CHAPTER III
ENVIRONMENTAL PROBLEMS

Based on the existing environmental conditions described previously, the following discussion identifies water-related environmental problems in the primary study area. Overall, there has been a general decrease in the quantity and quality of native habitat, and a subsequent decrease in the population of many individual plant and animal species. This has resulted in a growing number of threatened and endangered species inhabiting the region.

SHASTA LAKE AND TRIBUTARIES SUB-AREA

The follow discussion of environmental problems in the Shasta Lake and Tributaries sub-area is divided into two categories: problems related to warm-water and cold-water fisheries, and problems related to wetlands and riparian habitat.

Warm-water and Cold-water Fisheries

Within Shasta Lake itself, the primary problems related to warm-water and cold-water fisheries are acid mine drainage; lack of shallow-water, shoreline habitat; and human disturbances.

- **Acid mine drainage –** Acid mine drainage causes periodic fish kills in Shasta Lake, primarily during periods of high rainfall runoff. The areas of Shasta Lake most affected by acid mine drainage are the Little Backbone and West Squaw Creek arms, and the peninsula between the McCloud and Squaw Creek arms. Remedial actions have not been taken at many area mines contributing to fish kills.
- **Lack of shallow-water, shoreline habitat –** The shoreline of Shasta Lake provides important shallow-water habitat for warm-water fisheries and juvenile fish. However, shoreline cover in the form of vegetation and wood debris is very limited around the lake. This is primarily due to annual fluctuations in lake level that prevent the establishment of vegetation and accelerate shoreline erosion within the drawdown area. Other contributing factors include wavewash erosion from watercraft and the annual removal of woody debris.
- **Human disturbances –** Human disturbances have also contributed to a reduction in native fisheries in Shasta Lake. These include physical disturbances caused by watercraft (particularly around the mouths of tributaries) and pollution from houseboats and personal watercraft.

Problems related to fisheries differ somewhat on the tributaries to Shasta Lake, and include modification of seasonal flows; loss of access to historic spawning and rearing areas; and acid mine drainage.

- **Modification of seasonal flows –** Seasonal flow patterns have been significantly modified on some tributaries to Shasta Lake by dams and hydropower diversions, particularly the McCloud and Pit rivers. Most of the flow in the McCloud River is diverted to the Pit River at the McCloud Dam, significantly changing the hydrology of the lower McCloud River. Similarly, there are numerous hydropower diversions along the Pit River that reduce flow in

the stream channel, increase water temperatures, and cause rapid fluctuations in hydropower diversion impoundments. Changes in seasonal flow patterns are significant because they can alter the geomorphic characteristics of a river channel, disturbing sediment transport, impair water quality, and reduce instream aquatic and riparian habitat.

- **Loss of access to historic spawning and rearing areas –** Water resources development on the tributaries to Shasta Lake has also blocked access to historic fish spawning and rearing habitat, primarily on the McCloud and Pit rivers. Loss of historic spawning habitat on the McCloud River after the construction of McCloud Dam lead to the extirpation of the McCloud bull trout population. Similarly, populations of native fish are prevented from moving along the lower Pit River by numerous dams and reservoirs.

- **Acid mine drainage –** Acid mine drainage is problematic on numerous smaller tributaries to Shasta Lake, including Little Backbone Creek and West Squaw Creek. Aquatic life can no longer be supported in several tributaries due to toxicity from acid runoff and high metal concentrations in streambed soils. Abandoned mines also contribute large amounts of sediment to area streams, which can increase turbidity and reduce juvenile fish survival. As noted previously, the tributaries to Shasta Lake provide important spawning and rearing habitat for native fish species.

Riparian and Wetland Habitat

Problems related to riparian and wetland habitat in the Shasta Lake and Tributaries sub-area include increased erosion and sediment input, and non-native species.

- **Increased erosion and sediment input –** Increased erosion and sedimentation can degrade riparian and wetland habitat in tributaries to Shasta Lake. Excessive sediment input to area streams can impede riparian vegetation succession and prematurely fill-in wetland and meadowland areas. The increase in erosion and sediment input is due to a combination of factors, including fire suppression, severe wildfires, timber harvesting, unpaved forest roads, livestock grazing, and other land management practices.

- **Non-native species –** Non-native species have colonized large portions of the primary study area and replaced native habitats, especially riparian habitats. Invasive exotic species can out-compete native vegetation and change the type, density, and/or value of habitat provided. Invasive species of concern include yellow star thistle, Himalayan blackberry, Scotch broom, and various grasses. Mitigation for exotic species has been limited to small sites adjacent to Shasta Lake.

SHASTA DAM TO RED BLUFF SUB-AREA

Environmental problems in the Shasta Dam to Red Bluff sub-area are separated into two categories: problems related to anadromous fish, and problems related to riparian, floodplain, and wetland habitat.

Anadromous Fish

The primary problems related to anadromous fish in the Shasta Dam to Red Bluff sub-area include water temperature; physical migration barriers; diversions and flow regulation; reduction in suitable spawning gravels; acid mine drainage, and unnatural predation rates.

- **Water temperature –** Water temperatures that are too high, or too low, during certain periods can be detrimental to anadromous fish. High water temperatures can harm spawning adults, reduce egg viability, increase juvenile fry mortality, reduce overall water quality, and generally diminish the resulting ocean population and number of return spawners. Temperatures that are too cold, on the other hand, can slow the growth of fall- and late fall-run juveniles and reduce their chance of successful out-migration. Minimum flow requirements and the construction of a temperature control device on Shasta Dam have improved water temperature conditions on the Sacramento River, but there is still a need for cooler water during dry and critically dry years. Temperature conditions on tributaries also play an important role in sustaining anadromous fish populations. Agricultural water diversions and the loss of streamside riparian habitat can elevate water temperatures on the tributaries, notably on Battle, Cow, and Cottonwood creeks.

- **Physical migration barriers –** One of the most significant factors contributing to the decline in anadromous fish populations is the construction of dams and other physical migration barriers that have blocked access to hundreds of miles of historic spawning and rearing habitat. These migration barriers are present along the Sacramento River as well as many of its tributaries, including Battle Creek and Cow Creek. Barriers and impediments along the Sacramento River include the RBDD, ACID Diversion Dam, Keswick and Shasta dams. While fish passage is permitted at the Red Bluff and ACID diversion dams via fish ladders and gate operations, they nevertheless pose a significant impediment to upstream and downstream migration. Dams on Battle and Cow creeks block access to cooler, upper watershed stream habitat.

- **Diversions and flow regulation –** Diversions from the Sacramento River, and its tributaries, can significantly reduce flows during low-flow periods. These flow reductions, in turn, can affect anadromous fish by increasing water temperatures, increasing predation, and disorientating migrating adults and juveniles. Diversions can also cause rapid fluctuations in river flows that result in sidebar stranding and juvenile mortality. Flow regulation and diversions on important spawning tributaries, such as Clear Creek and Battle Creek, can cause similar problems for anadromous fish. Flow regulation also effects the natural, geomorphic processes that help to maintain and replenish healthy aquatic habitat; this includes processes that move gravel downstream, flushing flows that clean spawning gravels, and channel-forming processes that help establish pools/riffles and shaded riparian aquatic habitat.

- **Reduction in suitable spawning gravels –** While physical migration barriers have blocked access to historic spawning areas, they have also blocked historic instream gravel resources. The mountainous tributaries upstream from Shasta Dam once provided a significant source of high-quality gravels to the Sacramento River. Loss of these gravel recruitment sources has resulted in an overall decrease in the amount of suitable spawning gravel for anadromous fish in the upper Sacramento River. This is most clearly evidenced by the scoured, bedrock

channel immediately downstream from Keswick Dam. Smaller dams and other water resources projects on Sacramento River tributaries downstream from Keswick Dam, including Clear Creek and Battle Creek, have further reduced the amount of gravel entering the Sacramento River. Instream gravel mining operations on the Sacramento River and tributaries such as Cottonwood Creek have also reduced the amount of available spawning gravel. Spawning gravel could become a limiting factor in the recovery of anadromous fish populations in the Sacramento River basin.

- **Acid mine drainage –** Acid mine drainage can be a key contributor to water quality problems in the Sacramento River, resulting in periodic fish kills and aquatic habitat degradation. One of the largest contributors to acid mine drainage in the Sacramento River is the mine complex, west of Keswick Reservoir. Toxic runoff from this area enters Keswick Reservoir, and releases from Keswick Damcan be adjusted to reduce the impact on Sacramento River water quality. However, the drainage continues to contribute large amounts of copper, cadmium, and other heavy metals to the Sacramento River.

- **Unnatural predation rates –** Fish predation can be unnaturally high in the impoundments created by water diversions and dams. High predation occurs in Lake Red Bluff and in pool areas just downstream from the diversion dam. High predation can also occur at the downstream side of fish ladders, where fish often rest or queue before entering the ladder. Unusually low flows during dry and critically dry years can also increase fish predation by reducing the number of deep pools, limiting access to cover, and stranding fish in streamside channels or gravel pits.

Riparian, Floodplain, and Wetland Habitat

The primary problems related to riparian, floodplain, and wetland habitat in the Shasta Dam to Red Bluff sub-area include: changes to natural geomorphic processes; urban and agricultural encroachment and other land management changes; and invasive species.

- **Changes to natural geomorphic processes –** Flow regulation, dams, and diversions have changed the natural flow patterns in the Sacramento River and many of its tributaries. These changes have altered channel geomorphology and changed how channels interact with adjacent floodplains. Channel-forming processes drive riparian habitat succession and are integral to the health of floodplain habitats. Changes in channel geomorphology have resulted in a decline in the quantity, quality, and connectivity of riparian and floodplain habitat. Some floodplain areas no longer interact with adjacent stream channels due to decreased streamflows. In other reaches, river channels experience less lateral movement, impairing the regeneration and succession of streamside riparian vegetation.

- **Urban and agricultural encroachment, and other land management changes –** Land development has had a significant impact on riparian, floodplain, and wetland habitat in the sub-area. Urban encroachment along the Sacramento River in the Red Bluff to Redding reach has reduced the quality, quantity, and connectivity floodplain and riparian habitat. Lower Clear Creek has experienced similar problems along its riparian corridor. Riparian habitat is highly fragmented in many areas and gravel mining has modified floodplains. Along the tributaries to the Sacramento River, cattle grazing adjacent to streams and

wetlands, gravel mining, timber and ranchland management practices, and urban/agricultural encroachment have decreased the quality and quantity of riparian corridors.

- **Invasive species -** Non-native species have colonized large portions of the primary sub-area and changed native habitats, especially riparian and grassland habitats. Competition by non-native invasive species has reduced the diversity of riparian habitats and the wildlife that use these habitats. Invasive species of concern include yellow star thistle, Himalayan blackberry, arundo (giant reed), pampas grass, fig, Scotch broom, and various grasses.

OTHER ENVIRONMENTAL CONDITIONS IMPACTED BY HUMAN USES

Several human-induced environmental impacts have been discussed in the previous sections, including the impacts of mining operations, dams and hydropower development, and fire suppression. Other environmental impacts from human settlement and uses of lands within the sub-area include those associated with transportation and forest roads, recreation, and urbanization. These impacts tend to be similar in both of the study sub-areas, and generally less damaging than the problems previously discussed.

- **Transportation** - Road development within the study area tends to be low on public lands and denser on privately owned lands, particularly those lands that are used for timber harvesting. Many forest roads are not surfaced (paved or graveled) or regularly maintained, leading to erosion and accelerated transport of sediment into area streams. Recently, the FS has been identifying and decommissioning forest roads that are no longer needed for management of public lands or access to private lands. Major roads may also pose migration barriers to area wildlife, particularly Interstate 5.

- **Recreation –** Recreation in the region includes boating and water skiing, angling, camping, hiking, spelunking, and sightseeing. Negative environmental impacts include water and noise pollution, which result from the use of marinas, watercraft, campgrounds, off-road vehicles and OHV parks, and other recreation facilities, and wildlife disturbance. Because the quality of recreation in the region is often associated with its natural beauty and remoteness, many recreation facilities are low-use or low-density and have less significant environmental impacts.

- **Urbanization –** Urban development is limited within the region to the Redding and Red Bluff areas, various small communities, seasonal recreational facilities, and summer homes. Urban impacts are primarily related to water quality (stormwater and waste runoff) and noise pollution. However, the environmental impacts of urbanization and infrastructure tend to be site-specific compared with far-reaching effects of other human activities, such as timber harvesting and mining.

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