Alternative (see page 3D-54).

Los Angeles Aqueduct and Irrigation Canals

Impacts on fishery resources under the 6,390-Ft Alternative would be similar to those under the 6,372-Ft Alternative (see page 3D-63).

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

Rush Creek

- Causes resource changes similar to those of the 6,377-Ft Alternative (see page 3D-71), except for increased severity of streambank erosion, habitat restoration impacts, and spawning gravel losses.

Mitigation Measures. Mitigation measures are identical to those specified for the 6,377-Ft Alternative (see page 3D-72).

Lee Vining Creek

- Causes resource changes similar to those of the 6,377-Ft Alternative (see page 3D-72).

Mitigation Measures. Mitigation measures are identical to those specified for the 6,377-Ft Alternative (see page 3D-72).

Parker and Walker Creeks

- Creates and maintains good fish habitat. Significant benefits to resource conditions under the 6,390-Ft Alternative would be identical to those associated with the 6,377-Ft Alternative (see page 3D-73).

Grant Lake Reservoir

- Improves brown trout spawning success by decreasing lake level fluctuations.
- Significantly reduces fish productivity (-11%).

Mitigation Measures. Mitigation measures associated with the 6,390-Ft Alternative are not required, as discussed for the 6,383.5-Ft Alternative. Enhancement opportunities are available, as discussed for the 6,383.5-Ft Alternative (see page 3D-79).

Upper Owens River

- Causes significant adverse resource changes similar to those of the 6,383.5-Ft Alternative (see page 3D-80).

Mitigation Measures. Mitigation measures are identical to those specified for the 6,383.5-Ft Alternative (see page 3D-80).

Lake Crowley Reservoir

- # Slightly decreases fish productivity (less than 3%).

Middle Owens River

- # Causes resource changes similar to those of the 6,372-Ft Alternative (see page 3D-65).

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

- # Causes no significant changes in fish productivity.

Los Angeles Aqueduct and Irrigation Canals

- # Reduces fisheries habitat by less-than-significant levels.

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

Changes in Resource Conditions

Rush Creek

Changes in resource conditions under the 6,410-Ft Alternative would be similar to those occurring under the 6,377-Ft Alternative (see page 3D-66), except for increased magnitude and duration of flows capable of inducing streambank erosion in Segment 6 (causing adverse effects on habitat restoration efforts), loss of spawning gravels in Segments 2 and 3, and a substantial increase in available brown trout spawning habitat in October and November. Because adult habitat was not increased to a similar extent, the potential benefits of additional spawning habitat would be limited by the amount of adult habitat available during spring and summer, which does not change appreciably under lake-level alternatives at or above the 6,372-foot lake elevation.

Lee Vining Creek

Changes in resource conditions under the 6,410-Ft Alternative would be similar to those occurring under the 6,377-Ft Alternative (see page 3D-67), except for a relatively large increase in available brown trout spawning habitat resulting from higher flows in October and November (Table 3D-13, Figure 3D-9). The overall increase in spawning habitat largely reflects WUA increases in Segments 5 and 6. Spawning WUA in Segment 2, however, would decrease relative to the 6,377-Ft Alternative (Table 3D-13). Because of the importance of Segment 2 for brown trout spawning and recruitment in lower Lee Vining Creek, the 6,410-Ft Alternative would potentially reduce brown trout production relative to the 6,377-Ft Alternative, but available spawning habitat would still be significantly greater than that available under point-of-reference conditions.

Parker and Walker Creeks

Changes in resource conditions associated with the 6,410-Ft Alternative would be similar to those associated with the 6,377-Ft Alternative (see page 3D-68).

Grant Lake Reservoir

Reservoir Fluctuations. Changes in spawning success associated with the 6,410-Ft Alternative would be similar to those associated with the 6,377-Ft Alternative (see page 3D-69).

Reservoir Productivity. Changes in fish productivity associated with the 6,410-Ft Alternative would be nearly identical to those associated with the 6,383.5-Ft Alternative (see page 3D-75). Average monthly reservoir elevations for the April-October period under the 6,410-Ft Alternative would be reduced by 7 feet relative to the point-of-reference level. Lower average monthly reservoir levels would reduce average monthly reservoir surface area by 114 acres (13%). Reservoir simulations for the 1940-1989 hydrologic period indicate there would be approximately 26 years with significant impacts on fish production.

Upper Owens River

Physical Habitat

Brown Trout. Under the 6,410-Ft Alternative, brown trout adult habitat would be reduced 39% in dry years, 38% in normal years, and 30% in wet years relative to point-of-reference levels (Table 3D-20). Brown trout spawning habitat would be reduced 28% in dry years and 25% in normal years and increased 38% in wet years (Table 3D-20).

Rainbow Trout. Adult rainbow trout habitat would be reduced 37% in dry years, 36% in normal years, and 29% in wet years relative to point-of-reference levels (Table 3D-20). Rainbow trout spawning habitat would be reduced by 6% in dry years, and increased by 22% in normal years and 48% in wet years (Table 3D-20).

Water Temperature. Under the 6,410-Ft Alternative, the frequency of monthly flows less than 75 cfs during June through September would occur in 30-60% of the years compared to less than 10% of the years under the point of reference (see Chapter 3A, "Hydrology"). Water temperature conditions, particularly in the reach below Hot Creek, would be further degraded relative to the 6,390-Ft Alternative. Fisheries impacts are considered significant relative to point-of-reference conditions.

Water Quality. Water quality conditions under the 6,410-Ft Alternative would be further degraded relative to the 6,383.5-Ft Alternative (see page 3D-76). Significant impacts on fisheries may occur in Segment 3 relative to point-of-reference conditions.

Channel Morphology and Spawning Gravel Characteristics. Under the 6,410-Ft Alternative, mean monthly flows would nearly always fall within the optimum range for maintaining channel and streambed conditions (see Chapter 3A, "Hydrology"). Benefits would likely occur relative to point-of-reference conditions.

Fish Population Characteristics. Under the 6,410-Ft Alternative, significant reductions in brown and rainbow trout habitat and increased exposure to adverse water temperature and water quality conditions in Segment 3 in most years would result in additional adverse impacts on trout populations relative to the 6,383.5-Ft Alternative (see page 3D-76).

Lake Crowley Reservoir

Lake Crowley reservoir operations under the 6,410-Ft Alternative would decrease average monthly water surface elevations during the April-October period and cause average reservoir surface area to decrease by approximately 212 acres (5%) relative to the point-of-reference level (Table 3D-21). Similarly, average surface area during the November-March period would decrease by approximately 192 acres (4%) compared to the point-of-reference level (Table 3D-21). Lower reservoir elevations under the 6,410-Ft Alternative during either period would adversely affect fish productivity in Lake Crowley reservoir but only at less-than-significant levels. The 6,410-Ft Alternative would have slightly greater impacts on fish productivity in Lake Crowley reservoir compared to the alternatives discussed earlier.

Middle Owens River

Physical Habitat

Brown Trout. Under the 6,410-Ft Alternative, brown trout spawning, juvenile, and adult habitat would be increased relative to the 6,390-Ft Alternative and would be significantly increased relative to point-of-reference levels (Figures 3D-13 through 3D-16). Spawning, juvenile, and adult WUA would be increased by 31%, 13%, and 13%, respectively from the point-of-reference levels (Tables 3D-22 through 3D-25). Spawning WUA would be increased by 25% in Segment 1 and by 38% in Segment 2, and WUA at individual spawning transects would increase up to 25% (Table 3D-26). Fry habitat would still show little change from point-of-reference levels.

Aquatic Invertebrates. The amount of suitable aquatic invertebrate habitat under the 6,410-Ft Alternative would be increased relative to the 6,390-Ft Alternative (Figure 3D-17); average WUA would be substantially greater (92%) than the point-of-reference value (Table 3D-27).

Largemouth Bass. Under the 6,410-Ft Alternative, largemouth bass spawning habitat would be increased relative to the 6,390-Ft Alternative; average spawning WUA would be substantially greater (96%) than the point-of-reference value (Table 3D-28). Adult WUA would increase by 12%, while fry and juvenile WUA would remain virtually unchanged.

Water Temperature. Water temperatures would be similar to those occurring under the 6,390-Ft Alternative (see page 3D-84) except that suboptimum water temperatures would occur more frequently during the warmest summer periods. The number of days with mean daily water temperatures above the optimum range at Five Bridges Road would increase up to approximately 7 days in August. Maximum daily water temperatures would remain below the upper tolerance limit at all times throughout the principal brown trout rearing area. Measurable impacts on brown trout survival, growth, or reproduction would not be expected.

Under the 6,410-Ft Alternative, water temperatures would be slightly improved for largemouth bass relative to the 6,377-Ft Alternative (see page 3D-70) but would remain below optimum ranges during the spring and summer months. No measurable benefits would be expected.

Channel Morphology and Spawning Gravel Characteristics. Under the 6,410-Ft Alternative, mean monthly Pleasant Valley Reservoir releases above 600 cfs would occur less frequently (approximately 20% of the years) than under the 6,390-Ft Alternative (approximately 30% of the years) or point-of-reference conditions (approximately 40% of the years) (see Chapter 3A, "Hydrology"). No substantial changes in channel and streambed conditions would be expected.

Fish Population Characteristics

Brown Trout. Relative to point-of-reference conditions, brown trout production would be potentially increased by significant increases in spawning, juvenile, and adult habitat under the 6,410-Ft Alternative. Fry habitat, however, would continue to be a major limiting factor in many years. The brown trout population would not likely differ significantly from the population under the 6,372-Ft Alternative (see page 3D-63).

Largemouth Bass. Potential changes in the largemouth bass population would be similar to those described for the 6,372-Ft Alternative (see page 3D-63).

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

Impacts on fishery resources under the 6,410-Ft Alternative would be the same as those described above under the No-Restriction Alternative (see page 3D-54).

Los Angeles Aqueduct and Irrigation Canals

Impacts on fishery resources under the 6,410-Ft Alternative would be similar to those under the 6,372-Ft Alternative (see page 3D-63).

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

Rush Creek

- Causes resource changes similar to those of the 6,377-Ft Alternative (see page 3D-71).

Mitigation Measures. Mitigation measures are identical to those specified for the 6,377-Ft Alternative (see page 3D-72).

Lee Vining Creek

- Causes resource changes similar to those of the 6,377-Ft Alternative (see page 3D-72), except for a significant reduction in spawning habitat in Segment 2.

Mitigation Measures. Mitigation measures are identical to those specified for the 6,377-Ft Alternative (see page 3D-72).

Parker and Walker Creeks

- Creates and maintains good fish habitat. Substantial benefits to resource conditions under the 6,410-Ft Alternative would be identical to those associated with the 6,377-Ft Alternative (see page 3D-73).

Grant Lake Reservoir

- # Improves brown trout spawning success by decreasing lake level fluctuations.
- # Significantly reduces fish productivity (13%).

Mitigation Measures. Mitigation measures associated with the 6,410-Ft Alternative are identical to those discussed for the 6,383.5-Ft Alternative (see page 3D-79).

Upper Owens River

- # Causes significant adverse resource changes similar to those of the 6,383.5-Ft Alternative (see page 3D-80), but somewhat exacerbated.

Mitigation Measures. Mitigation measures are identical to those specified for the 6,383.5-Ft Alternative (see page 3D-80).

Lake Crowley Reservoir

- # Slightly decreases fish productivity (less than 5%)

Middle Owens River

- # Causes resource changes similar to those of the 6,372-Ft Alternative (see page 3D-65).

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

- # Maintains fish productivity.

Los Angeles Aqueduct and Irrigation Canals

- # Reduces fisheries habitat by less-than-significant levels.

IMPACTS AND MITIGATION MEASURES FOR THE NO-DIVERSION ALTERNATIVE

Changes in Resource Conditions

Rush Creek

Changes in resource conditions under the No-Diversion Alternative would be similar to those occurring under the 6,410-Ft Alternative (see page 3D-86).

Lee Vining Creek

Changes in resource conditions under the No-Diversion Alternative would be similar to those occurring under the 6,410-Ft Alternative (see page 3D-87), except for the occurrence of higher winter flows, which could significantly increase the risk of winter trout mortality associated with ice formation and downstream displacement of trout (Aquatic Systems Research 1992). Some evidence indicates that brown trout in lower Lee Vining Creek may be more susceptible to downstream displacement and increased mortality during the winter. Flows ranging from 18 cfs to 54 cfs (mean 35 cfs) from December 1989 through March 1990 were associated with a decline in survival and abundance of 1-year-old and 2-year-old trout, coinciding with apparent downstream trout movements from the reach above U.S. 395 to the reach below U.S. 395 (EA Engineering, Science, and Technology 1990b). These changes contrasted with relatively stable trout abundance and distribution observed during flows of 5-10 cfs since 1987.

Parker and Walker Creeks

Average monthly flows in Parker and Walker Creeks under the No-Diversion Alternative would be significantly higher than levels under all other alternatives in most water years and months (see Chapter 3A, "Hydrology"). Flows in the driest years would be identical or similar to those of other lake-level alternatives at or above the 6,372-foot lake elevation but would be significantly higher in other water-year types, particularly in wet years.

Habitat impact analyses based on the Tennant Method indicate overall good aquatic habitat conditions with excellent habitat conditions occurring in Walker Creek during normal water years (Table 3D-17). Compared to all other alternatives, the No-Diversion Alternative improves habitat conditions during all but the high-flow months (Appendix O, Table O-1). The No-Diversion Alternative would significantly benefit aquatic habitats and resources compared to point-of-reference conditions in both Parker and Walker Creeks. There would also be significant resource benefits in Walker Creek during normal years compared to other lake alternatives at or above the 6,372-foot lake elevation.

Flushing flows would occur frequently in June and July (every other year on average) in Walker Creek and nearly 80% of the years in Parker Creek (see Chapter 3A, "Hydrology"). In wet years, the June and July flows in both Parker and Walker Creeks would greatly exceed the recommended flushing flows. Given the unstable channel configuration of certain reaches of both Parker and Walker Creeks, high flows resulting from the No-Diversion Alternative would adversely affect resource conditions through channel erosion. Despite these adverse effects, aquatic habitat conditions would nonetheless benefit substantially under the No-Diversion Alternative when compared to point-of-reference conditions. Rush Creek may also be adversely affected by the increased frequency and magnitude of high flows in Parker and Walker Creeks, which could exacerbate erosion impacts in Segments 5 and 6 of lower Rush Creek.

Grant Lake Reservoir

Reservoir Fluctuation. Under the No-Diversion Alternative, no adverse impacts on brown trout spawning success from reservoir fluctuations would occur for any water year. Compared to the other alternatives, the No-Diversion Alternative would have the greatest beneficial effect on brown trout spawning success in Grant Lake reservoir.

Reservoir Productivity. Grant Lake reservoir operations under the No-Diversion Alternative would increase average monthly water surface elevations for the April-October period by 23 feet and increase average monthly reservoir surface area by approximately 220 acres, relative to point-of-reference conditions (Table 3D-19). The No-Diversion Alternative would have substantial beneficial effects on reservoir fish populations from approximately 25% increases in reservoir surface area relative to point-of-reference conditions. Reservoir simulations for the 1940-1989 hydrologic period indicate there would be approximately 35 years with substantial benefits to fish production. The No-Diversion Alternative would provide the most beneficial conditions for Grant Lake reservoir fish productivity compared to the other alternatives.

Upper Owens River

Physical Habitat

Brown Trout. Under the No-Diversion Alternative, brown trout adult habitat would be reduced 39% in dry years, 39% in normal years, and 31% in wet years relative to point-of-reference levels (Table 3D-20). Brown trout spawning habitat would be reduced 32% in dry years and 28% in normal years and increased by 27% in wet years (Table 3D-20).

Rainbow Trout. Adult rainbow trout habitat would be reduced 38% in dry years, 37% in normal years, and 30% in wet years relative to point-of-reference levels (Table 3D-20). Rainbow trout spawning habitat would be reduced 9% in dry years and increased 20% in normal years and 52% in wet years (Table 3D-20).

Water Temperature. Summer water temperature impacts under the No-Diversion Alternative would be nearly identical to those under the 6,410-Ft Alternative (see page 3D-88).

Water Quality. Water quality conditions under the No-Diversion Alternative would be nearly identical to those under the 6,410-Ft Alternative (see page 3D-88).

Channel Morphology and Spawning Gravel Characteristics. Channel and streambed conditions under the No-Diversion Alternative would be nearly identical to those occurring under the 6,410-Ft Alternative (see page 3D-88).

Fish Population Characteristics. Under the No-Diversion Alternative, significant reductions in brown and rainbow trout habitat and increased exposure to adverse water temperature and water quality conditions in Segment 3 in most years would result in slight additional adverse effects on trout populations relative to the 6,383.5-Ft Alternative (see page 3D-76).

Lake Crowley Reservoir

Changes in lake productivity associated with the No-Diversion Alternative would be nearly identical to those associated with the 6,410-Ft Alternative (see page 3D-88), except that reservoir surface area during the November-March period would be slightly lower (Table 3D-21). The No-Diversion Alternative would have the greatest impacts on fish productivity in Lake Crowley reservoir compared to the alternatives discussed earlier; however, reservoir surface area would still be reduced by less than 5%, so that impact is considered less than significant.

Middle Owens River

Physical Habitat

Brown Trout. Changes in spawning, juvenile, and adult brown trout habitat under the No-Diversion Alternative would be similar to those under the 6,410-Ft Alternative (Figures 3D-13 through 3D-16). Increases in spawning, juvenile, and adult habitat would be 37%, 14%, and 14%, respectively (Tables 3D-22 through 3D-25). Spawning WUA would increase by 31% in Segment 1 and by 38% in Segment 2, and changes in WUA at individual spawning transects would exhibit increases up to 29% (Table 3D-26).

Aquatic Invertebrates. Aquatic invertebrate habitat under the No-Diversion Alternative would increase relative to the 6,410-Ft Alternative (Figure 3D-17); average WUA would be substantially greater (101%) than the point-of-reference level (Table 3D-27).

Largemouth Bass. Largemouth bass physical habitat available under the No-Diversion Alternative would be similar to that available under the 6,410-Ft Alternative except for an increase in spawning habitat (Figures 3D-18 through 3D-21). Average spawning WUA would be substantially greater (112%) than the point-of-reference level (Table 3D-28).

Water Temperature. The magnitude and frequency of water temperatures under the No-Diversion Alternative (Tables 3D-32 and 3D-33) would be similar to those occurring under the 6,410-Ft Alternative (see page 3D-89).

Channel Morphology and Spawning Gravel Characteristics. Channel and streambed conditions under the No-Diversion Alternative would be similar to those occurring under the 6,410-Ft Alternative (see page 3D-89).

Fish Population Characteristics

Brown Trout. Potential increases in brown trout production would be similar to those described for the 6,410-Ft Alternative, but fry habitat would continue to limit populations. The brown trout population under the No-Diversion Alternative would not differ significantly from the population under the 6,372-Ft Alternative (see page 3D-63).

Largemouth Bass. Potential changes in the largemouth bass population would be similar to those described for the 6,372-Ft Alternative (see page 3D-63).

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

Impacts on fishery resources under the No-Diversion Alternative would be the same as those described for the No-Restriction Alternative (see page 3D-54).

Los Angeles Aqueduct and Irrigation Canals

Impacts on fishery resources under the No-Diversion Alternative would be similar to those under the 6,372-Ft Alternative (see page 3D-63).

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

Rush Creek

- Causes resource changes similar to those of the 6,377-Ft Alternative (see page 3D-71).

Mitigation Measures. Mitigation measures are identical to those specified for the 6,377-Ft Alternative (see page 3D-72).

Lee Vining Creek

- Causes resource changes similar to those of the 6,410-Ft Alternative (see page 3D-90), except for higher winter mortality.

Mitigation Measures. Mitigation measures are identical to those specified for the 6,377-Ft Alternative (see page 3D-72). In addition, diversions during October through March could be modified to prevent flows in lower Lee Vining Creek from exceeding 20 cfs; this change would reduce the increased risk of winter trout mortality associated with higher flows and would reduce overall brown trout habitat in Lee Vining Creek. It is unknown whether the benefits of reduced winter trout mortality at lower flows would be offset by population impacts from reduced habitats.

Parker and Walker Creeks

- Creates and maintains good fish habitat. The No-Diversion Alternative would have substantial benefits to resource conditions in Parker and Walker Creeks compared to point-of-reference conditions. In addition, habitat conditions would be significantly improved in Walker Creek under the No-Diversion Alternative compared to other lake level alternatives between the 6,372- and 6,410-foot lake elevations; however, habitat benefits would be minimized or eliminated because of adverse effects from high peak flows on unstable channel reaches.

Mitigation Measures. Control of flushing flows is infeasible under this alternative. Unstable reaches could be stabilized over the long term through habitat restoration efforts; peak flows resulting from the No-Diversion Alternative after that time would not create the adverse effects that would occur short-term. Habitat restoration efforts could be focused on enhancing natural channel stabilization features, such as restricting livestock grazing, restoring riparian vegetation, effectively using side channels for water conveyance during peak flow conditions, and establishing bank protection and habitat improvement structures compatible with the stream channel morphology. Because conditions under this alternative would be improved relative to point-of-reference conditions, however, no mitigation measures are required.

Grant Lake Reservoir

- Improves brown trout spawning success by decreasing lake level fluctuations.
- Substantially increases fish productivity (25%).

Upper Owens River

- # Causes significant adverse resource changes similar to those of the 6,383.5-Ft Alternative (see page 3D-80).

Mitigation Measures. Mitigation measures are identical to those specified for the 6,383.5-Ft Alternative (see page 3D-80).

Lake Crowley Reservoir

- # Slightly decreases fish productivity (less than 5%).

Middle Owens River

- # Causes resource changes similar to those of the 6,372-Ft Alternative (see page 3D-65).

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

- # Maintains fish productivity.

Los Angeles Aqueduct and Irrigation Canals

- # Slightly reduces fisheries habitat by less-than-significant levels.

CUMULATIVE IMPACTS OF THE ALTERNATIVES

Related Impacts of Earlier Stream Diversions by LADWP

Mono Basin Tributaries

Substantial changes in aquatic habitat and fish populations occurred in Rush, Lee Vining, Parker, and Walker Creeks from LADWP diversions and are described in detail by numerous scientists (Beak Consultants 1991; Trihey & Associates 1991; Aquatic Systems Research 1992; Stine 1992a, 1992b). Significant diversions beginning in the late 1940s caused prolonged periods of little or no flow that severely degraded aquatic and riparian habitats and virtually eliminated the trout populations below the diversion facilities (Beak Consultants 1991, Trihey & Associates 1991, Aquatic Systems Research 1992). Much of the former habitat values that existed in the lower reaches of these creeks (i.e., complex channel structure and habitat features in the bottomlands) was lost as a result of catastrophic geomorphic changes that occurred in response to riparian vegetation losses, declines in Mono Lake levels, and large uncontrolled spills (Stine 1992a, 1992b). In general, these changes adversely affected fish habitat by creating a steeper, broader, shallower main channel; stranding historical side channels; eliminating pools and woody cover; and coarsening streambed sediments (Trihey & Associates 1991; Aquatic Systems Research 1992; Stine 1992a, 1992b).

Additional impacts contributing to the poor fish populations in the four streams include likely short-term LADWP operations detrimental to fish populations and habitat, gravel recruitment losses from LADWP diversion facilities, streamflow reductions and fish entrainment attributable to in-basin irrigation diversions, and migration limitations from road crossings and LADWP diversion facilities.

Grant Lake Reservoir

In the late 1930s, LADWP enlarged the area of Grant Lake reservoir to 1,094 acres and its capacity to 47,525 af (Sada 1977). With the construction of the Lee Vining conduit and the Mono Craters Tunnel, Grant Lake reservoir was operated as the main diversion pool for delivering water from Rush, Lee Vining, Parker, and Walker Creeks to the Owens River basin. The enlargement of Grant Lake reservoir provided increased lacustrine habitat for planted and resident trout, but large lake level fluctuations reduced lake productivity and created adverse effects on spawning success in the reservoir inundation zone (Sada 1977).

Upper Owens River

During 1941 through 1989, water exports from Mono Basin increased average annual discharge in the Upper Owens River from 76 to 168 cfs and led to increased channel erosion, widening, and straightening, and construction of artificial channels to bypass additional high flows. The higher flow regime has been accompanied by a reduced number of channel meanders and reduced channel length between East Portal and the Hot Creek confluence. Changes in channel meanders and bank stability are attributed to a combination of increased flows since 1941 and continued livestock grazing. (EBASCO Environmental et al. 1993.)

Despite physical changes to the Upper Owens River, fish population surveys conducted recently and in the 1980s indicate that trout population densities in the Upper Owens River are comparable or higher than densities estimated in other eastern Sierra Nevada streams (EBASCO Environmental et al. 1993). Trout collected in 1990 were in excellent condition and showed rapid growth (EBASCO Environmental et al. 1993). Although pre-1941 data are extremely limited, existing trout populations are in excellent condition; therefore trout populations likely have been maintained or perhaps increased by LADWP flow augmentations into the Upper Owens River. The increased flows since 1941 significantly increased adult trout habitat and reduced adverse water temperature and water quality effects in the Upper Owens River, particularly below Hot Creek.

Lake Crowley Reservoir

The formation of Lake Crowley reservoir in 1941 created habitat for a unique and highly productive fishery. Lake Crowley reservoir has been the focus of an intense hatchery stocking program, supporting one of the largest trout fisheries in California. The large inundation area, high alkalinity, relatively shallow depth, and moderate lake level fluctuations have all contributed to the reservoir's high productivity (Pister 1965), which likely exceeds that provided by the former stream environment. Substantial spawning habitat remains in the Upper Owens River for Lake Crowley reservoir trout, despite inundation of a section of the lower end of the Upper Owens River. The native Owens sucker is still abundant in Lake Crowley reservoir, but the tui chub has hybridized with the Lahontan subspecies that was introduced as bait by anglers (Moyle 1976).

Middle Owens River

Mono Basin water exports and the construction and operation of Long Valley Dam and Pleasant Valley Dam changed the Middle Owens River flow regime substantially. Flow augmentation and regulation increased average annual discharges and created a more variable flow regime characterized by more rapid flow fluctuations than existed historically (Hickson and Hecht 1992). Since 1947, these changes, along with spraying, burning, and removal of riparian vegetation by grazing interests, were accompanied by increases in channel width and loss of bank cover. Further flow increases beginning in 1970 are reported to have accelerated bank erosion and collapse of many of the existing undercut banks by 1971 (Ponder and Deinstadt 1978). A recent investigation of geomorphic and vegetative changes indicates that the Owens River channel between Pleasant Valley Dam and Five Bridges Road has not undergone large or systematic changes in channel pattern, hydraulic geometry, and geomorphic characteristics since 1971 (Hickson and Hecht 1992).

The construction of Pleasant Valley Dam blocked gravel recruitment to spawning areas below the dam and formed a complete barrier to fish migration. A combination of reduced gravel recruitment and high flows below the dam reduced the amount of suitable spawning gravels, degraded the streambed, and armored the streambed with coarser materials (Williams 1975). Fish kills or "near" fish kills occurred below the dam in the 1970s from low dissolved oxygen levels in Pleasant Valley Reservoir. An aerating device was subsequently installed at the dam to avoid future fish kills (Ponder and Deinstadt 1978).

Changes in the Middle Owens River flow regime may have contributed to declines in native fish species, but the earlier introduction of nonnative species, such as brown trout, probably had the greatest impact on native fish distribution and abundance. In the late 1960s, fisheries management changed from a predominantly put-and-take fishery maintained by hatchery rainbow trout to a wild brown trout fishery.

The 16-mile reach below Pleasant Valley Dam was designated a wild trout management area in 1972 and became California's top brown trout stream in terms of total angler use and number of trout harvested (Deinstadt and Wong 1980a). Periodic creel surveys since 1967 detected a general decline in angler use and catch during the 1970s followed by a return to higher levels in the 1980s; catch per unit effort exhibited no apparent trend between 1967 and 1988 (Deinstadt 1988, Deinstadt and Wong 1980a). Although brown trout populations have evidently not declined during this period, high flows during the spawning and early rearing period were identified as having negative effects on brown trout recruitment (Deinstadt and Wong 1980a, 1980b).

Lower Owens River

Few specific data are available on Lower Owens River fish populations and habitat and how these resources were affected by LADWP operations. LADWP's modified flow regimes, in concert with the large number of nonnative species introduced into the Lower Owens River system, were major factors contributing to the decline in native fish fauna and the establishment of the existing fishery. Dewatered conditions in the Lower Owens River below the LA Aqueduct had substantial adverse effects on native fish populations before 1941, but these impacts were associated with other LADWP water export projects.

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

Pleasant Valley and Tinemaha Reservoirs impounded Owens River flows and inundated former stream habitat. The reservoirs' habitats are more favorable to introduced species, and impacts were primarily on native fish species. Construction of Haiwee Reservoir, an off-river storage impoundment, resulted in creation of warmwater fisheries habitat.

Los Angeles Aqueduct and Irrigation Canals

These LADWP conveyance facilities have provided new habitat for limited populations of introduced warmwater and coldwater fish species.

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

Mono Basin Tributaries

In-basin agricultural diversions contributed to altered streamflow and habitat conditions in Mono Basin tributaries prior to and during LADWP diversions. Irrigation diversions significantly reduced summer flows along portions of Lee Vining, Rush, Parker, and Walker Creeks (Trihey & Associates 1992a; EBASCO Environmental and Water Engineering and Technology 1991b, 1991c). Summer flow reductions, especially during drought periods, would have had a significant adverse effect on the quality and quantity of aquatic habitat immediately below the diversion points and farther downstream as well, depending on specific diversion quantities and locations. The diversion structures and unscreened conveyance facilities from these diversions would have caused passage problems and direct losses of trout fry, juveniles, and adults and aquatic invertebrate drift.

In Lee Vining Creek, regulation of flows for power production reduced natural flows during spring and summer and augmented natural flows during winter. Storage and peaking operations at upstream reservoirs and hydroelectric facilities on Lee Vining Creek would have modified flow regimes and had some undocumented effect on fisheries populations.

Road crossings by LADWP and others have interrupted natural trout migrations and movements in all four streams.

Although quantitative information on pre-1941 aquatic habitat conditions and fish populations is extremely limited, historical records and accounts indicate that lower Lee Vining Creek and Rush Creek were characterized by a multiple channel system, dense riparian vegetation, and diverse aquatic habitat (Stine 1992a, 1992b; Trihey & Associates 1991). Lee Vining Creek and Rush Creek supported good to excellent fisheries; catchable-size rainbow and brown trout were abundant (McAfee 1990; Vestal 1990, Court Testimony, Volumes I and II). Parker and Walker Creeks also supported fisheries, but information on their fisheries is less definitive than for Lee Vining and Rush Creeks. These excellent fishery conditions existed in Mono Basin tributaries despite ongoing in-basin agricultural diversions, livestock grazing, and hydroelectric power operations. Not until LADWP activities were underway were fisheries resources in the four major streams substantially altered.

Grant Lake Reservoir

Before LADWP diversions, Grant Lake's natural outlet was dammed and water was diverted into several irrigation canals (Stine 1992b). The resulting impoundment was relatively small but supported a fishery for hatchery-reared trout and wild brown trout produced in upstream spawning areas in Rush Creek or in the lake inundation zone. Consequently, Grant Lake reservoir provided generally similar habitats both before and after LADWP activities. Before LADWP's enlargement of Grant Lake reservoir, the reservoir's smaller size would have minimized adverse effects on natural production resulting from brown trout spawning within the reservoir inundation area. Future reductions in inflow to Grant Lake reservoir resulting from new or increased in-basin water diversions would be a cumulative impact on available water supply for meeting beneficial uses identified in the EIR.

Upper Owens River

Impacts on aquatic and riparian habitat in the Upper Owens River before LADWP Mono Basin exports were largely related to in-basin agricultural diversions and livestock grazing. Agricultural diversions decreased flows along portions of the Upper Owens River and caused additional water quality impacts associated with agricultural return drainage. Livestock grazing reduced riparian vegetation, increased streambank erosion, and was the primary source of nutrient loading to the river. Future reductions in inflows from in-basin agricultural diversions would contribute to significant cumulative water quality and temperature impacts on aquatic resources.

Lake Crowley Reservoir

Impacts on fish habitat and populations in the Upper Owens River before the formation of Lake Crowley reservoir occurred seasonally because of diversions for agricultural and grazing purposes. Impacts were probably localized and limited to drought periods. Unscreened diversions probably caused direct losses of fish, and in some cases, seasonally dewatered portions of the channel or significantly reduced flows.

Lake Crowley reservoir is an LADWP-controlled impoundment, and other past, present, or anticipated projects or events have had limited effects on the fish populations or habitats present since Lake Crowley reservoir was constructed.

Middle Owens River

Changes in channel form and riparian habitat reported in 1971 were likely triggered by intensive grazing, clearing of dense riparian vegetation, and further increases in streamflows associated with Mono Basin diversions. Additional water available for agricultural use also increased nutrient loading to the river as a result of increased agricultural return drainage. The relative importance of each of these factors is unclear, but all factors likely degraded habitat conditions since 1941.

Lower Owens River

Most impacts are similar to impacts on the Middle Owens River, including intensive grazing and removal of riparian vegetation.

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

These reservoirs are all LADWP-controlled impoundments, and other past, present, or anticipated projects or events have had limited effects on the fish populations or habitats present in these reservoirs.

Los Angeles Aqueduct and Irrigation Canals

These conveyance facilities are all LADWP-controlled facilities, and other past, present, or anticipated projects or events have limited effects on the fish populations or habitats present in these facilities.

Significant Cumulative Impacts for All Alternatives

Mono Basin Tributaries

Long-term LADWP operations have resulted in significant cumulative impacts on geomorphology and fish populations in Rush, Lee Vining, Parker, and Walker Creeks.

None of the proposed EIR alternatives would succeed in restoring aquatic habitat and fish populations to prediversion levels within the reasonable future. Implementation of the No-Restriction Alternative would dewater lower Lee Vining Creek, lower Rush Creek, Parker Creek, and Walker Creek in many years and return these streams to the degraded state that existed before restoration of permanent flows. Because of additional habitat degradation associated with geomorphic and vegetative changes, mostly associated with LADWP's long-term diversions, restoration of continuous flows under the 6,372-Ft Alternative and higher elevation lake level alternatives would not fully restore the habitat values or fisheries that existed before 1941. All alternatives, therefore, would continue to have significant adverse cumulative impacts on geomorphology and fish populations would remain on major sections of Rush, Lee Vining, Parker, and Walker Creeks, particularly in the lower portions of Rush and Lee Vining Creeks.

Short-term LADWP operations have resulted in significant cumulative impacts on geomorphology and fish populations in Rush, Lee Vining, Parker, and Walker Creeks.

None of the proposed EIR alternatives would succeed in restoring aquatic habitat and fish populations if short-term LADWP operations include rapid flow changes as occurred on Lee Vining Creek in May 1990. These types of events likely occurred periodically since 1941, causing significant cumulative effects by minimizing or completely eliminating the benefits of restored minimum flows or habitat restoration efforts.

LADWP diversion facilities have resulted in significant cumulative impacts on gravel recruitment in Rush, Lee Vining, Parker, and Walker Creeks.

Downstream gravel recruitment from upstream sources is impeded at all LADWP's diversion structures. None of the proposed EIR alternatives would succeed in restoring gravel recruitment to the four affected streams. Higher flows will not address this impact because gravels will still be trapped behind the diversion facilities, and higher flows would serve to transport many of the gravels completely through the system into Mono Lake because of the loss of the complex channel structure that served to retain gravels at high flows.

- # Road crossings and LADWP diversion facilities have resulted in significant cumulative impacts on migrating trout populations in Rush, Lee Vining, Parker, and Walker Creeks.

None of the proposed EIR alternatives would correct existing problems from road crossings and LADWP diversion structures that limit or preclude upstream migrations of spawning trout. The overall significance of these barriers is individually relatively small, but, when taken together and with the other impacts on the creeks, these barriers have contributed to the significant adverse effects that have depleted fish populations since 1941.

Grant Lake Reservoir

LADWP's enlargement of Grant Lake reservoir expanded the lacustrine habitat and potential carrying capacity of the lake, which increased fish production over levels that occurred during the prediversion period. Over the range of proposed alternatives, lake levels would fluctuate within the range of historical levels, but production would remain higher than prediversion levels. No significant cumulative adverse effects would occur under any alternative.

Upper Owens River

Under historical conditions, flow augmentation, in combination with continued livestock grazing and channel creation in the Upper Owens River, has altered aquatic habitat conditions from prediversion levels, but changes in game and or nongame native fish populations cannot be ascertained with available data. Given the excellent trout fishery that has been maintained on the Upper Owens River, no significant cumulative impacts on trout resources have occurred.

Several conditions associated with Mono Basin exports and flow augmentation have maintained and even enhanced aquatic habitat and fish populations in the Upper Owens River. The enhanced flow levels substantially increase the amount of suitable trout habitat by increasing available physical habitat throughout the Upper Owens River and improving water temperature and water quality conditions, particularly in the reach below the Hot Creek confluence. The Upper Owens River channel has apparently adjusted to the higher flow regime, and no significant problems are related to channel stability or flushing flows (EBASCO Environmental et al. 1993). Spawning gravels have remained abundant under the higher flow regime. In addition, LADWP's creation of Lake Crowley reservoir and the intensive trout planting program have greatly increased the fish production potential of the basin and provided a productive lake environment for trout produced in the Upper Owens River.

Lake Crowley Reservoir

Game fish in Lake Crowley reservoir have been substantially benefited relative to their preimpoundment habitat and fish populations. No significant cumulative adverse impacts would occur under any alternative.

Middle Owens River

The aquatic habitat conditions that would occur in the Middle Owens River over the range of proposed EIR alternatives generally fall within the range of conditions that have occurred since flows were augmented further by Mono Basin diversions in 1971. While changes in resource conditions since that time have not been significant, impacts related to bank erosion, streambed armoring, and loss of riparian vegetation in earlier years appear to have occurred and may be significant. Without pre-1941 data, however, the effects of these habitat modifications on brown trout or nongame native fish populations cannot be ascertained.

Given the current excellent condition of the Middle Owens River brown trout fishery, the habitat impacts that have occurred have not caused significant cumulative impacts on brown trout populations. Since 1971, several changes in the Wild Trout Management Area have minimized cumulative impacts on fisheries resources and habitat. Losses of undercut banks and riparian vegetation have been partially compensated for by substantial increases in the extent of dense riparian vegetation in the lower reaches of the Wild Trout Management Area. Similar increases have not occurred in the upper reaches, possibly because of localized channel incision; past disturbances to soil and vegetation; and continued grazing, recreational use, and dam maintenance activities (Hickson and Hecht 1992). Impacts related to reductions in usable spawning gravels have also been reduced by construction of the Pleasant Valley Spawning Channel, which continues to provide an important spawning area for brown trout. Potential impacts of fluctuating flows on spawning and early rearing success have been reduced by LADWP's efforts to limit and stabilize flows during the migration, spawning, incubation, and early rearing period.

- Multiple factors contribute to significant cumulative adverse impacts on Owens tui chub and Owens speckled dace.

Native Owens tui chub and Owens speckled dace populations apparently had declined by 1940 but were still present in the main river where somewhat stable populations of Owens sucker still occurred. The Owens tui chub and Owens speckled dace populations are still relatively low. The complex interactions between water diversions, water impoundments, modified flow patterns, grazing, and competition from introduced species such as brown trout have been responsible for the declines, but specific data are unavailable to attribute these declines to any specific factor. Continued declines in their populations since 1941 cannot be verified.

Lower Owens River

The dewatering of the Lower Owens River below the LA Aqueduct caused significant cumulative impacts on all fisheries resources in the affected river segment. Owens tui chub, Owens speckled dace, and Owens sucker likely were present in the Lower Owens River, but populations were probably declining before LADWP diversions. The dewatering of the Lower Owens River below the LA Aqueduct is a major contributing factor to the population losses of these species, but because the dewatering occurred before 1940 and is unchanged by any of the EIR alternatives, it is not considered further in this EIR.

The coldwater trout fishery that exists immediately below Tinemaha Reservoir is maintained largely by plantings of catchable-size rainbow trout and would be relatively unaffected by any of the alternatives.

Pleasant Valley, Tinemaha, and Haiwee Reservoirs

No significant cumulative impacts are associated with any of the alternatives to these reservoirs.

Los Angeles Aqueduct and Irrigation Canals

No significant cumulative impacts are associated with any of the alternatives to the LA Aqueduct or irrigation canals.

Mitigation Measures for Significant Cumulative Impacts for All Alternatives

Mono Basin Tributaries and Grant Lake Reservoir

- # Long-term LADWP operations have resulted in significant cumulative impacts on geomorphology and fish populations in Rush, Lee Vining, Parker, and Walker Creeks.

Mitigation measures for the significant cumulative impacts to the natural stream channels and fish populations in the four streams cannot fully reduce the impacts in certain stream segments because of the severity of the impacts. This is particularly true for lower Rush and Lee Vining Creeks where complete habitat restoration will require 50 or more years. The severity of the cumulative impacts requires mitigation that goes beyond the standard provision of adequate or optimum flows. Additional stream rehabilitation is necessary to shorten the time frame that would be required to restore habitat to near 1940 conditions.

Establish Minimum Instream Flow Requirements. Minimum instream flow requirements should be established to improve brown trout habitat conditions under existing channel conditions. The minimum instream flow recommendations for lower Rush Creek (Beak Consultants 1991) and Lee Vining Creek (Aquatic Systems Research 1992) generally provide the basis for meeting this objective. The court has specified that licenses require LADWP to "release sufficient water . . . to reestablish and maintain the fisheries that existed in them prior to its diversion of water" (Caltrout II decision). This court order is more specific than California Fish and Game Code Section 5937, which requires sufficient bypass flows to keep in "good condition" any fish that may be planted or exist below the dams.

Preliminary DFG stream evaluation report recommendations below apply to existing channel conditions only, and these recommendations should be reevaluated after 10 years from date of implementation to ensure that such flows are still appropriate (Table 3D-32). Major segments of all four streams are not in dynamic equilibrium, and natural channel dynamics in association with any habitat restoration efforts could substantially change channel morphology over time, which could affect these possible instream flow requirements.

Beak Consultants (1991) specified the following instream flows for Rush Creek under dry, normal, and wet year hydrologic conditions (in cfs):

April - 35, 59, 60;
May - 60, 60, 60;
June - 60, 60, 60;
July - 45, 60, 60;
August - 42, 60, 60;
September - 40, 60, 60;
October - 36, 58, 60;
November - 30, 40, 56;
December - 30, 40, 56;
January - 31, 44, 57;
February - 32, 48, 54; and
March - 34, 52, 54.

Rush Creek minimum instream flow recommendations proposed by DFG (Gibbons pers. comm.), which are based on Beak Consultants (1991) are as follows for dry, normal, and wet year hydrologic conditions (in cfs):

April - 35, 59, 84;
May - 75, 100, 100;
June - 72, 100, 100;

July - 45, 100, 100;
August - 42, 93, 100;
September - 40, 69, 100;
October - 36, 58, 93;
November - 30, 40, 71;
December - 30, 40, 71;
January - 31, 44, 57;
February - 32, 48, 54; and
March - 34, 52, 54.

The Beak Consultants (1991) report did not consider tributary inflow from Parker and Walker Creeks and also established a maximum flow limit (100 cfs) identical to the minimum flow requirement in certain months and water year conditions. Consequently, flows higher than are actually necessary to optimize fishery conditions would occur in lower Rush Creek because of the additional flow requirements from Parker and Walker Creeks. Observed channel losses would also likely decline over time as channel and adjacent groundwater tables are recharged. In addition, such flows would exceed 100 cfs and induce streambank erosion and channel meandering in lower Rush Creek (Beak Consultants 1991). DFG's instream flow recommendations for Rush Creek should be reevaluated to reflect the contributions from Parker and Walker Creeks.

Lee Vining Creek minimum instream flow requirements or the natural flow, whichever is less, as measured immediately below the LADWP diversion dam, should be as follows (Aquatic Systems Research 1992):

April 1-September 30: 45 cfs and
October 1-March 30: 40 cfs.

October through March minimal flow requirements between 20 and 40 cfs would reduce winter-related trout mortalities and should also be considered. Flows as low as 20 cfs during this period would minimize winter-related mortalities and optimize available spawning habitat in Segment 2 over the short term because few adults are present in Segments 5 and 6 to use the greater spawning habitat created at higher flows in these segments.

Parker Creek minimum instream flow requirements or the natural flow, whichever is less as measured immediately below the LADWP diversion dam, should be the court-ordered flows as follows (California Department of Fish and Game 1992a):

October-March - 6 cfs and
April-September - 9 cfs.

Walker Creek minimum instream flow requirements or the natural flow, whichever is less as measured immediately below the LADWP diversion dam, should be the court-ordered flows as follows (California Department of Fish and Game 1992b):

- October-March - 4.5 cfs and
- April-September - 6 cfs.

Develop and Implement Appropriate Habitat Restoration Plans. The recommended mitigation is to develop and implement certain aspects of the proposed habitat restoration plans for Rush Creek (Trihey and English 1991), Lee Vining Creek (Trihey and English 1991, Aquatic Systems Research 1992), Parker Creek (California Department of Fish and Game 1992a), and Walker Creek (California Department of Fish and Game 1992b). These restoration plans could provide the mechanism for successful mitigation to the degree possible.

The purpose of the habitat restoration programs is to help reestablish aquatic and riparian habitat conditions that benefited fish populations before 1941 (Trihey and English 1991). Such work, however, is intended to partially mitigate for catastrophic losses of aquatic and riparian habitat by accelerating what otherwise would be a very slow natural recovery process (Trihey & Associates 1991). Some of the physical characteristics that benefited pre-1941 fish populations cannot be restored, and compensation for such losses will be achieved by improving some portions of Rush and Lee Vining Creeks beyond their pre-1941 conditions (Trihey & Associates 1991).

The need for channel maintenance and flushing flows should be assessed periodically as part of the habitat restoration monitoring program. With the restrictions on high flows discussed above, gravel quality and channel conditions should be evaluated periodically to determine the need for a controlled flushing flow event. The addition of gravels or scarification of existing gravels should be considered in lieu of high flows if adverse effects on habitat restoration efforts in lower reaches are anticipated. As habitat restoration proceeds and channels and streambanks become more resistant to erosion, channel maintenance and flushing flows should be reevaluated.

Mitigation measures discussed below must be coordinated and integrated with current and future habitat restoration and monitoring efforts to ensure a maximum probability of achieving restoration goals.

Limit Magnitude and Frequency of High Flow Events. An important element of the habitat restoration plans and the analyses conducted in this EIR is to limit the magnitude of potentially damaging high flows in all four creeks by allowing LADWP exports during high flows, dispersing high flows among additional stream channels, or diverting a portion of the flow into irrigation canals for spreading and groundwater recharge. Under existing channel conditions, reducing the frequency and magnitude of peak flows in Mono Basin tributaries will facilitate the progress of habitat restoration efforts, as well as minimize adverse impacts of high flows on the trout population. As geomorphic conditions change on each creek, specific channel maintenance and flushing flow requirements should be reevaluated.

Rush Creek instream flow releases, as measured immediately below the LADWP diversion, should not exceed 80 cfs except when the diversion capacity is unable to limit flows to this level. This maximum flow limitation, which accounts for Parker and Walker Creeks inflow, would minimize streambank erosion and adverse effects on habitat restoration efforts in lower Rush Creek. Periodic channel maintenance and flushing flows should be gradually implemented through the habitat restoration plans, including specific magnitudes, frequencies, and durations. An example channel maintenance and flushing flow schedule for Rush Creek would be to ramp flows up to 125-150 cfs for 3 days once during the 1995-1999 period, up to 150-175 cfs for 5 days once during the 2000-2004 period, and so forth, during natural high flow periods in June and July.

Similar to Rush Creek, Lee Vining Creek instream flow releases, as measured immediately below the LADWP diversion, should not exceed 100 cfs except when the diversion capacity is unable to limit flows to this level. All other conditions described above for Rush Creek apply to Lee Vining Creek, as well. Aquatic Systems Research (1992) recommended a 160-cfs maximum flow, the present court-mandated flushing flow. This flow is too high, however, with respect to the adverse impacts on fish populations observed at streamflows between 112 and 204 cfs in 1990 and 1991. Lee Vining Creek, in its present condition, has extremely limited refuge habitat in the lower portion of the creek, and flows higher than approximately 100 cfs will likely cause much greater direct mortality to trout than the indirect impacts of less-than-adequate flushing flows.

Parker Creek instream flow releases, as measured immediately below the LADWP diversion, should not exceed 25 cfs except when the diversion capacity is unable to limit flows to this level or flushing flows are being released. DFG (1992a) recommends flushing flows of 25-40 cfs for a few days each year during the snowmelt season, with monitoring to determine the actual duration. These flushing flows should be timed initially so that they do not coincide with flushing flows in Rush Creek (which could cause excessive erosion in lower Rush Creek) and should not be implemented until steep, erodible portions of the channel are stabilized and undersized culverts replaced (California Department of Fish and Game 1992a, 1992b). The frequency and magnitude of these annual flushing flows also should be reduced and the flushing flow should be implemented on a more gradual basis. Again, the specific channel maintenance and flushing flows should be developed in the habitat restoration plans, and adjustments should be made as needed as channel conditions dictate.

Walker Creek instream flow releases, as measured below the LADWP diversion, should not exceed 15 cfs except when the diversion capacity is unable to limit flows to this level. DFG (1992b) recommends the court-ordered flushing flows of a 3-day (during dry years) or 30-day (during wetter years) flushing flow of 15 cfs starting no earlier than May 1 and no later than July 1. As with the other Mono Lake tributaries, specific channel maintenance and flushing flows should be developed in the habitat restoration plans, and adjustments should be made as needed as channel conditions dictate.

Short-term LADWP operations result in significant cumulative impacts on geomorphology and fish populations in Rush, Lee Vining, Parker, and Walker Creeks.

Establish Specific Ramping Rate and Sluicing Criteria for All LADWP Releases. Frequent, and even relatively infrequent, short-term fluctuations in streamflow and sluicing events can have significant long-term adverse effects on fish populations and habitat. Specific ramping rates and sluicing requirements should be developed and implemented on all four streams.

LADWP diversion facilities result in significant cumulative impacts on gravel recruitment in Rush, Lee Vining, Parker, and Walker Creeks.

Establish Specific Gravel Restoration Plans as Part of the Habitat Restoration Plans for Each Stream. Appropriate gravels and spawning habitat are potentially limiting factors in several stream segments and are currently trapped behind LADWP diversion facilities. Gravel restoration can be successful only if it is integrated with other channel and flow restoration efforts on each of the streams. Consequently, the habitat restoration plans discussed above should contain a specific plan for augmenting each stream with appropriately sized gravels to improve spawning habitat.

Road crossing and LADWP diversion facilities result in significant cumulative impacts on migrating trout populations in Rush, Lee Vining, Parker, and Walker Creeks.

Establish Specific Measures to Improve Trout Migrations at Existing Instream Facilities. LADWP and other entities maintain instream facilities that adversely affect brown trout migrations and movements. These impacts contribute to the overall significant cumulative adverse effect on fisheries resources on all four streams. Existing habitat restoration plans already contain adequate plans for providing adequate fish passage conditions at diversion facilities, road crossings, and other known or potential barriers.

Owens River Basin

LADWP exports result in substantial benefits to fisheries of the Upper Owens River under the No-Restriction Alternative.

The 6,377-Ft Alternative to the No-Diversion Alternative would result in significant adverse impacts on adult brown and rainbow trout habitat, with adverse effects increasing with higher lake levels.

Mitigation Measures. Specific instream flow requirements for the Upper Owens River should be established to reduce impacts to less-than-significant levels as specified for the 6,377-Ft Alternative and other higher lake-level alternatives. Brown and rainbow trout habitat losses could be minimized by modifying LADWP operations of Grant Lake reservoir and the Mono Craters tunnel to augment Upper Owens River flows, as described in more detail for the 6,377-Ft Alternative.

Fixed minimum instream flows were identified that would reduce the adult brown trout and rainbow trout habitat impacts to less-than-significant levels (allowing for a 9% reduction from point-of-reference conditions). Minimum flows of approximately 150 cfs in Segment 1 (below East Portal), 135 cfs in Segment 2 (above Hot Creek), and 180 cfs in Segment 3 (below Hot Creek) would reduce impacts to less-than-significant levels for brown trout. Minimum flows of approximately 150 cfs in Segment 1 (below East Portal), 135 cfs in Segment 2 (above Hot Creek), and 170 cfs in Segment 3 (below Hot Creek) would reduce impacts to less-than-significant levels for rainbow trout.

Fixed maximum instream flows at no more than 200 cfs below the East Portal and no more than 270 cfs below the Hot Creek confluence (EBASCO Environmental et al. 1993) could be used in association with minimum instream flow requirements to fully mitigate impacts.

- The 6,383.5-Ft Alternative to the No-Diversion Alternative would result in significant adverse effects on water temperature conditions and water quality conditions below the Hot Creek confluence.

Mitigation Measures. Specific minimum instream flow requirements for the Upper Owens River should be established. Maintaining a minimum flow of 75 cfs, as measured below East Portal, would mitigate these impacts to less-than-significant levels, assuming current diversion rates in the upper Owens River. Maintaining a minimum flow of approximately 150 cfs, as measured below East Portal, would mitigate these impacts completely, assuming current diversion rates in the Upper Owens River.

- Multiple factors result in significant cumulative adverse impacts on Owens tui chub and Owens speckled dace in the Middle Owens River.

Establish Specific Ramping Rate Criteria for LADWP Releases below Pleasant Valley Reservoir. Native Owens tui chub and Owens speckled dace populations have been adversely affected by numerous and complex factors. Mitigation to restore these populations on the Middle Owens River would involve infeasible measures such as removing introduced species, including brown trout. Specific ramping rate requirements should be developed to minimize geomorphic impacts from frequent and rapid fluctuations in streamflow.

CONSIDERATION OF PRE-1941 FISHERY STANDARDS SET BY COURT ORDER

Background

This EIR does not determine the required minimum streamflows for fishery protection but provides technical information to assist the SWRCB to make the required determinations after a public hearing process. In addition to meeting its responsibilities under CEQA, the SWRCB must also meet specific criteria established in court orders addressing fisheries resources in Mono Lake tributaries.

Assessing both project and cumulative impacts on environmental resources required that two points of reference, or baseline conditions, be defined in this EIR. Environmental conditions on August 22, 1989, when the El Dorado Superior Court issued a minute order to the SWRCB describing the issuance of a preliminary injunction regarding the water surface level of Mono Lake, define the point of reference for assessing impacts of the diversion alternatives. Environmental conditions prior to the beginning of diversions in Mono Basin in 1941 define the point-of-reference for examining cumulative impacts of the diversion alternatives.

In *California Trout, Inc. v. Superior Court* 218 Cal.App.3d 187 (1990) (Caltrout II), the Court of Appeals held that its opinion in Caltrout I foreclosed any argument that the SWRCB had authority to balance the public interest in competing water uses and to set instream flow requirements insufficient to maintain fish in good condition. The court directed the SWRCB to exercise its ministerial duty to amend LADWP's water right licenses for appropriation of the Mono Lake tributaries to include conditions in accordance with California Fish and Game Code Sections 5937 and 5946. Section 5937 requires sufficient bypass flows around dams, including diversion dams, to keep in good condition any fish that may be planted or exist below a dam. Section 5946 states that no license to appropriate water in portions of Mono or Inyo Counties can be issued after September 9, 1953, unless conditioned on full compliance with Section 5937. Most importantly, the court further specified that licenses require LADWP to "release sufficient water into the streams from its dams to reestablish and maintain the fisheries that existed in them prior to its diversion of water".

Caltrout II, therefore, establishes a specific target resource condition for fisheries that must be met regardless of any public trust balancing conducted by the SWRCB. This standard has an overriding influence on the evaluation and selection of alternative lake levels, as described later in this section.

Definition of Pre-1941 Fishery Conditions

Prediversion fishery conditions are described at the outset of this chapter under "Prediversion Conditions". Most existing information is habitat-based and qualitative; few data are available to quantitatively describe fish populations in any of the Mono Lake tributaries. It is difficult to conclusively establish alternatives, instream flow requirements, or mitigation measures that will meet the court order because the pre-1941 fisheries cannot be described in any quantitative terms, such as fish densities or fish biomass. Nonetheless, the mostly qualitative description of pre-1941 habitat conditions provides information on habitat types that supported larger trout populations than do existing habitat conditions.

Limitations to Reestablishing Pre-1941 Fishery Conditions

Several factors limit reestablishing pre-1941 fishery conditions in the Mono Lake tributary streams. As indicated above, one major limitation is that pre-1941 fishery conditions cannot be accurately described and, consequently, it would be difficult to ascertain whether the objective of reestablishing the pre-1941 conditions was ever met. Recognizing the dearth of pre-1941 data, the Restoration Technical Committee developed a program to help reestablish conditions that benefited the fisheries by emphasizing actions that accelerate the natural recovery of aquatic and riparian habitats, rather than those that might provide a specific number of fish (Trihey & Associates 1991). Additional limitations occur in two specific areas: the practicality of reestablishing pre-1941 conditions and the limitations of existing fisheries studies.

Practicality of Reestablishing Pre-1941 Fishery Conditions

The intent of the court order to reestablish and maintain pre-1941 fishery conditions is clearly understood. It was recognized early in the habitat restoration program ordered by the court, however, that existing conditions may preclude restoration of some specific pre-1941 physical conditions. The Restoration Technical Committee therefore agreed to and adopted the goal of developing and implementing programs to establish aquatic and riparian conditions and resource values equivalent to those existing in the streams prior to 1941 as an acceptable substitute for the overall goal of reestablishing the conditions that benefited the fisheries that existed in the creeks prior to 1941. Establishing even equivalent conditions that benefited the pre-1941 fishery is impossible in the short term and possible in the long term only if aggressive and substantial habitat restoration programs, in concert with major instream flow releases, are undertaken.

Limitation of Existing Fishery Studies

Existing fishery studies, such as IFIM analyses and fish population monitoring, have been developed in certain reaches of the Mono Lake tributaries that have undergone extensive geomorphological changes. In particular, the complex pre-1941 aquatic habitats in lower Rush and Lee Vining Creeks have been substantially modified. The existing fishery studies analyze the new channel characteristics and their effects on the fish populations. Consequently, extrapolation of existing fish population and habitat data, trends, and models to the pre-1941 period is extremely difficult and must be done qualitatively.

Effects of Lake Alternatives on Ability to Restore Pre-1941 Fishery Conditions

Compared to the 1989 point of reference, all alternatives have substantial fishery benefits in the Mono Lake tributaries. Compared to the pre-1941 conditions, however, significant cumulative impacts were identified for all alternatives. Similarly, none of the alternatives can restore and maintain pre-1941 fishery conditions for at least 50 or more years. Major geomorphic alterations are simply too great to allow restoration of the complex habitat functions present in lower Rush and Lee Vining Creeks in the pre-1941 period. Without such major channel changes, pre-1941 fishery conditions could largely be restored by releasing flows of the same monthly magnitude, duration, and pattern that existed in the pre-1941 period. Unfortunately, the geomorphic changes in certain reaches have resulted in new channel configurations that provide different habitat values than would have occurred under the same flow patterns in the pre-1941 period. Successful restoration efforts now will require greater short-term control of high flows while channel and habitat conditions are stabilized and restored.

Effects of Fishery Protection Flows in DFG Stream Evaluation Reports

DFG Stream Evaluation Reports provide fishery protection flows and other measures to optimize fishery conditions in Mono Lake tributaries. It is unclear whether these reports represent DFG's formal recommendations for each stream or are consultants' recommendations only. Nonetheless, the Stream Evaluation Reports represent the best available information provided by DFG for establishing conditions that approach, to the greatest degree possible, the pre-1941 habitat conditions desired by the court. DFG has produced stream evaluation reports for the four diverted tributary streams (Beak Consultants 1991; EBASCO Environmental and Water Engineering and Technology 1991b, 1991c; Aquatic Systems Research 1992) and the Upper Owens River (EBASCO Environmental et al. 1993). These reports contain instream flow recommendations for each stream (Table 3D-34).

The aqueduct model was used to predict long-term Mono Lake surface elevations resulting from these recommended flows, including the specified minimum, maximum, and flushing flow values. As for the alternative simulations, these diversion rules were combined with aqueduct operations constraints and applied to the 1940-1989 historical hydrology. In this simulation, however, no lake level targets and lake release rules were specified.

Two simulations were conducted, the first based on DFG's consultants' original flow recommendations for Rush Creek, which specify a maximum release of 60 cfs during the peak runoff period (Beak Consultants 1991), and the second based on DFG's subsequent flow recommendations, which specify a maximum release of 100 cfs (Gibbons pers. comm.). Recommended flows for Lee Vining, Parker, and Walker Creeks were identical for the two simulations.

The recommendation for flows for the Upper Owens River below the East Portal (a maximum flow limit of 200 cfs and a constant release rate) could not be modeled explicitly because changes would be required in operation of Grant Lake reservoir to distribute exports more evenly throughout the year. Model applications, however, suggest that total annual exports and Mono Lake surface elevations would not change appreciably with this additional constraint.

The recommended flows would cause the surface elevation of Mono Lake to rise to an average elevation of 6,381 feet, for the maximum Rush Creek flow of 60 cfs, or to 6,385 feet for the maximum Rush Creek flow of 100 cfs (Figure 3D-24). The transition period to the dynamic equilibrium would be about 40 years, and lake levels would fluctuate 6-7 feet thereafter. The simulations indicate that uncontrolled spills would not likely occur in the Mono Basin tributaries under the conditions specified. Minimum instream flow recommendations for Rush Creek would be met in most years, but available flows in Lee Vining, Parker, and Walker Creeks would often be insufficient to meet the specified minimum flows in dry and normal runoff years.

These simulated lake level ranges, when compared to the lake level regimes described for each alternative, indicate the degree to which each alternative is capable of meeting the pending DFG instream flow recommendations for protection of fishery resources. The 6,383.5-Ft Alternative is the nearest alternative that satisfies preliminary DFG recommendations developed to optimize fisheries conditions. The average lake level (6,385 feet) based on the 6,383.5-Ft Alternative would meet DFG's pending instream flow requirements.

CITATIONS

Printed References

Aquatic Systems Research. 1992. Instream flow requirements for brown trout in Lee Vining Creek, Mono County, CA. (DFG Stream Evaluation Report No. 92-4, Volume I.) Loomis, CA. Prepared for California Department of Fish and Game and Los Angeles Department of Water and Power, Sacramento and Los Angeles, CA.

Beak Consultants, Inc. 1991. Instream flow requirements for brown trout, Rush Creek, Mono County, California and appendices to the technical report. (DFG Stream Evaluation Report No. 91-2, Volumes I and II.) August and May. Sacramento, CA. Prepared for California Department of Fish and Game and Los Angeles Department of Water and Power, Sacramento and Los Angeles, CA.

Bovee, K. D. 1982. Guide to stream habitat analysis using the instream flow incremental methodology. (Instream Flow Information Paper No. 12.) U.S. Fish and Wildlife Service. Fort Collins, CO. Prepared for U.S. Department of the Interior, Washington, DC.

California Department of Fish and Game. n.d. Inyo-Mono calendar year report 1985, 1986, 1987, 1988, and 1989. Bishop, CA.

___________. [1987.] [Excerpts from wild trout program IFD, Mono Basin Creeks, Fisheries File, February 24, 1987.] Bishop, CA.

__________. 1992a. Habitat restoration investigation for Parker Creek, Mono County, California. (Stream Evaluation Report No. 91-5.) Sacramento, CA.

__________. 1992b. Habitat restoration investigation for Walker Creek, Mono County, California. Sacramento, CA.

__________. 1992c. California sport fishing regulations. Sacramento, CA.

Deinstadt, J. M. 1988. Lower Owens River wild trout fishery - 1988 survey. California Department of Fish and Game. Sacramento, CA.

Deinstadt, J. M., and D. M. Wong. 1980a. Status of the brown trout population in lower Owens River - preliminary draft. California Department of Fish and Game, Inland Fisheries Division. Sacramento, CA.

__________. 1980b. Review of brown trout spawning and habitat requirements in relation to recruitment in the Lower Owens River in 1979. The Resources Agency, California Department of Fish and Game, Sacramento, CA.

Deinstadt, J. M., D. R. McEwan, and A. M. Wong. 1985. Survey of fish populations in streams of the Owens River drainage: 1983-1984. August. (Administrative Report No. 85-2.) Rancho Cordova, CA. Prepared for California Department of Fish and Game, Resources Agency. Sacramento, CA.

EA Engineering, Science, and Technology. 1989. Fish populations in Lower Lee Vining Creek, 1986-1988. Draft report. March. Lafayette, CA. Prepared for City of Los Angeles Department of Water and Power, Los Angeles, CA.

___________. 1990a. Fish populations in lower Lee Vining Creek, 1989. Draft report. Lafayette, CA. Prepared for City of Los Angeles Department of Water and Power, Los Angeles, CA.

__________. 1990b. Fish populations in lower Lee Vining Creek, 1990. Draft report. Lafayette, CA. Prepared for Los Angeles Department of Water and Power, Los Angeles, CA.

___________. 1990c. Fish populations in lower Rush Creek, 1985-1989. Draft report. December. Lafayette, CA. Prepared for City of Los Angeles Department of Water and Power, Los Angeles, CA.

__________. 1991. A sixth year of fish population studies in lower Rush Creek, 1990. Draft report. Lafayette, CA. Prepared for City of Los Angeles Department of Water and Power, Los Angeles, CA.

EBASCO Environmental and Water Engineering and Technology, Inc. 1991a. Habitat restoration for South Parker Creek, Mono County, California. (DFG Stream Evaluation Report 91-4.) Sacramento, CA, and Fort Collins, CO. Prepared for California Department of Fish and Game and Los Angeles Department of Water and Power, Sacramento and Los Angeles, CA.

__________. 1991b. Habitat restoration for Parker Creek, Mono County, California. December. (DFG Stream Evaluation Report 91-5.) Sacramento, CA, and Fort Collins, CO. Prepared for California Department of Fish and Game and Los Angeles Department of Water and Power, Sacramento and Los Angeles, CA.

__________. 1991c. Habitat restoration for Walker Creek, Mono County, California. December. (DFG Stream Evaluation Report 91-6.) Sacramento, CA, and Fort Collins, CO. Prepared for California Department of Fish and Game and Los Angeles Department of Water and Power, Sacramento and Los Angeles, CA.

EBASCO Environmental, Water Engineering and Technology, Inc., and W. Davis and Associates. 1993. Instream flow and habitat restoration investigations for the Upper Owens River, Mono County, California. February. (DFG Draft Stream Evaluation Report, February 1993, Volume I.) Sacramento, CA, Fort Collins, CO, and Chandler, AZ. Prepared for California Department of Fish and Game and the City of Los Angeles Department of Water and Power, Los Angeles, CA.

English, S. M., and C. Skibinski. 1991. Rush and Lee Vining Creeks: 1991 restoration work. October 25, 1991. Prepared for Trihey & Associates, Walnut Creek, CA.

__________. 1992. Lee Vining Creek subsegment 3A 1992 habitat improvement work. Prepared for Trihey & Associates, Walnut Creek, CA.

Federal Energy Regulatory Commission. 1984. Environmental assessment. Leggitt project. (FERC No. 3272 - California: June 29, 1984.) Division of Hydrology Licensing, Office of Electric Power Regulation. Washington, DC.

Hickson, T., and B. Hecht. 1992. Changes over time in geomorphic conditions, sediment transport and riparian cover in the Owens River below Pleasant Valley Dam, Inyo County, California. Prepared for Jones & Stokes Associates, Sacramento, CA.

Hubbs, C. L., and R. R. Miller. 1948. The zoological evidence: correlation between fish distribution and hydrographic history in the desert basins of western United States. In the Great Basin, with emphasis on glacial and post-glacial time. University of Utah Bulletin 33(20):18-166. Salt Lake City, UT.

Jones & Stokes Associates, Inc. 1992. Middle Owens River instream flow incremental methodology study. (Mono Basin EIR Auxiliary Report No. 23.) Sacramento, CA. Prepared for California State Water Resources Control Board, Sacramento, CA.

__________. 1993. Summary of hydrologic simulations of Mono Basin EIR alternatives with Los Angeles Aqueduct monthly program (LAAMP) model with historical 1940-1989 hydrology. (Mono Basin EIR Auxiliary Report No. 18.) Prepared for California State Water Resources Control Board. Sacramento, CA.

Kabel, C. S., and R. L. Butler. 1956. Rush Creek test stream, Mono County: summary report. (Inland Fisheries Administrative Report No. 59-15.) California Department of Fish and Game. Sacramento, CA.

Leitritz, E. 1970. A history of California's fish hatcheries, 1870-1960. California Department of Fish and Game. Sacramento, CA.

McAfee, W. 1990. See Superior Court for the State of California for the County of El Dorado, 1990. Volume II.

McEwan, D. 1990. Utilization of aquatic vegetation and some aspects of life history of the Owens tui chub (*Gila bicolor snyderi*) in the Hot Creek headsprings, Mono County, California. M.S. thesis. California State University, Sacramento. Sacramento, CA.

McPherson, W. 1990. See Superior Court for the State of California for the County of El Dorado, California, 1990.

Morhardt, E. 1990. See Superior Court for the State of California for the County of El Dorado, 1990. Volume V.

Moyle, P. B. 1976. Inland fishes of California. University of California Press. Berkeley, CA.

Moyle, P. B., J. E. Williams, and E. D. Wikramanayake. 1989. Fish species of special concern of California. University of California. Davis, CA. Submitted to California Department of Fish and Game, Inland Fisheries Division. Rancho Cordova, CA.

Pister, P. 1965. The trout fishery of Crowley Lake, Mono County, CA. n.p.

Ponder, G. W., and J. M. Deinstadt. 1978. California wild trout management program; Lower Owens River management plan. California Department of Fish and Game, Resources Agency. Sacramento, CA.

Raleigh, R. F., L. D. Zuckerman, and P. C. Nelson. 1986. Habitat suitability index models and instream flow suitability curves: brown trout. (Biological Report 82[10.124].) U.S. Fish and Wildlife Service, Washington, DC.

Raleigh, R. F., T. Hickman, R. C. Solomon, and P. C. Nelson. 1984. Habitat suitability information: rainbow trout. (Biological Report 82 [10.60].) U.S. Fish and Wildlife Service, Washington, DC.

Sada, D. W. 1977. The effects of reservoir fluctuations on brown trout (*Salmo trutta L.*) spawning success in Rush Creek, tributary to Grant Lake, Mono County, California. California State University. Long Beach, CA.

___________. 1978. A survey of spawning preferences, locations and limitations of the brown trout population inhabiting Grant Lake, Mono County, California. U.S. Forest Service. Inyo National Forest, CA.

Simmons, R. K. 1991. Lee Vining Creek channel stability. Aquatic Resource Specialists. Walnut Creek, CA. Prepared for Trihey & Associates, Walnut Creek, CA.

Smith, O. R., and P. R. Needham. 1935. A stream survey in the Mono and Inyo National Forests, California, 1934. U.S. Bureau of Fisheries, Department of Commerce. Washington, DC.

Stine, S. 1992a. Past and present geomorphic, hydrologic, and vegetative conditions on Lee Vining Creek. Appendix A. Pages 1-7 in M. Katzel (ed.), Comparison of historic and existing conditions on lower Lee Vining Creek, Mono County, California. Final draft. Prepared by Trihey & Associates, Walnut Creek, CA.

___________. 1992b. Oast and present geomorphic, hydrologic, and vegetative conditions on Rush Creek. Prepared for Trihey & Associates, Walnut Creek, CA.

Stuber, R. J., G. Gebhart, and O. E. Maughan 1982. Habitat suitability index models: largemouth bass. (Fish and Wildlife Services, OBS-82/10.16.) U.S. Fish and Wildlife Service, Western Energy and Land-Use Team, Division of Biological Services, Research and Development. [Washington, DC.]

Superior Court of the State of California for the County of El Dorado. 1990. Coordination proceeding - special title (Rule 1550[b]), streamflow. Volume II. South Lake Tahoe, CA.

Tennant, D. L. 1975. Instream flow regimes for fish, wildlife, recreation and related environmental resources. U.S. Fish and Wildlife Service. Billings, MT.

Trihey & Associates. 1991. A conceptual plan for the restoration of aquatic and riparian habitats in Rush and Lee Vining Creeks, Mono County, California. Trihey & Associates. Walnut Creek, CA.

___________. 1992a. Comparison of historic and existing conditions on Lower Lee Vining Creek, Mono County, California. Final draft. January. Walnut Creek, CA.

___________. 1992b. 1992 pilot project treatments for Lee Vining Creek, Mono County, California. April 1, 1992. Walnut Creek, CA.

Vestal, E. H. 1954. Creel returns from Rush Creek test stream, Mono County, California, 1947-1951. California Fish and Game 40[2]:89-104.

__________. 1990. See Superior Court for the State of California for the County of El Dorado, 1990. Volumes I and II.

Wesche, T. A., and P. A. Richard. 1980. Summary of instream flow methods for fisheries and related research needs. (Eisenhower Consortium Bulletin 9.) Water Resources Research Institute, University of Wyoming. Laramie, WY.

Wesco. 1981. Letter report regarding fishery impacts of the Leggitt hydroelectric project, Mono County to Mr. J. M. Keating, Keating Associates, Placerville, CA. San Rafael, CA.

Williams, R. P. 1975. Erosion and sediment transport in the Owens River near Bishop, California. (Water-Resources Investigations 49-75.) U.S. Geological Survey. Sacramento, CA.

Personal Communications

Bontadelli, Pete. Director. California Department of Fish and Game, Sacramento, CA. April 14, 1988 - letter to Dr. C. David Vanicek, California-Nevada Chapter of the American Fisheries Society.

Dalton, Brian. Aquatic biologist. Trihey & Associates, Walnut Creek, CA. May 4, 1993 - facsimile to Bill Mitchell regarding summary of completed Rush Creek restoration work.

Deinstadt, John. Fishery biologist. California Department of Fish and Game, Rancho Cordova, CA. November 15, 1990 - telephone conversation with Jeff Kozlowski.

English, Scott. Stream restoration specialist. Northwest Biological Consulting, Ashland, OR. December 8, 1992 - memorandum to Restoration Technical Committee regarding 1991-1992 treatment work in Segments 1, 2, and 3 of Lee Vining Creek; May 6, 1993 - telephone conversation regarding channel and habitat restoration on Parker and Walker Creeks.

Gibbons, Boyd. Director. California Department of Fish and Game, Sacramento, CA. February 19, 1992 - letter and addendum to interested parties regarding Rush Creek Instream Needs Investigation Final Report.

Hubbs, Carl. Ichthyologist. See Moyle 1976.

Lipp, Thomas. Warden. California Department of Fish and Game, Bishop, CA. October 4, 1991 - telephone conversation regarding discussion of DFG trout planting schedule and location in Lower Owens River.

Loudermilk, Bill. Associate fishery biologist. California Department of Fish and Game, Resources Agency, Sacramento, CA. January 11, 1983 - memorandum regarding Crowley Lake, Mono County: summary of rainbow trout, brown trout, and Sacramento perch summer food habitats evaluation, 1982.

Miller, R. R. Ichthyologist. See Moyle 1976.

Milliron, Curtis. Fishery biologist. California Department of Fish and Game, Bishop, CA. October 4, 1991 - telephone conversation regarding fish species present in Lower Owens River and reservoir.

Parmenter, Steve. Fishery biologist. California Department of Fish and Game, Bishop, CA. November 30, 1990 - Memorandum regarding planting of brown trout in Parker and Walker Creeks (Mono County) to Region 5 files.

Parnell, Jack C. Director. California Department of Fish and Game, Sacramento, CA. See Environmental Assessment 1984.

Pickard, Alan. Fishery biologist. California Department of Fish and Game, Bishop, CA. November 1, 1991 - telephone conversation regarding Lower Owens River and Haiwee Reservoir.

Pister, Edwin P. Associate fishery biologist. California Department of Fish and Game, Sacramento, CA. See Moyle 1976; see Sada 1977; see EA Engineering, Science, and Technology 1989.

Stine, Scott. Ph.D. researcher. Berkeley, CA. January 14, 1992 - text of report given at Restoration Technical Committee.

Tillemans, Brian. Range and wildlife specialist. Los Angeles Department of Water and Power, Bishop, CA. November 4, 1991 - telephone conversation regarding Lower Owens River and habitat management plan.

Trihey, E. Woody. Principal. Trihey & Associates, Walnut Creek, CA. June 13, 1992 - letter to Randy Neudeck of LADWP regarding release of excess water stored in Grant Lake reservoir.

Vestal, Eldon H. Fisheries biologist. California Department of Fish and Game, Sacramento, CA. See Moyle 1976.

White, Brian. Biologist. Los Angeles Department of Water and Power, Los Angeles, CA. February 10, 1992 - telephone conversation regarding Haiwee Reservoir.

Wong, Darrell. Fishery biologist. California Department of Fish and Game, Sacramento, CA. June 16, 1982 -memorandum discussing Pleasant Valley reservoir electroshock survey, 1981; June 23, 1986 - memorandum discussing current knowledge of the Crowley Lake/Upper Owens River fishery with reference to potential changes in angling regulations.

Worthley, Fred. Regional manager. California Department of Fish and Game, Region 5, Long Beach, CA. December 2, 1987 - letter to Dr. Carl Mesick, EA Engineering, Science, and Technology, Lafayette, CA.