riparian habitat through permanent removal of habitat to construct roads, penstocks, powerhouses, canals, and dams. Impacts of reservoirs include flooding of riparian vegetation and impediments to establishment of new shoreline vegetation by fluctuating water levels. Dams can alter the temperature and sediment load of the rivers they impound (Cole and Landres 1996, p. 175). Dams, water diversions, and their associated structures can also alter the natural flow regime with unseasonal and fluctuating releases of water (Kondolf *et al.* 1996, p. 1014). We expect most such effects to occur in stream systems below the extant range of the mountain yellow-legged frogs, although it is possible that stream localities at the northern extent of the range or at low elevations may be affected (see also CDFW 2013, pp. 2–4).

The extent of past impacts to mountain yellow-legged frog populations from habitat loss or modification due to reservoir projects has not been quantified. CDFW (2013, p. 3) has noted that there are locations where the habitat inundated as the result of dam construction (for example, Lake Aloha in the Desolation Wilderness) may have been of higher quality for mountain yellow-legged frogs than the created impoundment. Reservoirs can provide habitat for introduced predators, including fish, bullfrogs, and crayfish, and in some cases, the past construction of reservoirs has facilitated the spread of nonnative fish (CDFW 2013, pp. 3, 4). In such cases, reservoirs may function as barriers to movement of mountain yellow-legged frogs. However, CDFW reported observing mountain yellow-legged frogs dispersing through fishless reservoirs (CDFW 2013, p. 4). (For a complete discussion of the impacts of fish stocking see Habitat Modification Due to Introduction of Trout to Historically Fishless Areas above and the discussion under Factor C.).

Most of the dams constructed within the historic range of the mountain yellow-legged frogs are small streamflow-maintenance dams (CDFW 2013, p. 13) at the outflows of high-elevation lakes. These small dams may create additional habitat for the species and can act as barriers to fish migration from downstream tributaries into fishless habitats, although they do not impede frog movement (CDFW 2013, p. 3). CDFW staff (2013, p. 13) have observed that extant frog populations may have persisted where such dams have helped to preserve a fishless environment behind the dam.

Based on comments from CDFW and others and the provision of additional information, we have reviewed the analysis of dams and diversions that we presented in the proposed rule. We find that most large facilities are below the current range of the mountain yellow-legged frogs and have revised our finding. In the proposed rule, we stated that dams and diversions presented a moderate, prevalent threat to persistence and recovery of the species. In this final rule, we find that dams and water diversions present a minor, localized threat to persistence and recovery of the species where structures occur.

Livestock Use (Grazing)

The combined effect of legacy conditions from historically excessive grazing use and current livestock grazing activities has the potential to impact habitat in the range of the mountain yellow-legged frog. The following subsections discuss the effects of excessive historical grazing, current extent of grazing, and current grazing management practices. As discussed below, grazing has the potential to reduce the suitability of habitat for mountain yellow-legged frogs by reducing its capability to sustain frogs and facilitate dispersal and migration, especially in stream areas.

Grazing of livestock in riparian areas impacts the function of the aquatic system in multiple ways, including soil compaction, which increases runoff and decreases water availability to plants; vegetation removal, which promotes increased soil temperatures and evaporation rates at the soil surface; and direct physical damage to the vegetation (Kauffman and Krueger 1984, pp. 433–434; Cole and Landres 1996, pp. 171–172; Knapp and Matthews 1996, pp. 816–817). Streamside vegetation protects and stabilizes streambanks by binding soils to resist erosion and trap sediment (Kauffman *et al.* 1983, p. 683; Chaney *et al.* 1990, p. 2). Grazing within mountain yellow-legged frog habitat has been observed to remove vegetative cover, potentially exposing frogs to predation and increased desiccation (Knapp 1993b, p. 1; Jennings 1996, p. 539), and to lead to erosion which may silt in ponds and thereby reduce the water depth needed for overwinter survival (Knapp 1993b, p. 1). However, an appropriately managed grazing regime (including timing and intensity) can enhance primary riparian vegetation attributes that are strongly correlated to stream channel and riparian soil stability conditions necessary to maintain a functioning riparian system (George *et al.* 2011, p. 227). Although, where highly degraded conditions such as downcut channels exist, grazing management alone may not be sufficient to restore former riparian conditions (George *et al.* 2011, p. 227).

Aquatic habitat can also be degraded by grazing. Mass erosion from trampling and hoof slide causes streambank collapse and an accelerated rate of soil transport to streams (Meehan and Platts 1978, p. 274). Accelerated rates of erosion lead to elevated instream sediment loads and depositions, and changes in stream-channel morphology (Meehan and Platts 1978, pp. 275–276; Kauffman and Krueger 1984, p. 432). Livestock grazing may lead to diminished perennial streamflows (Armour *et al.* 1994, p. 10). Livestock can increase nutrient-loading in water bodies due to urination and defecation in or near the water, and can cause elevated bacteria levels in areas where cattle are concentrated (Meehan and Platts 1978, p. 276; Stephenson and Street 1978, p. 156; Kauffman and Krueger 1984, p. 432). With increased grazing intensity, these adverse effects to the aquatic ecosystem increase proportionately (Meehan and Platts 1978, p. 275; Clary and Kinney 2000, p. 294).

Observational data indicate that livestock can negatively impact mountain yellow-legged frogs by altering riparian habitat (Knapp 1993a, p. 1; 1993b, p. 1; 1994, p. 3; Jennings 1996, p. 938; Carlson 2002, pers. comm.; Knapp 2002a, p. 29). Livestock tend to concentrate along streams and wet areas where there is water and herbaceous vegetation; grazing impacts are, therefore, most pronounced in these habitats (Meehan and Platts 1978, p. 274; U.S. Government Accounting Office (GAO) 1988, pp. 10–11; Fleischner 1994, p. 635; Menke *et al.* 1996, p. 17). This concentration of livestock contributes to the destabilization of streambanks, causing undercuts and bank failures (Kauffman *et al.* 1983, p. 684; Marlow and Pogacnik 1985, pp. 282–283; Knapp and Matthews 1996, p. 816; Moyle 2002, p. 55). Grazing activity can contribute to the downcutting of streambeds and lower the water table. The degree of erosion caused by livestock grazing can vary with slope gradient, aspect, soil condition, vegetation density, and accessibility to livestock, with soil disturbance greater in areas overused by livestock (Meehan and Platts 1978, pp. 275–276; Kauffman *et al.* 1983, p. 685; Kauffman and Krueger 1984, p. 432; Bohn and Buckhouse 1985, p. 378; GAO 1988, p. 11; Armour *et al.* 1994, pp. 9–11; Moyle 2002, p. 55).

Livestock grazing may impact other wetland systems, including ponds that can serve as mountain yellow-legged frog habitat. Grazing can modify shoreline habitats by removing overhanging banks that provide shelter, and grazing contributes to the siltation of breeding ponds. Bradford (1983, p. 1179) and Pope (1999, pp. 43–44) have documented the importance of deep lakes to overwinter survival of these species. We expect that pond siltation due to grazing may reduce the depth of breeding ponds and cover underwater crevices in some circumstances where grazing is heavy and where soils are highly erodable, thereby making the ponds less suitable, or unsuitable, as overwintering habitat for tadpoles and adult mountain yellow-legged frogs.

Effects of Excessive Historical Grazing

In general, historical livestock grazing within the range of the mountain yellow-legged frog was at a high (although undocumented), unregulated and unsustainable level until the establishment of National Parks (beginning in 1890) and National Forests (beginning in 1905) (UC 1996a, p. 114; Menke *et al.* 1996, p. 14). Historical evidence indicates that heavy livestock use in the Sierra Nevada has resulted in widespread damage to rangelands and riparian systems due to sod destruction in meadows, vegetation destruction, and gully erosion (see review in Brown *et al.* 2009, pp. 56–58). Within the newly established National Parks, grazing by cattle and sheep was eliminated, although grazing by packstock, such as horses and mules, continued. Within the National Forests, the amount of livestock grazing was gradually reduced, and the types of animals shifted away from sheep and toward cattle and packstock, with cattle becoming the dominant livestock. During World Wars I and II, increased livestock use occurred on National Forests in the west, causing overuse in the periods 1914–1920 and 1939–1946. Between 1950 and 1970 livestock numbers were permanently reduced due to allotment closures and uneconomical operations, with increased emphasis on resource protection and riparian enhancement. Further reductions in livestock use began again in the 1990s, due in part to USFS reductions in permitted livestock numbers, seasons of use, implementation of rest-rotation grazing systems, and to responses to drought (Menke *et al.* 1996, pp. 7, 8). Between 1981 and 1998, livestock numbers on National Forests in the Sierra Nevada decreased from 163,000 to approximately 97,000 head, concurrent with Forest Service implementation of standards and guidelines for grazing and other resource management (USFS 2001, pp. 399–416).

Effects of Current Grazing

Yosemite, Sequoia, and Kings Canyon National Parks remain closed to livestock grazing. On USFS-administered lands that overlap the historical ranges of the mountain yellow-legged frog in the Sierra Nevada, there are currently 161 active Rangeland Management Unit Allotments for livestock grazing. However, based on frog surveys performed since 2005, only 27 of these allotments have extant mountain yellow-legged frog populations, while some allotments that were located in sensitive areas have been closed (USFS 2008, unpubl. data; CDFW (CDFG) unpubl. data). As of 2009, USFS data indicated that grazing occurs on about 65 percent of National Forest lands within the range of the mountain yellow-legged frog; that livestock numbers remain greatly reduced from historical levels; and that numerous watershed restoration projects have been implemented, although grazing may still impact many meadows above mid-elevation and restoration efforts are far from complete (Brown *et al.* 2009, pp. 56, 57). However, Brown *et al.* (2009, p. 56) report that livestock grazing is more likely to occur in certain habitat types used by mountain yellow-legged frogs than others, indicating that populations found in meadows, stream riparian zones, and lakes in meadows are more likely to encounter habitat effects of grazing than populations found in the deeper alpine lakes that the species more likely inhabit (Brown *et al.* 2009, p. 56).

USFS standards and guidelines in forest land and resource management plans have been implemented to protect water quality, sensitive species, vegetation, and stream morphology. Further, USFS standards have been implemented in remaining allotments to protect aquatic habitats (see discussion of the aquatic management strategy under Factor D for examples). USFS data from long-term meadow monitoring collected from 1999 to 2006 indicate that most meadows appear to be in an intermediate quality condition class, with seeming limited change in condition class over the first 6 years of monitoring. In addition, USFS grazing standards and guidelines are based on current science and are designed to improve or maintain range ecological conditions, and standards for managing habitat for threatened, endangered, and sensitive species have also been incorporated (Brown *et al.* 2009, pp. 56–58). The seasonal turn-out dates (dates at which livestock are permitted to move onto USFS allotments) are set yearly based on factors such as elevation, annual precipitation, soil moisture, and forage plant phenology, and meadow readiness dates are also set for montane meadows. However, animals turned out to graze on low-elevation range (until higher elevation meadows are ready) may reach upper portions of allotments before the meadows have reached range readiness (Brown *et al.* 2009, p. 58).

Menke *et al.* (1996) have reported that grazing livestock in numbers that are consistent with grazing capacity and use of sustainable methods led to better range management in the Sierra Nevada over the 20 years prior to development of the report. They also noted that moderate livestock grazing has the potential to increase native species diversity in wet and mesic meadows by allowing native plant cover to increase on site. Brown *et al.* (2009, p. 58) expect proper livestock management, such as proper timing, intensity, and duration, to result in a trend towards increased riparian species and a trend towards restored wet and mesic meadows on National Forests. To date, the scientific and commercial information available to us does not include descriptive or cause-effect research that establishes a causal link between habitat effects of livestock grazing and mountain yellow-legged frog populations; however, anecdotal information of specific habitat effects suggests that, in specific locations, the current grazing levels may have population-level effects (see Knapp 1993b, p. 1; Brown *et al.* 2009, p. 56). In addition, where low-elevation populations occur in meadows, additional conservation measures may be required for recovery (USFS 2013, p. 5).

In summary, the legacy effects to habitat from historical grazing levels, such as increased erosion, stream downcutting and headcutting, lowered water tables, and increased siltation, are a threat to mountain yellow-legged frogs in those areas where such conditions still occur and may need active restoration. In the proposed rule, we stated that grazing presented a minor prevalent threat. Based on USFS and public comments, we have reevaluated our analysis of grazing to clarify effects of past versus current grazing. We have reworded the finding to more accurately reflect the contribution of legacy effects of past grazing levels to this threat assessment, as follows: Current livestock grazing activities may present an ongoing, localized threat to individual populations in locations where the populations occur in stream riparian zones and in small waters within meadow systems, where active grazing co-occurs with extant frog populations. Livestock grazing that complies with forest standards and guidelines is not expected to negatively affect mountain yellow-legged frog populations in most cases, although limited exceptions could occur, especially where extant habitat is limited. In addition, mountain yellow-legged frogs may be negatively affected where grazing standards are exceeded. Rangewide, current livestock grazing is not a substantial threat to the species.

Mining

Several types of mining activities have occurred, or may currently occur, on National Forests, including aggregate mining (the extraction of materials from streams or stream terraces for use in construction), hardrock mining (the extraction of minerals by drilling or digging into solid rock), hydraulic mining (a historical practice using pressurized water to erode hillsides, outlawed in 1884), placer mining (mining in sand or gravel, or on the surface, without resorting to mechanically assisted means or explosives), and suction-dredge mining (the extraction of gold from riverine materials, in which water, sediment, and rocks are vacuumed from portions of streams and rivers, sorted to obtain gold, and the spoils redeposited in the stream (see review in Brown *et al.* 2009, pp. 62–64).

Aggregate mining can alter sediment transport in streams, altering and incising stream channels, and can cause downstream deposition of sediment, altering or eliminating habitat. Aggregate mining typically occurs in large riverine channels that are downstream of much of the range of the mountain yellow-legged frog complex (see review in Brown *et al.* 2009, pp. 62–64). However, Brown *et al.* (2009, pp. 62–64) note that effects of aggregate mining may occur in some portions of the Feather River system where such operations occur within the historic range of the Sierra Nevada yellow-legged frog, and potentially in localized areas within the range of both species, where the USFS maintains small quarries for road work. They note that, although effects of aggregate mining on mountain yellow-legged frogs are unstudied, impacts are probably slight.

Hardrock mining can be a source of pollution where potentially toxic metals are solubilized by waters that are slightly acidic. Past mining activities have resulted in the existence of many shaft or tunnel mines on the forest in the Sierra Nevada, although most are thought to occur below the range of the species. Most operations that are thought to have the potential to impact the mountain yellow-legged frogs occur in the lower elevation portions of the Sierra Nevada yellow-legged frog range on the Plumas National Forest and in the ranges of both species on the Inyo National Forest (see review in Brown *et al.* 2009, pp. 62–64).

Hydraulic mining has exposed previously concealed rocks that can increase pollutants such as acid, cadmium, mercury, and asbestos, and its effect on water pollution may still be apparent on the Feather River. However, most of the area that was mined in this way is below the elevation where Sierra Nevada yellow-legged frogs are present, so effects are likely highly localized (see review in Brown *et al.* 2009, pp. 63, 64). Although placer mining was dominant historically, today it's almost exclusively recreational and is not expected to have habitat-related effects.

Brown *et al.* (2009, p. 64) report that suction-dredge mining is also primarily recreational noting that, because nozzles are currently restricted to 6 inches or smaller, CDFW (CDFG, 1994) expects disturbed areas to recover quickly (although CDFW notes that such dredging may increase suspended sediments, change stream geomorphology, and bury or suffocate larvae). Suction dredge mining occurs primarily in the foothills of the Sierra Nevada, thus presenting a risk primarily to mountain yellow-legged frog populations at the lower elevations of the species' range. Suction dredging is highly regulated by the CDFW, and in the past, many streams have been seasonally or permanently closed (see review in Brown *et al.* 2009, p. 64). Currently CDFW has imposed a moratorium on suction dredging.

The high-elevation areas where most Sierra Nevada yellow-legged frogs and mountain yellow-legged frogs occur are within designated wilderness, where mechanical uses are prohibited by the Wilderness Act. Designated wilderness was withdrawn for new mining claims on January 1, 1984, although a limited number of active mines that predated the withdrawal still occur within wilderness (see Wilderness Act under Factor D, below). Therefore, we expect that mining activities may pose local habitat-related impacts to the species at specific localities where mining occurs.

Packstock Use

Similar to cattle, horses and mules may significantly overgraze, trample, or pollute riparian and aquatic habitat if too many are concentrated in riparian areas too often or for too long. Commercial packstock trips are permitted in National Forests and National Parks within the Sierra Nevada, often providing transport services into wilderness areas through the use of horses or mules. Use of packstock in the Sierra Nevada increased after World War II as road access, leisure time, and disposable income increased (Menke *et al.* 1996, p. 919). Packstock grazing is the only grazing currently permitted in the National Parks of the Sierra Nevada. Since the mid-1970s, National Forests and National Parks have generally implemented regulations to manage visitor use and group sizes, including measures to reduce packstock impacts to vegetation and soils in order to protect wilderness resources. For example, Sequoia and Kings Canyon National Parks have the backcountry area with the longest history of research and management of packstock impacts (Hendee *et al.* 1990, p. 461). Hendee *et al.* (1990, p. 461) report that the extensive and long-term monitoring for Sequoia, Kings Canyon, and Yosemite National Parks makes it possible to quantify impacts of packstock use, showing that the vast majority of Sierra Nevada yellow-legged frog and mountain yellow-legged frog populations in the Parks show no to negligible impacts from packstock use (National Park Service 2013, p. 3). In the Sixty-Lakes Basin of Kings Canyon National Park, packstock use is regulated in wet meadows to protect mountain yellow-legged frog breeding habitat in bogs and along lake shores from trampling and associated degradation (Vredenburg 2002, p. 11; Werner 2002, p. 2; National Park Service 2013, p. 3). Packstock use is also regulated in designated wilderness in National Forests within the Sierra Nevada.

Packstock use is likely a threat of low significance to mountain yellow-legged frogs at the current time, except on a limited, site-specific basis. As California's human population increases, the impact of recreational activities, including packstock use and riding on the National Forests in the Sierra Nevada, are projected to increase (USDA 2001a, pp. 473–474). However, on the Inyo National Forest, current commercial packstock use is approximately 27 percent of the level of use in the 1980s reflecting a decline in the public's need and demand for packstock trips. From 2001 to 2005, commercial packstock outfitters within the Golden Trout and South Sierra Wilderness Areas averaged 28 percent of their current authorized use (USFS