Chapter IV: Affected Environment

Introduction

This chapter presents topics included in the analysis of the *Merced Wild and Scenic River Revised Comprehensive Management Plan/Supplemental Environmental Impact Statement* (Revised Merced River Plan/SEIS) and a rationale for their inclusion. These topics were selected based on federal law, regulations and executive orders, National Park Service management policies, and concerns expressed by the public, park staff, or other agencies during the public scoping period. This chapter also provides a discussion of topics that were dismissed from further analysis.

Existing conditions are described based on the most recent analyses completed for each topic area. The affected environment described in this chapter covers the geographical area included with all of the alternatives, and also includes areas adjacent to the Merced River corridor. The potential impacts of each alternative within each topic area are presented in Chapter V, Environmental Consequences.

Because this document is a supplemental environmental impact statement to the original *Merced Wild and Scenic River Comprehensive Management Plan and Final Environmental Impact Statement* (Merced River Plan/FEIS), impact topics discussed below have been updated to reflect current conditions, where appropriate. In addition, some of the impact topics related to biological resources, cultural resources, and recreation in the El Portal area were updated to accurately reflect additional research conducted to identify and locate the Outstandingly Remarkable Values associated with these resources in the El Portal Administrative Site.

Impact Topics Considered in this Plan

Natural Resources

The federal and state Endangered Species Acts (and associated legislation), Clean Water Act, Clean Air Act, and NEPA require that the effects of any federal undertaking examine natural resources. In addition, the National Park Service management policies and natural resource management guidelines call for the consideration of natural resources in planning proposals. Significant natural resources (such as rare, threatened, and endangered species) exist within the park and the El Portal Administrative Site and could be affected by implementation of the alternatives.

Originating in Yosemite National Park, the Merced River traverses a region of abundant natural resources. It is therefore necessary to characterize both these natural resources and the environmental consequences to these resources that could result from implementation of Revised Merced River Plan/SEIS alternatives.

Analysis was performed for the following natural resource topics:

- Geology, Geohazards, and Soils
- Hydrology, Floodplains, and Water Quality
- Wetlands
- Vegetation

- Wildlife
- Rare, Threatened, and Endangered Species
- Air Quality
- Noise

Cultural Resources

The National Historic Preservation Act, the Archeological Resources Protection Act, Native American Graves Protection and Repatriation Act, and NEPA require that the effects of any federal undertaking on cultural resources be examined. In addition, National Park Service management policies and cultural resource management guidelines call for the consideration of cultural resources in planning proposals. Many historic and archeological sites, museum collections, historic buildings and structures, cultural landscape resources, and traditional cultural properties exist within the park and the El Portal Administrative Site and could be affected by the alternatives.

Analysis was performed for the following cultural resource topics:

- Archeological Resources
- Traditional Cultural Resources
- Historic Sites, Structures, and Landscapes

Visitor Experience

Stewardship of Yosemite National Park requires the consideration of two integrated purposes: (1) to preserve Yosemite's unique natural and cultural resources and scenic beauty, and (2) to make these resources available to visitors for study, enjoyment, and recreation. Different options for implementing a user capacity program and river boundaries in El Portal considered in the Revised Merced River Plan/SEIS could affect patterns of visitor use and the type and quality of visitor experiences.

Analysis was performed for the following visitor experience topics:

- Recreation
- Orientation and Interpretation
- Visitor Services
- Wilderness Experience
- Scenic Resources

Social Resources

Analysis of social resources examines the effects of visitation on the social environment within the park and in the surrounding region, and how visitors experience social resources within the park. Transportation is analyzed because elements of the user capacity program presented in the alternatives considered in this Revised Merced River Plan/SEIS could affect how visitors circulate within and/or access the park. The park's scenic resources are a major component of the park visitor's experience. Conserving the scenery is a crucial component to the National Park Service 1916 Organic Act and the park's enabling legislation. NEPA requires that socioeconomic impacts

of the Revised Merced River Plan/SEIS be addressed. The Revised Merced River Plan/SEIS could affect socioeconomic activity within the park and in the surrounding gateway communities.

Analysis was performed for the following social resource topics:

- Land Use
- Transportation
- Socioeconomics
- Park Operations and Facilities

Impact Topics Dismissed from Further Analysis

Environmental Justice

Environmental justice analyses determine whether a proposed action would have "disproportionately high and adverse human health or environmental effects . . . on minority populations and low-income populations." The National Park Service and other federal agencies have determined that a disproportionately high and adverse effect on minority and low-income populations means an adverse effect that:

(1) is predominately borne by a minority population and/or a low-income population, or

(2) will be suffered by the minority population and/or low-income population and is appreciably more severe or greater in magnitude than the adverse effect that will be suffered by the non-minority population and/or non-low-income population.

Potential adverse effects identified in an environmental justice analysis include air, noise, and water pollution; soil contamination; destruction or diminution of aesthetic values; destruction or disruption of community cohesion and economic vitality; displacement of public and private facilities and services; increased traffic congestion; and exclusion or separation of minority or low-income populations from the broader community. Of particular concern is the effect on property acquisition and displacement of people.

No aspect of any alternative in the Revised Merced River Plan/SEIS would result in disproportionately high and adverse human health or environmental effects on minority populations or low-income populations. Any restriction on travel, lodging accommodations, or access to any area of the park that might result from the Revised Merced River Plan/SEIS would be equally applied to all visitors, regardless of race or socioeconomic standing. In addition, it is expected that minority populations comprising a portion of Yosemite visitation come from areas outside the immediate Yosemite area, such as the Central Valley, San Francisco, and Los Angeles, and have a variety of other recreation options available to them besides Yosemite National Park. Although levels of park employee housing in various areas may be affected by decisions made under the Revised Merced River Plan/SEIS, employee housing decisions are not expected to result in destruction or disruption of community cohesion and economic vitality, displacement of public and private facilities and services, increased traffic congestion, and/or exclusion or separation of minority or low-income populations from the broader community.

Prime and Unique Agricultural Lands

There are no known agricultural lands directly involved in this plan, and thus no further discussion of this topic is necessary. Also, this plan would not have any direct or indirect effects to downstream agricultural lands.

Public Health and Safety

Public health and safety is not presented as a separate topic in this plan because many impact topic sections (water quality, recreation, park operations, and others) evaluate park-related public health and safety issues.

Museum Collection

The Yosemite Museum collection is not presented as a separate topic. This Revised Merced River Plan/SEIS, as a programmatic document, does not specifically call for any data collection activities. Future projects undertaken in the river corridor could require data collection. Any effect from these projects on the Yosemite Museum collection would be addressed under future compliance documents.

Regional Setting

Yosemite National Park lies on the western slope of the Sierra Nevada, a massive mountain range dividing central and northern California from more arid lands to the east. Elevations in the park range from approximately 2,000 to 13,114 feet. The total area within the park's authorized boundary is 761,266 acres. The El Portal Administrative Site is approximately 1,398 acres. U.S. Forest Service land surrounds the park and is divided into four national forests: Stanislaus, Toiyabe, Inyo, and Sierra. The park includes lands within Mariposa, Tuolumne, and Madera Counties and shares a boundary with Mono County.

Yosemite National Park is located about 200 miles east and 4 hours by car from San Francisco, and about 320 miles northeast and 6 hours by car from Los Angeles. There are five entrances to the park. Four are on the west side of the Sierra Nevada: the Big Oak Flat Entrance along the Big Oak Flat Road; the Arch Rock Entrance Station on the El Portal Road; the Hetch Hetchy Entrance; and the South Entrance on the Wawona Road. The Tioga Pass Entrance on the Tioga Road offers seasonal access from the east side of the Sierra Nevada.

According to the bioregional characterizations developed as part of California's Agreement on Biological Diversity (a multiagency memorandum signed in 1993), the area is within the Sierra Nevada Bioregion. The region (which extends through the foothill zone on the west side and the base of the escarpment on the east side) is about 450 miles long and 100 miles wide (approximately 20,663,930 acres).

The Sierra Nevada range contains the headwaters of 24 major river basins, two of which are in the park: the Merced River and the Tuolumne River. In 1984, the U.S. Congress established portions of the main stem of the Tuolumne River and the Dana and Lyell Forks as part of the National Wild and Scenic Rivers System. In 1987, the Wild and Scenic Rivers Act was amended to include 114 miles of both the main stem and the South Fork of the Merced River as Wild and Scenic.

The Merced River flows from the headwaters in the high elevations of the Sierra Nevada, through Yosemite Valley, and down to the San Joaquin Valley, where it contributes to the San Joaquin River. The main stem of the Merced River drains approximately 250,000 acres from the headwaters within the park to the Foresta Road bridge in the El Portal Administrative Site. The main stem of the Merced River flows a total of 140 miles from its headwaters to its confluence with the San Joaquin River. Principal tributaries of the Merced River within the park boundaries include Lyell Fork, Triple Peak Fork, Red Peak Fork, Merced Peak Fork, Sunrise Creek, Illilouette Creek, Tenaya Creek, Yosemite Creek, Sentinel Creek, Ribbon Creek, Bridalveil Creek, Cascade Creek, Grouse Creek, Avalanche Creek, and Indian Creek. The principal tributaries of the South Fork of the Merced River within park boundaries include Chilnualna Creek, Big Creek, and Alder Creek. The South Fork drains the southern portion of the park, an area of approximately 76,000 acres. The Tuolumne River drains the northern portion of the park, an area of approximately 435,000 acres.

The major vegetation zones of the Sierra Nevada ecosystem form readily apparent large-scale north-south elevational bands along the axis of the Sierra Nevada. Major east-west watersheds that dissect the Sierra Nevada into steep canyons form a secondary pattern of vegetation. On the west side, forest types change from ponderosa pine to mixed conifer to firs with increasing elevation. A subalpine and alpine vegetation zone is located on the crest of the Sierra Nevada range. Fire suppression and changing land use practices have dramatically affected natural fire regimes, altering ecological structures and functions in Sierra Nevada plant communities (UC Davis 1996).

The Sierra Nevada is rich in plant diversity. As a group, Sierra Nevada plants are most at risk where habitat has been reduced or altered. However, rare local geologic formations and their derived unique soils have led to the evolution of ensembles of plant species restricted to these habitats. This is true in the El Portal area, which supports a number of California state-listed rare species that are sustained in a unique contact zone of metamorphic and granitic rock (UC Davis 1996).

About 300 terrestrial vertebrate species (including mammals, birds, reptiles, and amphibians) use the Sierra Nevada as a significant part of their range. Three modern vertebrate species that were formerly well distributed in the range are now extinct from the Sierra Nevada: Bell's vireo, California condor, and grizzly bear. Sixty-nine species of terrestrial vertebrates (17% of Sierra Nevada fauna) are considered at risk by state or federal agencies. These species include bighorn sheep, Yosemite toad, foothill yellow-legged frog, mountain yellow-legged frog, and the western pond turtle. The most important identified cause of the decline of Sierran vertebrates has been loss of habitat, especially foothill and riparian habitats and late successional forests (UC Davis 1996).

Aquatic and riparian systems are the most altered and impaired habitats of the Sierra Nevada. Dams and diversions throughout most of the Sierra Nevada have profoundly altered stream-flow patterns and water temperatures. Foothill areas below about 3,300 feet appear to have the greatest loss of riparian vegetation of any region in the Sierra Nevada (UC Davis 1996).

Humans are an integral part of Sierra Nevada ecosystems, having lived and sustained themselves in the region for at least 10,000 years. Indigenous populations were widely distributed throughout the range at the time of European immigrations. Archeological evidence indicates that American Indians practiced resource management through localized harvesting, pruning, irrigation, burning, and vegetation thinning. Immigration of Euro-American settlers in the mid-1800s began a period of increasingly intense resource extraction and settlement (UC Davis 1996).

Natural Resources

Geology, Geohazards, and Soils

Regional Geology and Geologic History

Yosemite National Park occupies approximately 1,170 square miles within the central portion of the Sierra Nevada (Spanish for "snowy mountain range"). The Sierra Nevada is the highest and most continuous mountain range in California. The range is generally asymmetrical, with a gentle west slope and a steep east escarpment. Elevations approach sea level on the western side and reach about 14,000 feet above mean sea level at the crest.

The Sierra Nevada is essentially an uplifted block of the earth's crust that was tilted westward by normal faults on the eastern boundary. Granitic bedrock is widespread in Yosemite National Park and dominates a significant portion of the Sierra Nevada. The granitic rock formed deep within the earth as plutons of melted rock. About 200 million years ago, as the granitic rocks were formed, heated, and melted, they slowly migrated toward the earth's surface and began to cool, forming subsurface bodies of solidified granitic rock called the batholith.

Between 100 million years ago and 65 million years ago, magma formation slowed and a long period of erosion began in the Sierra Nevada. Erosion removed the overlying rocks and exposed the underlying core of the granitic batholith. Eroded material was transported westward and filled the present-day Central Valley with deposits that were tens of thousands of feet thick. About 15 million years ago, the relief of the Sierra Nevada in the Yosemite region had gently rolling upland topography and a much lower elevation than the present-day range. The Merced River flowed westward at a gentle gradient through a broad river valley. Volcanic activity, prevalent in the northern Sierra Nevada from about 38 to 10 million years ago, deposited ash, filled valleys, buried streams, and altered river courses.

Mountain-building activity was reactivated about 25 to 15 million years ago, uplifting and tilting the Sierra Nevada to form its relatively gentle western slope and the more dramatic, steep eastern slopes. The uplift increased the gradients of the rivers and resulted in deeply incised river valleys.

Between 3 million years ago and 2 million years ago, snow and ice accumulated as glaciers at the higher alpine elevations and began to move westward down the mountain valleys. At least three major glacial periods occurred during the ice age in the Sierra Nevada and are known as the Pre-Tahoe (oldest), the Tahoe (intermediate), and the Tioga (youngest). The downslope movement of the ice masses cut and sculpted the valleys, cirques, and other glacially formed landforms throughout the Yosemite region and the Sierra Nevada. The depositional and erosional glacial features viewed today in Yosemite are primarily the result of the Tioga event, although the cumulative effects of the previous glaciations are responsible for the overall shape and character of the region.

The Tioga was the last glaciation event and began as late as 60,000 years ago, when the climate cooled sufficiently to allow small glaciers to form on erosional features sculpted by earlier glaciers. Throughout this period in the Yosemite area, the ice field grew and pushed fingers of ice into the major drainages on the west slopes, until it reached its maximum extent about 20,000 years ago. The Tioga glacier extended westward as far as Bridalveil Meadow and, when it receded,

left behind features such as erratics, glacial till, and moraines. The Tioga glacial event left the landscape scoured and small basins filled with silt and sediment (Huber 1989).

Bedrock of Yosemite

Granitic and metamorphic rocks dominate Yosemite National Park, with the granitic rocks being most abundant and metamorphic rocks constituting less than 5% of the area within the park (Huber 1989). The metamorphic rocks represent the older rock that the granitic plutons intruded. Granitic rocks form from the cooling and solidification of molten rock within the earth's crust.

The granitic batholith of Yosemite National Park is not monolithic, but rather was formed through a series of intrusive events over a period of 130 million years. The separate episodes of intrusion and solidification formed more than 100 discrete plutonic masses, making up several granitic rock types. The particular type of granitic rock is distinguishable by the varying mineral composition, texture, and percentages of primary minerals. Granitic rocks in Yosemite National Park include granite, granodiorite, and tonalite.

Upper Main Stem Geology

The upper reaches of the main stem of the Merced River are dominated by the interaction of a wild river flowing through granitic landscapes. This glaciated valley is narrow with steep gradients in some areas, and wider in other areas where the river flows at a gradual slope and forms a floodplain. The width of the river valley can range from 960 feet in the narrower, steeper sections to 2,600 feet in the wider areas. The Bunnell Cascades is an example of steep gradient flow within a relatively steep canyon; the Merced River through Little Yosemite Valley exemplifies a river flowing on a wider floodplain.

Yosemite Valley Geology

Yosemite Valley is primarily granitic in composition and glacially carved, with its floor ranging from 3,800 to 4,200 feet above sea level. The Valley is oriented in an east-west direction, and its sides rise 1,500 feet to 4,000 feet above the essentially flat Valley floor. Yosemite Valley—not including Tenaya Canyon or Little Yosemite Valley—is about 6.8 miles long and varies from a little under one-half mile wide to around three-quarters mile wide. The east Valley branches into the Tenaya Canyon to the north and the Little Yosemite Valley to the south.

The downslope movement of the ice masses cut and sculpted the U-shaped valley that is present today. When glaciers melt, the rock debris they transport (till) is deposited in ridge-shaped landforms known as moraines. A *medial* moraine at the east end of Yosemite Valley was created when glaciers extending from the Upper Merced and Tenaya canyons merged at the confluence of the two canyons. Two other prominent moraines were formed in Yosemite Valley after the last glacier (the Tioga) retreated about 15,000 years ago. A *terminal* moraine, marking the furthest extent of the glacier, lies just east of Bridalveil Meadow. The El Capitan moraine, lying further east, is a *recessional* moraine, formed after the leading edge of the glacier had retreated up the Valley from its farthest extent. After the last glacier melted, water flow was dammed by morainal material to form what is now referred to as the prehistoric Lake Yosemite. Stream deposits then filled in Lake Yosemite, adding to the 1,000-foot-thick sediment that underlies the present-day floor of Yosemite Valley and covers the glacially disturbed granite rock below. The moraines in the Valley, especially those below El Capitan Meadow and near Bridalveil Fall, along with other geological features, have been identified as features of the geologic Outstandingly Remarkable Value.

Merced River Gorge and El Portal Geology

The Merced River gorge begins at the west end of Yosemite Valley where the gradient of the Merced River abruptly increases and the river enters the gorge. The gorge has remained an incised, V-shaped feature because the most recent glacial events did not extend down the Merced River beyond Yosemite Valley. The transition from the U-shaped, glaciated Yosemite Valley to the steep-gradient, V-shaped, incised Merced River gorge, is identified a feature of the geologic Outstandingly Remarkable Value.

The granitic rocks within the Merced River gorge consist primarily of tonalite; the Bass Lake tonalite is the dominant bedrock feature. Among some of the oldest rocks found in the Sierra Nevada are those just east of El Portal, in the walls of the Merced River gorge. These rocks are metamorphic and remnants of ancient sedimentary and volcanic rocks that were deformed and metamorphosed, in part by granitic intrusions (Huber 1989). This metamorphosed sedimentary rock (which includes banded chert) was once part of the ocean floor that covered the region about 200 million years ago (Huber 1989). The transition from igneous to metasedimentary rocks is identified as a feature of the geologic Outstandingly Remarkable Value in the El Portal segment of the river.

South Fork Geology

From its headwaters, the South Fork flows west at a relatively consistent gradient through a glaciated alpine environment and then enters a V-shaped, unglaciated river canyon below Wawona. Glaciation sculpted the upper reaches of the South Fork. Compared to the main stem, there is more variation of the bedrock regime along the South Fork of the Merced River. At the headwaters, the South Fork is in contact with metamorphic volcanic rocks, including ash flow deposits. As it flows westward, the South Fork contacts granitic rocks, metamorphic rocks near Gravelly Ford, and granite (similar to that found in Yosemite Valley) 8 miles east of Wawona.

Wawona Dome, visible from the river, is an exfoliating granite dome with an elevation of approximately 6,900 feet above sea level. Upon entering Wawona, the South Fork cuts through the granitic tonalite, a predominant granitic rock found along the southwest boundary of the park. The riverbed remains within tonalite, except for a short section underlain by metamorphic rocks near the park boundary. These rocks are among the oldest exposed along the South Fork.

Geohazards

The Merced River flows through geologically active areas, where geologic and hydrologic forces continue to shape the landform. Geologic hazards associated with these forces, such as earthquakes and rockfalls, present potentially harmful conditions to visitors, personnel, and facilities in Yosemite National Park.

Regional Seismicity

The Sierra Nevada range of Yosemite National Park is not considered an area of particularly high seismic activity. No active or potentially active faults have been identified in the mountain region of the park (CDMG 1997). However, Yosemite can undergo seismic shaking associated with earthquakes on fault zones on the east and west margins of the Sierra Nevada range, as it has done in the past. These fault zones include the Foothills fault zone to the west, the volcanically active area in the Mono Craters-Long Valley Caldera area to the east, and the various faults within the Owens Valley fault zone, also to the east (CDMG 1996).

The Foothills fault zone, which includes the Melones Fault and Bear Mountain Fault, extends in a north-south direction within the foothills of the Sierra Nevada, approximately 30 to 50 miles west of Yosemite Valley. This fault zone has not experienced movement in the last 2 million years and thus is not considered active or potentially active (CDMG 1996).

The Mono Lake fault is located approximately 35 miles northeast of Yosemite Valley within the Mono Craters-Long Valley Caldera region. Since 1980, this area has experienced considerable seismic activity. Earthquakes have been attributed to movement on the Mono Lake fault (Sierra Nevada frontal fault) and movement associated with resurgent volcanic activity of the Long Valley Caldera. The Mono Craters last erupted 600 years ago. A 5.7 magnitude earthquake on the Mono Lake fault in October 1990 was felt as far west as Sacramento and the San Francisco Bay Area and caused landslides and rockfalls at Tioga Pass and on the Big Oak Flat Road (McNutt et al. 1991). In September 2004, a swarm of earthquakes, with two greater than magnitude 5, occurred in the Adobe Hills north of Long Valley and just east of Mono Lake; the epicenter of the swarm is in the vicinity of the Hunton Valley fault system (CISN 2004).

The Owens Valley fault, located approximately 100 miles southeast of Yosemite Valley, has experienced movement within the last 200 years, and the California Geological Survey considers this fault active (CDMG 1997). The most notable earthquake felt in Yosemite National Park was the Owens Valley earthquake of March 26, 1872. The Owens Valley earthquake is estimated to have had a magnitude of 7.6 and was one of the largest earthquakes in U.S. history (USGS 1990a). This earthquake reportedly caused damage in Sacramento and San Joaquin Valleys and caused significant rockfalls in Yosemite Valley.

Although earthquakes that are felt by people in Yosemite National Park are relatively infrequent, they have occurred in the past and will likely occur in the future. Ground shaking typically is expressed in terms of peak ground acceleration as a percent of 1 g (g is acceleration due to gravity, or 980 centimeters—32 feet—per second squared). The peak accelerations estimated in the Yosemite National Park region of the Sierra Nevada are between 0.1 and 0.2 g (CDMG 1999). Most people would likely feel this range of ground shaking, but structural damage would be negligible to slight in buildings constructed according to modern building standards.

Rockfall

Rockfall is used as a generic term to refer to all slope movement processes, including rockfall, rockslide, debris slide, debris flow, debris slump, and earth slump. Rocks have become dislodged and fallen off the sheer granite cliffs throughout the geologic history of Yosemite. Rockfalls can displace extremely large and catastrophic volumes of rock and can occur due to such processes as the climate-related expansion and contraction of rock, seismic shaking, or exfoliation. Exfoliation is caused by differential stresses that form within the rock mass as the stress of the overburden is released. This process causes concentric granitic plates, ranging in size from inches to several feet, to become dislodged from the granite face.

Expansion and contraction caused by alternating freezing and thawing of water in the cracks of Yosemite's cliffs weaken its structure and result in periodic rockfalls. Rockfalls have created steep talus (angular rock fragments) slopes along each side of the Valley that provide better drained soils and warmer microhabitats than are found on the adjacent Valley floor, as well as crevices and caves that are home to many animal species.

Most rockfalls are associated with triggering events such as earthquakes, rainstorms, or periods of warming that produce a rapid melting of snow. The magnitude and proximity of the earthquake, intensity and duration of the rainfall, and the thickness of the snow-pack/pattern of warming all influence the triggering of rockfalls. However, some rockfalls occur without a direct correlation to an obvious event and are probably associated with gradual stress release and exfoliation of the granitic rocks (USGS 1998b).

More than 500 rockfalls have been recorded within Yosemite National Park and some have resulted in injury and on occasion, death. Rockfalls can also result in the damage or destruction of roads, trails, and buildings.

A prehistoric rockfall dammed Tenaya Creek and formed Mirror Lake. Famed writer and naturalist John Muir was in Yosemite Valley when the 1872 Owens Valley earthquake occurred and described the earthquake-triggered rockfall he observed:

> The Eagle Rock, a short distance up the Valley, had given way, and I saw it falling in thousands of the great boulders I had been studying so long, pouring to the Valley floor in a free curve luminous from friction, making a terribly sublime and beautiful spectacle—an arc of fire fifteen hundred feet span, as true in form and as steady as a rainbow, in the midst of stupendous roaring rock storm.

Two types of areas of potential rockfall impact have been identified. The first is the area closest to the Valley or canyon walls and is called the talus zone. The second area, referred to as the rockfall shadow zone, extends out from the talus zone and is the area in which rocks may travel out from the talus. The frequency and magnitude of rockfall events vary considerably. Many small rockfalls may occur every year and go unnoticed, while larger rockfalls occur much less frequently (USGS 1998b). These larger rockfalls may result in blowdown, or sudden wind gusts associated with large slabs of rock hitting the ground, and which have the potential for threats to human safety and property damage. An example of this type of event occurred associated with a large rockfall at Happy Isles in 1996. The U.S Geological Survey and the National Park Service have cooperated in documenting potential geologic hazards in developed areas, including areas most susceptible to rockfalls (USGS 1999c). The National Park Service has developed *Yosemite Valley Geologic Hazard Guidelines* (Appendix C in NPS 2000e) with the intent to better protect park visitors and staff by avoiding placement of structures in areas with a high potential for rockfall impact.

Upper Main Stem and Yosemite Valley Geohazards

Yosemite Valley is in the upper or middle portion of the canyon of the Merced River, which was deepened by several episodes of glacial erosion. The most recent glaciation (Tioga) extended east of Bridalveil Meadow, where the Merced River now meanders across the relatively flat Valley. Except for large rock avalanches, the talus from rockfall and rockslide deposits seldom reaches the center of the Valley. However, debris flows (which are very fluid in nature) can carry boulder debris far into the Valley, even on moderately gentle slopes. The Yosemite Valley narrows to the west of Bridalveil Meadow, and talus from rockfalls and rockslides extends from the cliffs down to the banks of the Merced River.

Accumulating talus, ranging in size from small rocks to large boulders, forms slopes at the base of the sheer rock cliffs at the Valley edge. The rockfalls and associated talus slopes contribute to the natural topography and to the formation of soils on the Valley floor. Rockfalls from the sheer Valley walls have, over time, created talus cones of debris spreading away from the edges of the

cliffs. Some of the rockfalls are sizable and have contributed to altering the course of the Merced River.

Rockfalls have left abundant deposits of talus around the base of almost all the walls of Yosemite Valley. The extent of talus around the edge of the Valley is estimated at some places to be greater than 300 feet thick (Wieczorek and Jaeger 1996). At some locations, such as below El Capitan, where large prehistoric rock avalanches have occurred, these deposits extend from the base of the wall about 1,400 feet across the Valley floor.

An inventory of historical rockfalls in Yosemite National Park identified 519 rockfalls that occurred between 1857 and early 2004, according to published and unpublished accounts and field studies of recent rockfalls. Of these, about 330 occurred within Yosemite Valley, and most of the others occurred in the Merced River gorge or along El Portal Road. Report authors note that many more than 500 rockfalls undoubtedly occurred during this period, but some went unnoticed or unreported because of the small size of individual rockfalls or the lack of impact on trails, roads, structures, or utilities (USGS 2004a). Rockfalls in Yosemite National Park range in size from small individual blocks of less than 1 cubic meter to rock avalanches of several million cubic meters. All such events pose a potential hazard; even a rapidly moving small boulder can cause serious injury to people, vehicles, or buildings. The frequency of different-sized rockfalls has been determined from an analysis of historical events (Wieczorek et al. 1995).

Merced River Gorge and El Portal Geohazards

Significant incision of the river has created the present-day relief of the gorge and a change of gradient of over 2,000 feet in just over 7 miles between Pohono Bridge to the park boundary. The gorge area has had many rockfall incidences, including rockfalls that have occurred along El Portal Road. Of 519 historical rockfalls identified in a recent inventory, most of the approximately 190 rockfalls that did not occur within Yosemite Valley occurred in areas near the Valley such as along El Portal Road in the Merced River gorge (USGS 2004a). The high incidence of rockfalls is partly due to the steep, narrow configuration of the gorge, riverbank undercutting, and historic human activity such as the construction of El Portal Road. These events have been well documented (USGS 2004a) and provide information regarding historic rockslide hazards along the Merced River gorge and in areas where unstable rock slopes are known to pose a risk of future rockfall events. Rockfall hazards are similar in El Portal to those in the Merced River gorge. Areas with steep cliffs surrounding El Portal are susceptible to rockfall events, especially on cliffs composed of highly fractured granitic and metamorphic rocks. Hazards associated with seismic groundshaking would affect El Portal as they would the Merced River gorge and elsewhere in Yosemite National Park.

Soils

All soils form as a result of the combined effect of several factors, including geologic parent material, climate, biologic activity, topographic position/relief, and time. Within the park, topography is the most important factor contributing to soil differentiation. Topography influences surface runoff, groundwater, the distribution of stony soils, and the separation of various-aged alluvial soils (NPS 1978). More than 50 soil types are found within the park; general or local variations depend upon glacial history, microclimatic differences, and the ongoing influences of weathering and stream erosion/deposition (NPS 1978).

Soils of the Yosemite region are primarily derived from underlying granitic bedrock and are of similar chemical and mineralogical composition. Except for meadow soils, most high country soils developed in glacial material (glacial soils) or developed in place from bedrock (residual soils). Extensive areas above 6,000 feet are covered by glacial moraine material, a mixture of fine sand, glacial flour, and various-sized pebbles and boulders (NPS 1978). Alluvial soils developed along streams through erosion and deposition and tend to have sorted horizons of sandy material. Various areas of Yosemite National Park have meadow soils consisting of accumulated clays, silts, and organic debris that are subjected to occasional flooding. The El Capitan fine-sandy loam, found in and around El Capitan Meadow, is an example of a meadow soil. Colluvial soils have developed along the edges of cliffs where landslides and rockslides have occurred and are composed of various-sized rocks that have high rates of infiltration and permeability. Weathering processes break down talus to smaller-sized particles that are then transported by water and eventually become deposited in alluvial fans or in stream channels. The surface soil in Yosemite Valley, for instance, consists primarily of granitic sands in various stages of decomposition (NPS 1978).

Organic content within the upper soil profile varies with local influences of moisture and drainage. Thick sedges and grasses have significantly contributed to the organic content of soils near ponds, lakes, and streams. Coniferous forest soils have a high organic content and are relatively acidic. Soils lacking organic accumulations are frequently a result of granitic weathering, consist largely of sand, and support only scattered plants tolerant to drought conditions (NPS 1978).

Upper Main Stem Soils

Soils specific to the upper main stem of the Merced River have not been mapped but are similar in chemical and mineralogical composition to those in the Yosemite Valley region. Glacial history, weathering, fluvial process, and erosion contribute to the local variations in soil compositions. High country soils (excluding meadow soils) are typically glacial or residual, and alluvial soils can be found near streams. Glacial moraines and deposits cover areas above 6,000 feet.

Yosemite Valley Soils

Most of Yosemite Valley is an active floodplain of the Merced River. During Merced River flood events, alluvial soils are formed and removed as floodwaters deposit and erode material over the floodplain. The active flooding builds river terraces of fine- to coarse-textured sands. Old riverbeds of boulders and gravel may be buried under the terrace soils. Residual soils are scattered throughout Yosemite Valley where bedrock weathering has occurred. Glacial soils are associated principally with moraines. Colluvial soils have developed on the talus slopes along the edges of the Valley floor. Valley soil textures vary from fine sand to fine gravel. Most soils have a relatively undeveloped profile, indicating their relatively recent origin and young geologic age.

The Natural Resource Conservation Service identified 21 soil series/types in Yosemite Valley (SCS 1992). Each soil type has specific characteristics that influence plant growth, water movement, and land use capabilities, etc. Land use limitations are commonly associated with frequent flooding, a seasonally high water table, poor drainage, steep slopes, high rock concentration, and a poor soil structure. The El Capitan fine-sandy loam, found in and around El Capitan Meadow, is an example of a Yosemite Valley soil with physical constraints that limit land use due to occasional flooding.

Merced River Gorge and El Portal Soils

The soils in relatively flat topographic positions in the Merced River gorge and El Portal form from glacial and alluvial sediment deposition processes originating in Yosemite Valley, or by alluvial and colluvial deposition occurring locally within the gorge or near El Portal. Soils that formed in old river channels consist of alluvial boulders, cobbles, river wash, and loamy sands.

Upper South Fork Soils

Soils in the upper reaches of the South Fork are similar in chemical and mineralogical composition to those in the upper Merced River. Parent rock type, glacial history, weathering, fluvial process, and erosion contribute to the local variations in soil compositions. High country soils (excluding meadow soils) are typically glacial or residual, and alluvial soils typically form near streams.

Lower South Fork Soils

Soils of the Wawona area are primarily residual on slopes and alluvial in the Valley. Soil depth varies from 2 to 4 feet above bedrock; these soils are moderately to strongly acidic. Most soils are subject to erosion after disturbance or loss of vegetative cover. The major soil types are distinguished by their mixtures of loam, sand, and silt, and by the amount and type of rock fragments.

Hydrology, Floodplains, and Water Quality

Yosemite National Park has a variety of surface water features, some of which are major attractions for visitors, such as Yosemite, Bridalveil, Nevada, and Vernal Falls. Hydrologic processes—including glaciation, lake to meadow succession, and fluvial geomorphic response—have been fundamental in creating surface water features and landforms in the park. Flowing water (including glacial flow) has helped to create the existing landscape and will continue to modify the landscape through erosion and alluvial processes. The park includes the headwaters and significant stream reaches of the Tuolumne and Merced Rivers and contains approximately 1,591 lakes and 1,700 miles of streams within its boundary.

Hydrology

The Merced River basin encompasses the main stem of the Merced River and its watershed area, and the South Fork of the Merced River basin encompasses the South Fork and its watershed area. Within the park, these areas contain separate and unique watersheds, sustain separate hydrologic and aquatic resources, and support differing levels of development. Therefore, these watersheds are addressed separately in this discussion.

Watersheds and Drainage

Regional Watershed

The park is drained by two major watersheds: the Tuolumne and the Merced River, both of which are tributaries of the overall San Joaquin River basin. The Tuolumne and Merced River systems originate along the crest of the Sierra Nevada mountains and have carved river canyons 3,000 to 4,000 feet deep on their paths to the Central Valley. The Tuolumne River drains the entire northern portion of the park, an area of approximately 435,000 acres (681 square miles). The Merced River basin begins in the southern peaks of the park, primarily the southern aspects of the Cathedral Range and the Clark Range, and drains the southern one-third of the park, or 326,000 acres (511 square miles).

Merced River Basin

The main stem of the Merced River flows from the headwaters in the high elevations of the Sierra Nevada, through Yosemite Valley, and down to the Central Valley where it contributes to the San Joaquin River. This river basin drains 250,000 acres (391 square miles) within the boundaries of the park. The main stem of the Merced River flows a total of 140 miles from its headwaters to its confluence with the San Joaquin River (USGS 1992b). Principal tributaries of the Merced River within the park boundaries and the El Portal Administrative Site include the Merced Peak, Lyell, Triple Peak, and Red Peak Forks, as well as Sunrise, Illilouette, Tenaya, Yosemite, Sentinel, Ribbon, Bridalveil, Cascade, Grouse, Avalanche, Indian, and Crane Creeks.

For the purpose of discussion within this section, the Merced River basin is divided into three hydrologic segments: the upper Merced River, Yosemite Valley, and the Merced River gorge (which includes the El Portal Administrative Site). This division is based on the unique watershed characteristics of the three river areas. Discharge flows within the different hydrologic segments reflect the contribution of the overall watershed upstream of the noted streamflow gauging location.

Upper Main Stem Watershed. The upper Merced River watershed is located on the western slope of the Sierra Nevada mountains in Yosemite National Park.[1] The watershed encompasses 114,843 acres (181.9 square miles), with elevations ranging from 4,000 feet at Happy Isles Bridge to over 13,000 feet at Mt. Lyell. Located within the watershed are the sub-basins of the upper Merced River and Illilouette Creek as well as over 100 lakes and ponds (Williamson, Simonsen et al. 1996). The watershed consists of mountainous valleys with steep walls, large areas of exposed granite, and forested areas common along the valley floors. The upper Merced River watershed topography is characterized by jagged peaks, precipitous cliffs, steep canyons, broad inter-stream areas of glacially smoothed granite, small lakes and meadows, and thin, granitic soils. Above 9,600 feet are alpine and subalpine zones with little vegetation and low soil permeability. From 8,000 to 9,600 feet is a lodgepole pine zone with limited ability to hold soil moisture. Much of the area from 6,000 to 8,000 feet is red fir forest, which intercepts a high percentage of the rainfall and holds it in alluvial soils. Mixed coniferous forests grow on thin to moderate depth soils from 4,000 to 7,000 feet.

The upper Merced River descends from its headwaters through a glacially carved canyon at a gradient of about 8,000 feet over 24 miles, or an average gradient of approximately 330 feet per mile (USGS 1992b). Generally, the streambank and floodplains are vegetated with mature fir, pine, and cedar trees and abundant understory species.

Human infrastructure in the watershed includes hiking trails, bridges, a diversion wall, small utility systems, and wilderness campsites. Bridges in this upper watershed consist of footbridges made of wood and stone that can be obstructions to the free flow of the river during high flows. Before the turn of the century, a diversion wall was constructed at Nevada Fall to divert flow away from what is now the Mist Trail in order to protect the trail that once led to the former La Casa Nevada Hotel just below Nevada Fall.

The average daily discharge rate of the upper Merced River watershed (measured at the Happy Isles gauging station) is approximately 355 cubic feet per second, and the average annual total discharge is approximately 257,400 acre-feet (USGS 1998a).

[1] Upper Merced River watershed is defined herein as the Merced River basin above Happy Isles at the eastern edge of Yosemite Valley.

The Merced High Sierra Camp has a seasonal water system that draws surface water from the Merced River. This water system serves tent cabins, a kitchen/store, shower facilities, flush toilets, and a backpacker campground. Approximately 50 to 150 persons can be served by this water system on a daily basis, which is operational from the early part of July through the early part of September. The system has a design capacity of approximately 3,000 gallons per day and is permitted through the California Department of Health Services.

Yosemite Valley Watershed. The Yosemite Valley watershed includes Yosemite Valley and its tributary areas. The main tributaries to the Merced River in Yosemite Valley are Tenaya Creek, Illilouette Creek, Yosemite Creek, and Bridalveil Creek. At Pohono Bridge, the overall Merced River basin encompasses 205,000 acres (321 square miles) (USGS 1999b). Historic discharge in the river, measured at the Pohono Bridge gauging station, has ranged from a high of about 25,000 cubic feet per second to a low of less than 10 cubic feet per second. The mean daily discharge rate is about 600 cubic feet per second, with an average annual total discharge of approximately 435,400 acre-feet (NPS 1978).

During the most recent period of glaciation in Yosemite Valley, a glacier extended to approximately the location Pohono Bridge. Following glacial retreat, a large lake (Lake Yosemite) developed and eventually filled with sediment from the El Capitan moraine to upstream of Happy Isles (Huber 1989). The resulting valley floor has a very mild slope and is responsible for the meandering pattern of the present-day river. The Merced River has a relatively mild slope, with an average of 0.1% through Yosemite Valley (USGS 1992b). The Merced River is an alluvial river within Yosemite Valley, and the bed and banks of the channel are composed of smaller sediments and cobbles and soil layers. This condition makes for a dynamic river that alters its course periodically by eroding and depositing bed and bank material. In most locations, the river flows through a shallow channel approximately 100 to 300 feet wide. In the middle of Yosemite Valley, the Merced River has the capacity to convey an amount between the 2- and 5-year flow within the existing channel banks (NPS 1997b). Eleven bridges cross the Merced River between Happy Isles and the Pohono Bridge. Many of these bridges influence the width, location, and velocity of the Merced River (NPS 1991). In a natural river channel, the stream banks slope at an angle away from the stream, resulting in a wider channel as flows increase. However, arched bridges such as Stoneman and Pohono confine flows in the Merced River and result in a narrowing of the channel as flows increase. The velocity of the river through a bridge can be accelerated, causing increased channel scouring directly downstream of the bridge. Substantial scour around bridge abutments is evident at several bridges in Yosemite Valley.

If flow cannot be conveyed through a bridge during periods of high discharge, water backs up behind the bridge. This can inundate low-lying areas or overflow channels. Although the Happy Isles Bridge was removed in late 2001 and early 2002, the remaining Merced River within Yosemite Valley is constricted at all bridge sites between Happy Isles and Pohono Bridge (Milestone 1978).

Merced River Gorge and El Portal Watershed. The Merced River gorge watershed includes the watershed area from Pohono Bridge through the El Portal Administrative Site. Within this area, the Merced River has a much steeper gradient than in Yosemite Valley and consists mostly of continuous rapids. As the river exits Yosemite Valley, it cascades at an average gradient of approximately 70 feet per mile through the narrow, steep-sided Merced River gorge. The

riverbed and banks are largely composed of boulders and cobbles, ranging in size from a few inches to several yards in diameter.

The steeper river gradient in this area prevents the river from meandering as extensively as in Yosemite Valley. Additionally, riverbank areas in many locations have been developed and hardened for road and facility protection. Because of the steep gradient and development, the shifting of the river channel in El Portal usually occurs only during periods of large floods.

Flow volumes through the gorge are not available (there are no gauges in the immediate area), but should be only slightly larger than the volumes recorded at the Pohono Bridge gauging station. Tributaries within the gorge are relatively minor, although Cascade Creek flows into the Merced River as the river enters the steepest part of the gorge.

In late 2003 and early 2004, the Cascades Diversion Dam was removed from the Gorge segment of the river. The Cascades Diversion Dam was located near the far western end of Yosemite Valley as the river transitions from the Valley floodplain into the steep river gorge. This dam was originally constructed to divert water from the Merced River into a hydroelectric power plant that is no longer in use. The removal of the dam allowed the accumulation of sediments that were retained behind the dam to be redistributed down-river during periods of higher river flows. The river is in the process of re-establishing its normal channel and bank in this area, although it will likely be a few years before normal river dynamics are fully restored in this area.

South Fork Basin

The South Fork of the Merced River is the Merced River's major tributary in the park vicinity. The watershed area of the South Fork at Wawona is approximately 63,000 acres (98 square miles) and expands to 154,000 acres (76,000 acres within the park boundary) by the South Fork's confluence with the main stem outside of the park boundary. The headwaters of the South Fork originate near Triple Divide Peak at an elevation of approximately 10,500 feet. The South Fork flows westward over granitic bedrock to Wawona and then flows northwest over an area underlain by metasedimentary rocks at a 3,500-foot elevation (USGS 1996a). Upstream from Wawona, tributaries enter the steep-walled canyon (glacial gorge) of the South Fork from the north and south. In the Wawona area, the river meanders through a large floodplain meadow (part of a deep alluvial valley) with substantial gravel bars within the channel.

The total length of the South Fork is 43 miles from its headwaters to its confluence with the main stem of the Merced River several miles downstream from the western park boundary (USGS 1992b). The average annual flow at its confluence with the Merced River is 356 cubic feet per second, with a maximum recorded flow of 46,500 cubic feet per second and a minimum recorded flow of 2.2 cubic feet per second (USFS 1989).[2] At Wawona, upstream of the Big Creek confluence, the average annual flow was 174 cubic feet per second between 1958 and 1968, with an estimated maximum flow of 15,000 cubic feet per second in December 1955.[3] The 100-year flow volume of the river through the South Fork Bridge cross-section is estimated at 13,563 cubic feet per second. The average annual total discharge of the South Fork is approximately 250,000 acre-feet (NPS 1978).

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[2] These flow characteristics were determined from stream measurements taken between 1911 and 1921 when an operating U.S. Geological Survey stream gauge existed at this location.

[3] These characteristics were determined from stream measurements taken between 1958 and 1968 when an operating U.S. Geological Survey stream gauge existed at this location.

Within the Wawona area, a small impoundment created to pool water at the intake of Wawona's surface water supply is located near the end of Forest Drive. This area is designed to maintain a sufficient water level for the intake. Over time, the pool has filled with small cobbles, sands, and other sediments but does not represent a major source of sediment or act as a significant barrier to river flow and dynamics.

Precipitation

Merced River Basin

The overall climate in the Merced River basin is temperate, with hot, dry summers and cold, wet winters. About 85% of the precipitation falls between November and April. December, January, and February have the highest average precipitation, with a monthly average of 6 inches in Yosemite Valley at 4,000 feet. Average annual precipitation in Yosemite Valley is 36.5 inches. Annual precipitation decreases to 25 inches in El Portal at 2,000 feet and increases to 70 inches in the red fir forest at 6,000 to 8,000 feet (Eagan 1998). Most precipitation in Yosemite Valley falls as rain; only 29 inches of snow falls during an average year. At elevations above 5,000 feet, 80% of the annual precipitation falls as snow. Snowmelt drives the peak stream flows that occur in May and June, and minimum river flow is observed in September and October.

South Fork Basin

In Wawona (elevation 4,000 feet), precipitation occurs either as rain or snow, which melts quickly and flows into streams. At higher altitudes of the South Fork basin, precipitation usually occurs as snow, which melts more slowly and sustains the flow of the river during the spring and early summer. Average annual precipitation at the South Entrance Station is approximately 40 inches. Precipitation averages 50 to 60 inches per year in the upstream reaches of the South Fork basin.

Alluvial Processes

Yosemite National Park is composed of and underlain by various granite rock types; therefore, weathering, erosion, and transport of sediment can be a very slow process in the park. Unfractured granite is impermeable and weathers very slowly; however, granite weathers much more readily when the various granites are buried in soil and in contact with a chemically reactive mixture of water, atmospheric gases, and organic decay products. Joints and natural depressions further the weathering process.

Various areas of Yosemite National Park have significant soil layers where clays, silts, and organic debris have accumulated with the gravels and sands of the decomposed bedrock. These soils are subject to erosion and alluvial processes.

Merced River Basin

Sedimentation is a significant natural process within Yosemite Valley. The Merced River has a very low gradient within the Valley, approximately 0.1% or 6.25 feet per mile (NPS 1992c). This low gradient allows for significant sediment deposition within Yosemite Valley and the formation of the meandering Merced River through this reach. This sediment deposition and subsequent formation of the floodplain allows the river to migrate laterally within the floodplain. River impoundments such as bridges tend to alter the sediment distribution and formative streamflows, thereby disrupting the natural alluvial processes.

Two of the most significant changes to sediment transport dynamics along the Merced River were the removal of a portion of the El Capitan moraine and the construction of the Cascades

Diversion Dam. In 1879, the El Capitan moraine was reduced in elevation by blasting to decrease flooding in Yosemite Valley. This moraine served as a hydraulic control for the Merced River in Yosemite Valley and influenced the rate and distribution of sediment deposition. The reduction of flooding may have allowed encroachment of the forest into meadow areas near the river through a lowering of the water table and a lessening of meadow inundation by floodwaters. The construction of Cascades Diversion Dam in 1917 and 1918 had the opposite effect of the El Capitan moraine removal. The dam provided a condition where sediment that normally moved through the river system would settle and become trapped.

The National Park Service has recently completed two restoration projects along the Merced River to restore the river's natural free-flowing conditions and sediment transport patterns. In late 2003 and early 2004, the park removed the Cascades Diversion Dam. As part of this project, park staff removed or repositioned about 4,000 to 5,000 cubic yards of sediments trapped behind the dam. Park staff are currently removing a smaller dam upstream of Happy Isles that was part of an obsolete water diversion system.

Localized bank erosion is apparent in the wilderness areas above Nevada Fall where hiking trails parallel the river through Little Yosemite Valley. In east Yosemite Valley, localized loss of riverbank vegetation coupled with the backwater effect of undersized bridges has led to extensive bank erosion and channel widening. Downstream of Yosemite Valley, bank stability and sediment transport are affected by the alteration of the channel and floodplain due to historic roads and development.

South Fork Basin

Alluvial processes along the South Fork have not been substantially affected compared to Yosemite Valley and the El Portal area, although this area still faces the same pressures from development. Development in the Wawona area has locally altered alluvial processes from the placement of bridges and roads along streambanks.

Floodplains

This section describes floodplains and flood characteristics in the Merced River basin and addresses floodplain values, existing impacts associated with the occupation and modification of floodplains, and risks to life and property from flooding. A floodplain plays a necessary role in the overall adjustment of a river system. It exerts an influence on the hydrology of the basin and also serves as a temporary storage for sediment eroded from the watershed. Periodic flooding provides sediment and nutrients that are essential for the aquatic and vegetative health of the floodplain. Floodplains are features that are both the products of the river environment and important functional parts of the system. However, humanmade structures such as bridges and buildings placed within a floodplain can impede natural flow and result in injury to visitors and damage to structures. Discussion of flooding and floodplains is most relevant to the potential loss of life and the influence on the river from development in the floodplain.

The 100-year floodplain[4] is the area that would be inundated by the 100-year flood, or the peak flow that has a 1% chance of being equaled or exceeded in any given year. The 100-year floodplain is typically used to define the general floodplain boundary. Due to the variable and dynamic landscape of the park, the floodplain along the Merced River changes from one location

[4] The area along the river corridor that would receive floodwaters during a 100-year flood event. If a 100-year flood event occurs, the following year still has the same probability for the likelihood of a 100-year event.

to the next and has not been defined in all areas, particularly in the upper reaches of the Merced River. Observed and recorded inundation areas during flood events provide the best delineation of floodplains.

Within the park, flood levels are dependent upon the amount of snowpack, water content of the snowpack, rate of snowmelt, and amount and timing of rainfall. Although most of the park's precipitation occurs between October and April, melting of the snowpack caused by warming springtime temperatures usually signals the beginning of an increase in streamflow that persists into June (NPS 1991a). Flood events associated with this flow increase are often termed *spring floods*. Under normal conditions most of the runoff occurs from mid-April through July, with peak flows in May and June. From 1916 through 1989, 124 of 140 recorded high flows on the Merced River in Yosemite Valley occurred in response to snowmelt (NPS 1991a). A second type of flood typical of the Merced River can occur between September and April and is commonly referred to as a *winter flood* or a *rain-on-snow event* (NPS 1991a). These floods occur when a storm is accompanied by warm air temperatures and rainfall and coincides with the presence of snow in the vicinity of the storm. Although these events account for only about 10% of the floods in the park, they are responsible for the highest floods recorded, as seen by the events of January 1997. The January 1997 flood resulted from heavy, warm rains and melting snow, with rain at elevations up to 10,000 feet (NPS 1997i). Rain alone occasionally causes peak discharge events that are usually local in nature but sometimes cover a large area.

Merced River Basin

In some areas, the floodplain is nonexistent due to narrowing of valley walls or incision of the channel into moraine deposits. The Merced River watershed has had six significant winter floods since 1937 that caused substantial damage to National Park Service property within the floodplain. All of these floods took place between November 1 and January 30 as a result of rain-on-snow events (Eagan 1998).

Upper Main Stem Watershed. The floodplains along the upper Merced River (main stem – Wilderness) have not been defined in remote areas and support few human structures. Within Little Yosemite Valley, the floodplain likely encompasses most of the valley floor. Steep topography limits the floodplain in the upper canyon areas.

Yosemite Valley Watershed. Yosemite Valley has a well-developed floodplain, with major roads and structures along or within both sides of the floodplain. The character of the floodplain varies in different locations because of local hydraulic controls. From Clark's Bridge to Housekeeping Camp in the east Valley, the Merced River floods areas outside the main river channel with shallow, swift flows that cut across meander bends. Near Yosemite Lodge and downstream to the El Capitan moraine, floodwaters back up against the moraine and dense vegetation and tend to be deep and slow (Eagan 1998).

The broad floodplain in Yosemite Valley between the Housekeeping Camp area and the El Capitan moraine serves many hydrologic functions, including dissipation of floodwater energy as water spreads out over the flat, expansive plain. The meadows occur primarily in the floodplain and are maintained and rejuvenated by periodic floods. Development within the floodplains, such as roads across Stoneman, Ahwahnee, Cook's, Sentinel, and El Capitan Meadows, has varying degrees of influence on the function of the floodplain. Loss of vegetation and soil compaction in highly visited areas, channel confinement by riprap, and bridges can also influence functions of

the floodplain. Historic development has altered the hydrologic response of the Yosemite Valley watershed. Past land uses and related subsequent infrastructure brought indirect changes to the watershed, such as loss of streamside vegetation, soil compaction, channel confinement, and loss of wetlands and riparian vegetation. Since designation of the river in 1987, park staff have taken measures to reverse these effects through removal of some infrastructure in the floodplain and restoration of some meadows and riverbanks.

National Park Service field staff surveyed the extent of the January 1997 flood inundation in Yosemite Valley and El Portal immediately after the event. Flood flow rates during the January 1997 flood were estimated by evaluating data collected at the U.S. Geological Survey gauging stations in Yosemite Valley. This data allowed hydrologists to verify previous flood extent maps and calibrate recent hydraulic models that were used to fully delineate the January 1997 flood.

Significant flood events continue to alter the floodplain of Yosemite Valley and affect development within the park. The largest events occurred in 1937, 1950, 1955, and 1997 and were in the range of 22,000 to 25,000 cubic feet per second as measured at Pohono Bridge. These floods were the result of rain-on-snow events during which rain fell on winter snow pack and caused snowmelt in combination with rain-related runoff. At Pohono Bridge, the 100-year flood has been estimated by the U.S. Geological Survey to be in excess of 25,000 cubic feet per second (Eagan 1998).

The January 1997 flood was the largest recorded flood within the park. The flood inundated roads, picnic areas, park offices, and lodging units. The U.S. Geological Survey estimated that the flood had a peak discharge of 10,000 cubic feet per second at Happy Isles and 25,000 cubic feet per second at Pohono Bridge (Eagan 1998). The January 1997 flood was estimated to have a recurrence interval of 90 years (NPS 1997b) and resulted in extensive damage to National Park Service facilities, including roads, bridges, buildings, and Yosemite Valley's electric, water, and sewer systems. The flood also altered natural features and caused downed trees, movement of landslide talus into streams, channel erosion, and substantial changes in channel morphology (NPS 1997b).

Merced River Gorge and El Portal Watershed. From where the Cascades Diversion Dam was formerly located and downstream through the El Portal Administrative Site, the river channel is extremely steep and confined in a narrow river gorge. In this area, the floodplain is quite narrow and the flow velocities are very high. The river channel in El Portal can shift during large floods, including movement of large boulders that define the channel. Within this area, El Portal Road and small levees have altered the floodplain by restricting flow during flood events and forming a barrier to channel migration. During extreme flood events, the Merced River has shown the capability to undermine or spill over and damage the roadway.

South Fork Basin

The South Fork has a limited floodplain (except in the Wawona area) because of the steep topography through which the river flows. The only significant floodplain in the South Fork basin is in the Wawona area, which is an elongated alluvial valley. Development in the Wawona area has altered the floodplain. Diversion of surface water from the South Fork can affect the Wawona floodplain by reducing the water table in the floodplain during the dry season, when no precipitation occurs and high runoff is not apparent. Water diversion is governed by the *Wawona*

Water Conservation Plan, which includes provisions for reduction and/or cessation of withdrawals from the river when flow drops to critical levels (NPS 1987a).

Frazil Ice Flooding

Waterfalls in the park occasionally produce a winter phenomenon called frazil ice at the base of the fall. Small ice crystals develop in turbulent, super-cooled stream water, when air temperature suddenly drops to below freezing. The ice crystals join to become slush and then press together as more crystals form. Frazil ice lacks the erosional force of regular stream ice, but it can cause streams to overflow their banks and change course. Frazil ice sometimes reaches a depth of more than 20 feet along Yosemite Creek at the Lower Yosemite Fall Bridge. A 1954 flow of frazil ice completely filled the streambed of the creek and covered the footbridge near Lower Yosemite Fall with many feet of ice (Hubbard and Brockman 1961). The Yosemite Fall footbridge was covered with frazil ice in February 1996.

Nonflood Alterations of the Floodplain

Although floods are significant to ecosystems because they can induce large changes in channel morphology and the floodplain landscape, low streamflow characteristics are also important. Low streamflow during the summer can affect the surrounding floodplain as riparian and wetland habitats undergo a drying phase. Diversion of river flows for human consumption can aggravate this normal balance and induce further reduction of riparian habitats and destabilization of streambanks. Prior to 1985, the National Park Service and the park concessioner in Yosemite Valley relied almost entirely on surface water diverted from the Merced River upstream of Happy Isles. It is estimated that up to 54% of the low streamflow discharge may have been diverted for park facilities (NPS 1991a). This practice has been terminated in Yosemite Valley, and all potable water is now taken from groundwater wells. Water continues to be drawn from the South Fork for the Wawona area to augment groundwater supplies.

Water Quality

Water quality throughout Yosemite National Park is considered to be good and generally above state and federal standards. An inventory of water quality data performed by the National Park Service indicated excellent conditions in many parts of the park, but some water quality degradation in areas of high visitor use (NPS 1994h). The surface water quality of most park waters is considered beneficial for wildlife habitat, freshwater habitat, noncontact recreation, canoeing, rafting, and water contact recreation by the State of California, as indicated in the Central Valley Regional Water Quality Control Board's *Water Quality Control Plan* (CVRWQCB 1998).

Surface water draining granitic bedrock in the park exhibits considerable variability in chemical composition, despite the relative homogeneity of bedrock chemistry (Clow et al. 1996). Surface water in most of the Merced River basin is very diluted (lacking in dissolved solids), making the ecosystem sensitive to human disturbances and pollution (Clow et al. 1996). Studies have indicated a presence of *Giardia lamblia* and fecal coliform in various surface waters throughout the park, thereby limiting direct consumption of surface water by humans (Williamson, Spoto et al. 1996).

High water quality is critical for the survival and health of species associated with riparian and aquatic ecosystems. Water quality elements that affect aquatic ecosystems include water temperature, dissolved oxygen, suspended sediment, nutrients, and chemical pollutants. These

elements interact in complex ways within aquatic systems to directly and indirectly influence patterns of growth, reproduction, and mobility of aquatic organisms. For example, sediment may not be directly lethal to fish, but sediment deposited on the streambed may disrupt the productivity and life cycles of fish and aquatic insects.

Merced River Basin

The chemistry of surface waters in the Merced River basin is characterized by low electrical conductivity (limited ions due to a lack of dissolved solids), near-neutral pH, low alkalinity, and low nutrient concentrations (NPS 1994h). Calcium and bicarbonate are the predominant ions in the waters. Within the Merced River, major ion concentrations slightly increase downstream, but levels remain relatively low and no significant changes have been observed in pH, alkalinity, or nutrient concentrations (NPS 1994h). Due to the low alkalinity of the stream water, the buffering capacity (ability to absorb water chemistry changes or additions) of the Merced River and its tributaries is limited. Occasional concentrations of lead, cadmium, and mercury above drinking water and freshwater criteria have been noted within the Merced River (NPS 1994h). Potential sources of these metals include lead gasoline, stormwater runoff from developed surfaces such as parking lots, wastewater discharge, campsites, and fuel storage facilities (USGS 1999a).

Groundwater quality is generally good in the Merced River basin and it is the sole source of potable water for Yosemite Valley and El Portal. There are locations in Yosemite Valley where relatively high iron concentrations in groundwater result in a reddish deposit on the substrate surface (e.g., observed at surfacing springs near lower Tenaya Creek and several locations on the Merced River) (Williamson, Simonsen et al. 1996). These iron concentrations are not a threat to water quality. Federal regulations ensure that potable water systems that rely on groundwater are continually monitored and operated within set levels for turbidity, waterborne pathogens, and other potential pollutants.

South Fork Basin

Water quality within the South Fork basin is very similar to that of the main stem of the Merced River, with near excellent conditions in most areas and some water quality stressors near human development. The Wawona Golf Course does present a potential nonpoint pollution source from the occasional use of fertilizers and herbicides for maintenance of the course, although these products are used following strict guidelines for application and disposal. Water quality is sufficient for Wawona residents to use both surface water and groundwater as potable water. Surface water is drawn from the South Fork through the water treatment plant intake near Forest Drive.

Bank Erosion

Water quality has been affected by localized areas where visitor use of the Merced River is concentrated. High use of the streambank induces bank erosion through the loss of vegetative cover and soil compaction. Bank erosion can result in the widening of the river channel and loss of riparian and meadow floodplain areas. Water quality is then altered through increased suspended sediments caused by erosion, higher water temperatures from a lack of riparian cover, and lower dissolved oxygen levels due to elevated temperatures and more shallow river depths.

The National Park Service has recently completed multiple riverbank restoration projects to restore degraded riverbanks along the Merced River. Between 1991 and 1995, 11 riverbank restoration projects were completed spanning from Little Yosemite Valley to Devil's Elbow in Yosemite Valley. Crews removed riprap and historic dump deposits close to the river's edge,

recontoured riverbanks, decompacted soil, and planted appropriate vegetation. In 2002, the National Park Service completed an additional riverbank restoration project in Yosemite Valley at the confluence of Eagle Creek and the Merced River. As a result, crews restored numerous highly degraded riverbanks with sparse vegetation and erodable soil to stable riverbanks with well-established native vegetation.

Nonpoint Pollution Sources

Human activities and the use of vehicles can distribute potential water pollutants that may collect on land surfaces and later be transported into the river or its tributaries by stormwater runoff. Recreational activities such as horseback riding, swimming, and hiking can lead to the introduction of organic, physical, and chemical pollutants into aquatic systems. Nonpoint-source runoff from roads and parking lots may potentially affect water quality by contributing organic chemicals and heavy metals to land surfaces. Some pesticides are used in the park and also may enter streams, although strict federal guidelines are followed for all applications.

Stormwater runoff from developed surfaces is discharged directly or indirectly into the main stem and South Fork Merced Wild and Scenic River or other streams and lakes throughout the park. In the Yosemite Wilderness, nonpoint-source pollutants include human and livestock wastes and sediments contributed through erosion. These sources have the potential to affect water quality in all segments of the Merced River.

In addition to local sources, water resources in the park can be affected by regional air pollution through atmospheric deposition. The entire Sierra Nevada range has been designated as sensitive to acid precipitation because of its granitic substrate and the resulting low-buffering capacity of its water resources. Ongoing studies are examining the effects of external and internal air pollutants on natural resources, including surface water resources.

Underground Tanks and Abandoned Landfills

A variety of materials has been stored in the park over the last century, often in underground storage vessels. Since 1986, over 100 underground tanks have been located and removed. The park has over 30 known contamination sites from leaking underground storage tanks. Currently, 12 sites are being cleaned up and need to be given regulatory closure. The park also contains a number of old landfill and surface dumpsites. Regardless, these underground nonpoint pollution sources represent potential contaminant sources for the degradation of water quality.

Point Sources of Pollution

Point sources of pollution include discharges from pipes or other devices where the discharge can be traced to a single point or location. Facilities in Yosemite Valley and El Portal are connected to a wastewater collection system that terminates at the El Portal Wastewater Treatment Plant. Treated wastewater is discharged to percolation and evaporation ponds at the treatment facility. Water quality impacts from wastewater may occasionally occur as a result of sewerline blockage and wastewater backup and overflow. A tertiary wastewater treatment plant serves most of the public and private sources in Wawona, and the treated wastewater is used to irrigate the Wawona Golf Course. During the winter, the treated wastewater is discharged to the South Fork when storage capacity is insufficient and disposal to the golf course is not feasible because of snow cover.

Fires

Fire is a natural component of the Sierra Nevada and Yosemite National Park. The recurrence of fire shapes the ecosystems of the park, with many common plants exhibiting specific fire-adapted traits. The National Park Service has adopted a *Fire Management Plan* (NPS 2004b), which has clear guidelines about when and where to allow natural and prescribed fires to burn. The effects of fire on water quality are potentially great. Fires are a disturbance that can increase sediment contributions to aquatic systems, alter runoff patterns, and thereby influence concentrations of chemical and biological constituents in waterbodies.

Groundwater and Water Supply

Groundwater occurs in Yosemite National Park in four general types of settings: large alluvial valleys such as Yosemite Valley; small deposits of alluvium, colluvium, and glacial till; porous geologic formations; and fractured rocks. The shallow aquifers of alluvial deposits tend to be highly responsive to groundwater recharge and withdrawals. The deep aquifers within the fractured rock are mostly unresponsive to any yearly hydrologic change, although these deep systems have not been fully studied.

Merced River Basin

The surface water and groundwater function as one unit in Yosemite Valley and El Portal. Recharge of the shallow groundwater aquifers reaches its peak during spring snowmelt. In Yosemite Valley, the entire meadow system may become saturated to the forest edge, resulting in restricted tree growth that defines the forest/meadow boundaries and extensive Valley wetlands. In El Portal, steeper terrain and river gradients have played a role in limiting the extent of groundwater-supplied wetlands. In addition, historical development has caused impacts to the few remaining wetland systems.

In 1985, the National Park Service ceased the use of surface water in Yosemite Valley and the El Portal area (diversions from the Merced River) and began drawing from newly drilled groundwater wells (NPS 1991g). Groundwater is used in both Yosemite Valley and El Portal for potable water supplies. Three wells in Yosemite Valley have the capacity to produce approximately 2,800 gallons per minute (gpm) (NPS 2004n). In El Portal, six wells support a capacity of approximately 220 gpm (NPS 2004z).

South Fork Basin

In the Wawona area, the groundwater flows through upper unconsolidated fills and lower fractured rock aquifers that have not been defined. The primary aquifer that supplies potable water to private wells in Wawona comes from the fractured granitic rocks in the South Fork basin. Fractured granitic rock aquifers typical of the Sierra Nevada can be highly variable for groundwater flow and supply. Drilling tests in the Wawona area have indicated a local, shallow groundwater flow system sustained by groundwater from deeper fractures (USGS 1996a). Groundwater in the local, shallow aquifer likely does not circulate deeper than approximately 250 feet below the surface. Short-term pumping tests on domestic wells in 1995 indicated that the median yield of wells is less than 5 gpm from the shallow aquifer in Wawona (USGS 1996a).

Currently four potable water distribution systems and multiple private wells supply water to the Wawona Area. The National Park Service is responsible for operating one of the distribution systems that supplies surface water from the South Fork Merced Wild and Scenic River to National Park Service and concessioner employee residences, the Wawona Hotel, the Wawona

Campground, and 30 private residences. The National Park Service's potable water production system is regulated under a permit issued by the Regional Water Quality Control Board and is designed to draw 480 gpm. The three remaining water distribution systems are owned by private homeowners and are regulated under permits issued by Mariposa County (NPS 2004aa).

Wetlands

Wetland data presented in this section are descriptive and programmatic in nature. The intent is to provide general descriptions, functions, and values of wetland and water-dependent communities within the Merced River corridor. Details concerning actual extent (location on the ground, acreage) and jurisdictional determination are not included herein and are left for more specific planning and implementation documents. For vegetative descriptions, refer to the Vegetation section of this chapter; for data relating to wildlife and aquatic species, refer to the Wildlife section; and refer to the Rare, Threatened, and Endangered Species section for information on protected species of plant and wildlife.

Wetland Classification and Definition

Wetlands are ecologically productive habitats that support a rich array of both plant and animal life. They sustain a great variety of hydrologic and ecological functions vital to ecosystem integrity. These functions include flood abatement, sediment retention, groundwater recharge, nutrient capture, and high levels of plant and animal diversity. Wetlands and riparian areas are relatively rare compared to the entire landscape. When wetlands are converted to systems that are intolerant of flooding (drained agricultural lands, filled developed lands), their storage capacity decreases and downstream flooding increases (National Academy Press 1993, as in NPS 1997g). Modification of even small wetland areas induces effects that are proportionally greater than elsewhere in an ecosystem (Graber 1996).

Although there are several definitions for the term "wetland," the two used herein relate to National Park Service and U.S. Army Corps of Engineers (Corps) conventions. These definitions are presented below.

The National Park Service classifies and maps wetlands using a system created by the U.S. Fish and Wildlife Service, which is often referred to as the Cowardin classification system (USFWS 1979). This system classifies wetlands based on vegetative life form, flooding regime, and substrate material. Wetlands, as defined by the U.S. Fish and Wildlife Service and adopted by the National Park Service, are transitional lands between terrestrial and aquatic systems, where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification, wetlands must have one or more of the following attributes:

- The land supports predominantly hydrophytes, at least periodically. Hydrophytes are plants that grow in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content.
- The substrate is predominantly undrained hydric soils. Hydric soils are wet long enough to periodically produce anaerobic conditions.
- The substrate is saturated with water or covered by shallow water at some time during the growing season of each year (USFWS 1979).

Under Section 404 of the Clean Water Act, the U.S. Army Corps of Engineers issues permits for the discharge of dredged or fill material into "waters of the United States" (33 CFR 323.3).

Wetlands are a subset of waters of the United States and receive jurisdictional protection under Section 404 of the Clean Water Act. Waters of the United States (also regulated under Section 404 of the Clean Water Act) include features such as streams, rivers, bays, lakes, inlets, mudflats, washes, sloughs, sand flats, territorial seas, tributaries, and impoundments. Wetlands are defined under the Clean Water Act as, "Those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (33 CFR 328.3[b])." Streams, creeks, rivers, and natural drainages that are regulated under Section 404 of the Clean Water Act are defined as "other waters of the United States" and are referred to as such in this document. For purposes of this document, wetland waters of the United States and other waters of the United States are referred to collectively as waters of the United States, unless noted otherwise. Additionally, both waters of the United States and Cowardin wetlands are referred to as wetlands.

The Cowardin system and the U.S. Army Corps of Engineers both use the three wetland parameters to define wetlands: hydrophytic vegetation, hydric soil, and wetland hydrology. However, the Cowardin system defines more habitat types as wetlands than does the Corps definition. The Cowardin system also recognizes that many unvegetated sites (e.g., mudflats, stream shallows, saline lakeshores, playas, or deepwater) or sites lacking soil (e.g., rocky shores, gravel beaches) are wetland habitats. The reason these sites lack hydrophytic vegetation and/or hydric soil is due to natural chemical or physical factors. Although the Corps does not consider these sites to be wetlands, they are still subject to regulations under Section 404 of the Clean Water Act as other waters of the United States.

The U.S. Army Corps of Engineers also has jurisdiction over navigable waters of the United States under Section 10 of the Rivers and Harbors Act of 1899. Navigable waters of the United States are those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. A determination of navigability, once made, applies laterally over the entire surface of the waterbody and is not extinguished by later actions or events that impede or destroy navigable capacity (33 CFR 329.4). No portion of the Merced River[5] within Yosemite National Park is designated as navigable waterway under Section 10 of the Rivers and Harbors Act.

Regional Context

Aquatic and riparian systems are the most altered and impaired habitats of the Sierra Nevada (UC Davis 1996). Dams and diversions throughout most of the range have profoundly altered stream-flow patterns and water temperatures. Foothill areas below about 3,300 feet appear to have the greatest loss of riparian vegetation of any region in the Sierra Nevada (UC Davis 1996). Within the mountains, broad valleys with wide riparian areas were often reservoir sites, and much of the best former riparian habitat in the Sierra Nevada is now under water. The extent of the inundation across the range becomes apparent when one realizes that virtually all flatwater[6] on the western slope of the Sierra Nevada below 5,000 feet is artificial (UC Davis 1996). Wetlands in the Sierra Nevada have been drained since the earliest settlers attempted to reclaim meadows and other seasonally wet areas. Mountain meadows were commonly drained with the intent of improving forage conditions and to permit agriculture (Hughes 1934, as in NPS 1997g; UC Davis 1996).

[5] Twenty miles of the Merced River, from its confluence with the San Joaquin River upstream, is designated as navigable by the Corps.

[6] Lakes, reservoirs, and Class 1 river reaches with no rapids or whitewater.

Riparian Wetlands

Wetlands within the Merced River corridor are broadly classified as riparian in nature and include aquatic, riparian, meadow, and floodplain communities. The riparian zone is the plant community adjacent to a river or stream channel and serves as the interface between the river and the surrounding meadows, floodplain, and upland plant communities. It may be best described as the zone of direct interaction between land and water (Swanson et al. 1982, as in NPS 1997g; Gregory et al. 1991, as in NPS 1997g; Cummins 1992, as in UC Davis 1996).

Riparian areas are characterized by the combination of high species diversity, high species density, and high productivity. Continuous interactions occur among riparian, aquatic, and upland terrestrial ecosystems through exchanges of energy, nutrients, and species (Mitsch 1986, as in NPS 1997g). Compared to other wetland and aquatic types, riparian areas are open, with large energy, nutrient, and biotic interchanges between aquatic systems on the inner margin and upland terrestrial ecosystems on the upland margin. Riparian ecosystems are further distinguished from other ecosystem types, as described below.

- Riparian ecosystems have a linear form as a consequence of their proximity to rivers, streams, and lakes.
- Energy and material from the surrounding landscape converge and pass through riparian ecosystems in much greater amounts than with any other ecosystem.
- Riparian ecosystems connect upstream and downstream ecosystems.
- Floodwater and subsequent groundwater levels are the main determinants of the type and productivity of the vegetation found in the riparian zone.
- Floodwater also brings nutrient-rich sediment to the floodplain, exports organic and inorganic material from the floodplain, and serves as a primary agent for long-term aggregation and degradation of the floodplain (Mitsch 1986, as in NPS 1997g).

Riparian ecosystems play a critical role in a variety of ecosystem processes. Situated at the interface between terrestrial and aquatic ecosystems, these ecosystems act to buffer hydrology and erosional cycles, control and regulate biogeochemical cycles of nitrogen and other key nutrients, limit fire movements, and create unique microclimates for animal species (Rundel and Stuner 1998). Large trees within the riparian zone provide shade to keep water temperatures cooler in the summer. Thick vegetation along the river channel helps to stabilize soils, which tend to be easily eroded in the absence of vegetation because of their coarse texture.

The diversity and structural complexity of riparian vegetation creates a wide variety of habitats for animals. Both terrestrial and aquatic wildlife depend on riparian ecosystems with their year-round availability of water, nutrients, food sources, and organic matter. In addition to these critical components of food resources, riparian ecosystems provide wildlife with a structural complexity that includes mosaics of shade and sun, shelter, and protected corridors between adjacent plant communities. It is not surprising, therefore, that riparian ecosystems are centers of high biodiversity (Rundel and Stuner 1998).

Riparian communities are among the most affected in Yosemite Valley because of their proximity to water, the effects of trampling, and the placement of above- and below-ground infrastructure, including lift stations, bridges, and underground sewer lines within riparian zones. The National Park Service has initiated ecological restoration projects designed to protect these sensitive communities and riverbanks from unnaturally high rates of erosion and encourage the re-

establishment of vegetative cover. Visitors are directed to areas that can accommodate heavy visitor use without long-term impacts, such as to point bars and gravel bars along meandering river segments.

Wetland Classes

Specific wetland classes identified within the river corridor include riverine (rivers, creeks, and streams), palustrine (shallow ponds, marshes, swamps, sloughs), and lacustrine (lakes and deep ponds).

Using the Cowardin classification system, specific wetland and deepwater classes within the Merced River ecosystem consist of:

- *Riverine upper perennial* – main channels of the Merced River and South Fork
- *Riverine intermittent* – intermittent tributaries to the Merced River and South Fork
- *Palustrine emergent* – emergent wetland (marsh, meadow) habitat along the Merced River and South Fork subject to various flooding regimes
- *Palustrine forested* – riparian forest habitat along the Merced River and South Fork subject to various flooding regimes
- *Palustrine scrub shrub* – riparian scrub (e.g., willow) habitat along the Merced River and South Fork and their tributaries subject to various flooding regimes
- *Lacustrine limnetic* – naturally occurring deep-water lakes (e.g., Merced Lake, Washburn Lake) along the Merced River

Additional areas within the Merced River ecosystem are mapped as undesignated and may be considered potential wetland (USFWS 1995). In some of these areas, there is development in the wetland or fill soils on top of wetland soils. One undesignated block is the 16 acres of braided stream channel of lower Yosemite Creek.

The following discussion provides general descriptions for each wetland class identified within the Merced River ecosystem.

Riverine Upper Perennial

Riverine upper perennial habitat within the corridor includes the open and flowing water of the Merced River and the South Fork. It is the permanently flooded rock-, cobble-, or sand-bottom channel with little to no in-stream vegetation. Occasional sandbars form within and at the channel edge and typically support willows and emergent (grasses and herbs) vegetation. Based on the National Park Service guidelines, the majority of the main stem of the Merced River and the South Fork would be classified as wetland. Channel portions that lie at a depth of 2 meters below low water would be considered deepwater. The main channel of the Merced River and the South Fork of the Merced River would likely be considered as jurisdictional by the U.S. Army Corps of Engineers under Section 404 of the Clean Water Act, not as wetlands but as other waters of the United States.

Riverine Intermittent

Numerous riverine intermittent drainages (other waters of the United States) are tributary to the main stem Merced River and the South Fork. Almost all riverine intermittent drainages within the river corridor are classified as Cowardin wetlands and waters of the United States. These

drainages often have a nonsoil substrate that is saturated and/or covered by shallow water at some time during the growing season. These wetlands are typically narrow and encompass the lowest portion of creekbeds. Very little wetland vegetation is found in these areas because of the intermittent nature of the flows within the drainage channels. All above-ground drainages within the river corridor are subject to the National Park Service protection policies under Executive Order 11990. These drainages are classified as other waters of the United States and would be subject to Sections 401 and 404 of the Clean Water Act.

Palustrine Emergent

Palustrine emergent habitat includes alpine, subalpine, and montane meadows and seeps. Soils are generally deep and peaty, remaining saturated year-round or on a seasonal basis. Vegetation is dominated by grasses, sedges, rushes, and perennial herbs. The meadows in Yosemite National Park play a particularly critical role in the Merced River ecosystem. High spring flows create wet areas in side channels, low-lying wetlands, meadows, and cutoff channels. These areas support the concentration of organic matter, nutrients, microorganisms, and aquatic invertebrates throughout the relatively dry summer. When the flush of winter or spring flooding occurs, this stored aquatic biomass is washed into the main river channel, forming the base of the aquatic food chain. Examples of this wetland type include Wawona Meadow, El Capitan Meadow, and meadows adjacent to Washburn and Merced Lakes. These communities are typically considered wetlands under the Cowardin system and typically meet the U.S. Army Corps of Engineers' wetland criteria. Thus, palustrine emergent wetlands are subject to the National Park Service protection policies under Executive Order 11990 and Section 404 of the Clean Water Act.

Palustrine Forested

Palustrine forested wetlands are the riparian forest habitats along the main stem of the Merced River and South Fork that are regularly inundated by normal high-water or flood flows. Palustrine forests within the upper reaches of the main stem of the Merced River and South Fork consist mainly of evergreen pines and firs, with occasional aspens. In Yosemite Valley, where the river is broad, shallow, and slow-moving, deciduous cottonwoods, willows, and alders dominate the riparian corridor. Substrate under the palustrine forest community varies from rock, gravel, sand, clays, loams, and mud. Palustrine forests (riparian forests) are classified as wetlands based on the National Park Service guidelines (USFWS 1995). These areas are classified as either wetland or other waters of the United States by the U.S. Army Corps of Engineers, depending on site-specific vegetation, soils, and hydrologic conditions, and would be subject to Section 401 and/or 404 of the Clean Water Act.

Palustrine Scrub Shrub

Along the Merced River, palustrine scrub shrub is only found in the riparian corridor. This habitat type occurs sporadically along the banks of the main stem of the Merced River, the South Fork, and at lake margins. It is regularly inundated by normal high-water or flood flows. This habitat is dominated by various willows and often intergrades with meadow (palustrine emergent) and riparian (palustrine forest) communities. These communities are typically considered wetlands under the Cowardin system, would be subject to the National Park Service protection policies under Executive Order 11990, and typically meet the U.S. Army Corps of Engineers' wetland criteria. These areas may meet the Corps' criteria of a wetland or other waters of the United States, depending on site-specific vegetation, soils, and hydrologic conditions, and may be subject to Sections 401 and/or 404 of the Clean Water Act.

Lacustrine Limnetic

Lacustrine limnetic refers to naturally occurring deepwater lakes, such as Merced and Washburn Lakes. Both lakes were formed along the Merced River by glacial activity. In-lake vegetation is typically limited to rooted aquatic grasses, floating vascular plants, and algae. Meadow (palustrine emergent) and riparian (palustrine forest and palustrine scrub shrub) communities generally border lake margins.

These lakes provide important habitat for fish, amphibians, reptiles, and other aquatic species. Substrate varies from rock, gravel, sand, and mud. Lacustrine limnetic (deepwater lakes and ponds) are classified as deepwater habitat based on the Cowardin system (USFWS 1995). These areas are typically classified other waters of the United States by the U.S. Army Corps of Engineers and would be subject to regulation under Section 404 of the Clean Water Act.

Merced River Wetland and Aquatic Habitats

As the Merced River leaves its headwaters, it alternates between areas with very steep gradients, high velocities, and no floodplains (such as the reach between Nevada Fall and Happy Isles) and areas with low gradients, slow velocities, and wide floodplains (such as Yosemite Valley). These river reaches function in very different ways with regard to nutrient cycling, though they are part of the same river. Plant and animal life in the steeper river sections depend on nutrients and organic materials that are carried within the main river channel. Plant and animal life in low-gradient reaches consume nutrients and organic materials that come laterally from adjacent floodplains during annual flood events. Thus, the lateral connection between the floodplain and the river, and the downstream connection within the river corridor, are essential to maintaining the natural system balance for the aquatic, riparian, and meadow communities.

Wilderness Segment of the Main Stem Wetland and Aquatic Habitats

The upper Merced River watershed is characterized by steep canyons, broad interstream areas of glacially smoothed granite, lakes and meadows, and thin, granitic soils. The upper river segments have a narrow riparian band commonly dominated by pines, firs, and aspens. The riparian zone is controlled by stream gradient, slope, sedimentation, and aspect. High-elevation tributaries to the Merced River (e.g., the Merced Peak Fork, the Triple Peak Fork) are sparsely vegetated by scattered patches of alpine riparian scrub and alpine willow thickets. As the river descends and the gradient becomes more gentle, lodgepole pines, aspens, willows, and alders become more prevalent. Willows often colonize where sandbars collect at the margins of or within the river channel (e.g., at Merced Lake High Sierra Camp). Riparian species often intergrade with upland coniferous forest at or near the river's upper banks.

Merced and Washburn Lakes were formed where the Merced River canyon was carved by glaciers. In-lake vegetation is typically limited to rooted aquatic grasses, floating vascular plants, and algae. Meadow communities border lake margins, providing important wildlife habitat.

Although human intrusion into the wilderness reaches of the Merced River has been ongoing for thousands of years, the upper reaches of the Merced River and its associated wetland communities remain intact and relatively free from disturbance. Riparian communities of the upper Merced River zone are generally intact, except in a few locations where human use is intense (for example, in the vicinity of the Little Yosemite Valley Backpackers Campground, Moraine Dome Backpackers Campground, and Merced Lake High Sierra Camp and Backpackers Campground). Riparian vegetation at these locations has been degraded by trampling and

erosion, resulting in loss of natural structure, diversity, and productivity (USFS 1993). These impacted areas are but a fraction of the wetland and aquatic habitats in the Wilderness segments. Riparian areas to the north of the Merced River within Little Yosemite Valley experience relatively heavy use (along major trail routes and campsites) and are low in species diversity. Forests south of the river receive almost no use and are more rich and pristine in nature.

Yosemite Valley Wetland and Aquatic Habitats

Wetlands in Yosemite Valley are formed in low-gradient land adjacent to the Merced River, its tributaries, or other bodies of water that are, at least periodically, influenced by flooding or high water tables. These wetlands would be broadly identified as riverine upper perennial (e.g., Merced River), palustrine (e.g., riparian, tributaries, shallow ponds, meadows, marshes), and undesignated (USFWS 1995).

Within Yosemite Valley, the Merced River supports riparian, aquatic, and meadow communities. Riparian zones in Yosemite Valley are characterized by broadleaf deciduous trees such as white alder, black cottonwood, big-leaf maple, white fir, mountain dogwood, and willow species. Vegetation along moving water is regularly disturbed by the deposition and removal of soil and the force of floodwaters. Vegetation in this zone readily colonizes on newly formed river-edge deposits. Big-leaf maple riparian forests grow on moist, gravelly soils in protected spots at the base of cliffs and on alluvial soils bordering streams. Meadows, such as El Capitan Meadow, are characterized by grasses, sedges, rushes, and herbs.

Wetlands within Yosemite Valley have undergone systematic alteration since the middle of the 19th century as they were grazed, farmed, and used as recreational sites and corridors for travel. One of the earliest impacts to wetlands in Yosemite Valley occurred in 1879 with the blasting of El Capitan moraine in the west Valley. This action lowered the base hydrologic level and caused the Merced River to downcut several feet (Milestone 1978g; NPS 1992c). Vegetation in adjacent wetlands was probably altered, and wetland function would have been further compromised by actions designed to dewater these areas. Impacts to wet meadows would have been most severe immediately upgradient of the blast (El Capitan Meadow) and dissipated in the vicinity of Yosemite Lodge. The blasting of the moraine would have had minimal impact on Sentinel, Cook's, Stoneman, and Ahwahnee Meadows.

Other alterations that took place in the early 20th century include drainage ditches that were constructed to dewater wet meadows to reduce mosquito breeding areas and provide open land for grazing and agriculture. Many of these drainage ditches have not been filled in and still dewater wet meadows in Yosemite Valley. Road construction has involved drainage measures and diversion of surface water adjacent to many of the Valley's wetlands.

Although changes are qualitatively evident to wetlands in many parts of Yosemite, quantitative evidence to support these observations is rare. Wetland impacts through time have been documented to a degree for one type of wetland, the meadows in Yosemite Valley. Approximately 800 acres[7] of Yosemite Valley meadows existed in 1866, as mapped by geologist J. D. Whitney (Hoffman 1866). Vegetation maps from 1994 classified approximately 370 acres in Yosemite Valley as meadow (NPS 1994e), roughly 50% of the 1866 meadow acreage. Because meadows were not burned for well over 60 years and water-flow patterns have been altered by

[7] Maps of Yosemite Valley prepared in the late 19th century used generic vegetation classifications and crude mapping technologies, and may not be accurate in terms of acreage. These maps may have included all open, nonforested areas (e.g., meadows, grasslands, unvegetated, decomposed granite) as one category.

development, dense stands of conifers cropped up in previously open meadows. The National Park Service is actively burning remaining meadows on a 5-year rotational cycle. Restoration of wetland communities along the Merced River within Yosemite Valley to mid-19th century conditions is ongoing through a variety of management programs, including prescribed burning, non-native plant eradication, and increasing inundation levels through restoration of natural drainage patterns.

Wetland restoration activities in Cook's Meadow, Stoneman Meadow, and Sentinel Meadow span several decades since the National Park Service initiated the first project in 1987. The National Park Service constructed raised boardwalks in all three meadows to allow surface water to flow across meadows. Construction of the boardwalks also set the stage to remove thousands of linear feet of social trails (informal foot trails) throughout the meadows. In 2002, restoration workers removed an elevated historic dirt road in Cook's Meadow that functioned as a dam and blocked natural water flows. Park restoration crews also filled in human-constructed drainage ditches and redirected altered water flows. Resource Management and Science staff have also coordinated extensive invasive plant eradication projects in Yosemite Valley meadows.

Merced River Gorge and El Portal Wetland and Aquatic Habitats

The Merced River gorge extends from Pohono Bridge through the El Portal Administrative Site. Within this area, the Merced River has a much steeper gradient compared to Yosemite Valley and consists mostly of seasonally continuous rapids through the El Portal Administrative Site. The riverbed and banks are largely composed of boulders and cobbles, ranging in size from a few inches to several feet in diameter.

The Merced River gorge is lined with a narrow band of riparian vegetation along the river course. These communities include blue oak woodland, interior live oak woodland, foothill pine/oak woodland, interior live oak/chaparral, and riparian woodland. El Portal does not have the deep loam deposits that characterize Yosemite Valley. Flooding has been an important aspect of the development of riparian communities along the Merced River and its tributaries that intersect drier adjacent vegetation types of El Portal. Localized seasonal flooding creates debris flows in tributary channels, thus furthering a diversity of scour and depositional soils for riparian species. On the Merced River, natural flooding and vegetative patterns have been influenced by the construction of levees and application of riprap to confine the river.

Early to mid-20th century development in what is now the El Portal Administrative Site has affected some of the oxbows, river terraces, and seasonal river channels that were a part of the riparian wetlands of the area. Many of the sites that would be characterized as palustrine have been impacted to some degree. For example, Odger's Pond and the Abbieville wetland appear to be oxbows or backwater channels that were cut off from the main stem of the Merced River during construction of Highway 140 in the 1920s (ESA 2004a). These areas continue to maintain palustrine wetland characteristics and riparian vegetation even though they are no longer directly connected to the Merced River. The remaining wetland areas that appear on the USFWS (1995) wetland inventory are riverine perennial wetlands and are in proximity to the Merced River or other stream drainages. Direct human intrusion into the riparian areas of this river zone, especially to the south, is minimal because of the topography and difficulty of access.

Wilderness Reaches of the South Fork Wetland and Aquatic Habitats

The South Fork is the Merced River's major tributary in the park vicinity. The total length of the South Fork is 43 miles from its headwaters to its confluence with the main stem of the Merced River several miles downstream from the western park boundary (NPS 1997g). The headwaters of the South Fork originate near Triple Divide Peak at an elevation of 10,500 feet. The South Fork flows westward over granitic bedrock to Wawona and then flows northwest at an elevation of 3,500 feet over an area underlain by sedimentary rocks.

From its headwaters, the South Fork flows west at a relatively consistent gradient through a glaciated alpine environment and then enters a V-shaped, unglaciated river valley. The upper South Fork has limited riparian vegetation due to the steep topography through which the river flows. High-elevation tributaries to the South Fork are either unvegetated, high-velocity, and rocky in nature or are only sparsely vegetated. Subalpine meadows along the South Fork are similar in composition to those described for the upper main stem of the Merced River. In-lake vegetation is typically limited to rooted aquatic grasses, floating vascular plants, and algae. The upper South Fork is generally pristine and remains virtually undisturbed by human-related effects. The steep gradient below Wawona along the South Fork prevents the establishment of an extensive riparian zone. The riverbed and banks are largely composed of boulders and cobbles, ranging in size from a few inches to several feet in diameter. Typical riparian species include willow, alder, aspen, and maple and are restricted to a narrow fringe along the river. This section of the South Fork is difficult to access and receives almost no visitor use.

Wawona Wetland and Aquatic Habitats

In the Wawona area, the river meanders through a large floodplain meadow (part of a deep alluvial valley) and has substantial gravel bars within the channel. As the river descends and the gradient becomes gentler, riparian vegetation (aspens, willows, and alders) becomes more prevalent. Willows often colonize where sandbars collect at the margins of or within the river channel.

Wawona Meadow is a 200-acre, low-elevation meadow, the largest such meadow in Yosemite National Park. The low-elevation meadow community, present between 4,000 and 5,000 feet in elevation, is now reduced to about 965 acres parkwide. However, unlike most of the other low-elevation meadows in the park, encroachment of Wawona Meadow by woody species appears to be minimal. The reasons for this are unknown but are probably related to surface and groundwater hydrology.

Although Wawona Meadow is large and generally intact, it has been the site of repeated human intrusion since the beginning of the 20th century. Approximately 44 acres of meadow vegetation were converted into a nine-hole golf course in 1918. An airstrip of about 57 acres was established in the middle of the meadow in 1925. A barn, milk house, stable, and slaughterhouse also were constructed on the meadow's edge, and cattle grazed there until about 1934. Irrigation and drainage ditches were constructed in the meadow in the 1930s, which affected its natural hydrology. Although the majority of these facilities have been removed, the meadow continues to be affected by the ditches, the golf course, a sprayfield for reclaimed water disposal, and helicopter staging.

Vegetation

Regional Vegetation

The major vegetation zones of the Sierra Nevada form readily apparent, large-scale, north-south elevational bands along the axis of the Sierra Nevada. Major east-west watersheds that dissect the Sierra Nevada into steep canyons form a secondary pattern of vegetation. On the west side, as elevation increases, forest types change from ponderosa pine to mixed conifer to firs. Straddling the crest of the Sierra Nevada is a zone of subalpine and alpine vegetation.

Merced River Vegetation

Yosemite National Park supports five major biotic communities: chaparral/oak woodland, mixed conifer, montane, subalpine, and alpine. It is estimated that half of all plant species in the park occur within the Merced River corridor. The following narrative provides a general description of vegetation within the Merced River corridor. Descriptions of vegetative communities, including distribution limits, habitat requirements, community sensitivities, and a list of plant species characteristically found in conjunction with each plant assemblage appear in the *Vegetation Management Plan* (NPS 1997p), based on information presented in Sawyer and Keeler-Wolf (1995). Plant pathogens and diseases and non-native plant species are described within each section where pertinent.

Wilderness Segment of the Main Stem Vegetation

At its headwaters, the Merced River begins in the lower alpine/subalpine zone. The river then descends through the upper montane zone and concludes in Little Yosemite Valley within the lower montane mixed conifer zone. Vegetation in the upper main stem river corridor is loosely grouped into four categories: meadow, riparian, chaparral, and coniferous forest. This segment of the river is designated as Wilderness.

Wilderness Segment of the Main Stem Meadow Plant Communities. High-elevation meadows within the Merced River corridor typically occur on fine-textured, permanently to semi-permanently wet soils and are typically associated with seeps, lake margins, or topographic bowls. Vegetation consists of low-growing, native, tussock-forming grasses, sedges, rushes, and perennial herbs, including alpine everlasting, dwarf lewisia, cinquefoil, Sierra Nevada daisy, and lupine. Within the alpine zone (generally above 10,000 feet—the very highest portion of the Merced River's headwaters), meadows form thin margins around small glacial lakes. At slightly lower elevations, Merced and Washburn Lakes, for example, meadows form a transition zone from the aquatic environment to drier coniferous forests. A large meadow plant community occurs within Echo Valley. These communities are hydrologically controlled by natural water flow and are generally classified as wetlands.

Wilderness Segment of the Main Stem Riparian Plant Communities. The upper Merced River is bordered by a narrow riparian zone controlled by stream gradient, slope, sedimentation, and aspect. High-elevation tributaries to the Merced River (e.g., Merced Peak Fork and Triple Peak Fork) are sparsely vegetated with scattered patches of alpine riparian scrub and alpine willow thickets. As the river descends and the gradient becomes more gentle, lodgepole pines, aspens, willows, and alders become more prevalent. Willows often colonize where sandbars collect at the margins of, or within the river channel. Riparian species often intergrade with coniferous forest at or near the river's upper banks.

Wilderness Segment of the Main Stem Chaparral Communities. Chaparral communities along the upper Merced River are characterized by montane chaparral (NPS 1997p). Plant species typical of this diverse community include mountain whitethorn, greenleaf manzanita, chinquapin, bitter cherry, buckbrush, deer brush, currant, huckleberry oak, mountain mahogany, snowberry, and lupine.

Within the alpine and upper subalpine zones, montane chaparral typically forms small, low-growing tufts at the base of rocks or other semiprotected sites where sediment and water collect and cryptogamic crusts[8] are present. These assemblages are often referred to as cushion plant-cryptogam communities because they are dominated by cushion-like or mat-forming herbs, shrubs, lichens, and mosses. With a drop in elevation, chaparral plant communities dominate exposed slopes. Species in these areas are often prostrate (low growing), with occasional wind-pruned pines intermixed. Examples of chaparral communities occur in the vicinity of the confluence of the Merced Peak and Triple Peak Forks. Lower-elevation talus and scree fields are colonized by dense, shrubby trees and chaparral and slowly succeed to coniferous forest communities.

Wilderness Segment of the Main Stem Coniferous Forest Communities. Coniferous forest communities along the upper Merced River include subalpine, upper montane, and montane coniferous forest elements (NPS 1997p). Whitebark pine, western white pine, Jeffrey pine, red fir, sugar pine, incense-cedar, lodgepole pine, and mountain hemlock dominate the higher elevations above Little Yosemite Valley. Ponderosa pine dominates Little Yosemite Valley, with interspersed incense-cedar and canyon live oak. The forest plant species composition varies with elevation, slope, aspect, soils, water availability, and past and ongoing disturbance.

Subalpine coniferous forests are relatively open and exposed, and become more dense along river and stream channels. Forest understory is naturally sparse and ranges from barren rock to sparse shrubs and grasses. The subalpine zone is characterized by long, severe winters and brief, cool summers. Trees in this zone range between 10 and 70 feet in height and are typically long-lived. Intensely strong winds on exposed ridges near treelines cause low-growing krummholz.[9] Although western junipers occur throughout the upper Merced River zone, unusually large specimens of this species occur above Washburn Lake. Typical trees measure 30 feet in height and 6 to 8 feet in diameter and can be found in comparatively large concentrations.

Upper montane coniferous forests within the upper Merced River zone are high-diversity forests dominated by western white pine, Jeffrey pine, red fir, sugar pine, incense-cedar, lodgepole pine, and aspen. Species dominance varies with site conditions. For example, groves of aspens and lodgepole pines occur where moist soil conditions persist (e.g., the margin of Washburn Lake). Large concentrations of white fir occur in the 6,000- to 7,000-foot elevation range along the river corridor. Although the upper Merced River is not untouched by human intervention, the diversity of both forest-dominant and understory species above Little Yosemite Valley exemplifies the variability of vegetation through this upper montane to alpine zone of the Sierra Nevada. Understory species in the upper montane coniferous forests include a mix of scrub and chaparral as well as young conifers and fern dells. Species composition is diminished only within

[8] Cryptogams, or cryptogamic crusts, are a thin crust made up of mosses, lichens, algae, and bacteria. These organisms form a biotic layer over unvegetated areas between shrubs, grasses, and flowering plants in undisturbed arid and semiarid lands of the world, including the alpine zone of the upper Merced River. Cryptogams function as soil builders. They form a spongy layer that helps protect soil from erosion, absorbs moisture, and provides nitrogen and other nutrients for plant growth. When frozen, the cryptogamic crust uplifts and cracks. Cracks in the layer can provide germination sites for seeds.

[9] A stunted forest type typically found at timberline.

very localized areas, such as Merced Lake High Sierra Camp (denuded understory), the burn area within Echo Valley (even-aged stands of young conifers), or where abiotic factors dictate (e.g., barren rock outcrops). Generally, higher-diversity vegetative communities are regarded as more ecologically stable and less common, and are therefore usually accorded a higher degree of resource protection. High-diversity vegetative communities support a multitude of plant species that fill all or most available plant niches and are less susceptible to non-native invasive species.

Little Yosemite Valley is dominated by mixed conifer communities of ponderosa pine, incense-cedar, sugar pine, and occasional California black oaks and canyon live oaks. The most common understory shrubs are Mariposa manzanita, deerbrush, and bear-clover. With a descent in elevation from the upper reaches of the Merced River into Little Yosemite Valley, the impacts associated with visitor use become more apparent. Forests to the north of the Merced River experience relatively heavy use (along major trail routes and camping sites), typically have little understory vegetation, and are dense with young trees, dead material, and ladder fuels. Forests south of the river receive almost no use and are more rich and pristine in nature. Typical non-native species in this coniferous forest include European annual grasses, bull thistle, and common mullein.

Park programs to address eradication of non-native vegetation have been successful in reducing populations of non-native species.

Yosemite Valley Vegetation

Yosemite Valley is a broad, flat-bottomed valley formed by glaciation and subsequent alluvial deposition. The river corridor includes the Merced River in addition to portions of Illilouette Creek, Tenaya Creek, Yosemite Creek, Sentinel Creek, Ribbon Creek, and Bridalveil Creek. Yosemite Valley is in the lower montane mixed conifer zone and vegetation can be loosely lumped into four types: meadow, riparian, upland, and California black oak. Because the National Park Service considers California black oak a highly valued biological and cultural resource, this community is described separately from other upland communities.

Yosemite Valley Meadow Plant Communities. Low-elevation meadows on the Merced River floodplain are hydrologically driven communities. The maintenance of these communities is dependent on sustaining river processes including the frequency, duration, and magnitude of flooding, and frequent low-intensity broadcast fires. The meadows in Yosemite Valley are transition zones from drier upland and black oak communities to wetter riparian communities. The meadows themselves vary from wet to dry seasonally and link the Merced River and tributaries to permanently dry land. The aquatic food chain in the Merced River is dependent on a connection with overflow channels in the meadows, which spill over during periods of high water, releasing concentrated food sources into the river.

Yosemite Valley meadows are classified into three general types: (1) wet meadow dominated by native hydrophilic vegetation, (2) grass meadow, dominated by non-native grasses, Himalayan blackberry and bull thistle (introduced in turn-of-the-century agriculture), and (3) native hydrophilic forbs. Meadow acreage in the Valley has diminished to less than half of the 800 acres of meadow in 1866[10] (as mapped by state geologist J. D. Whitney) due to a type conversion from meadow to conifer forest that has occurred over an unnaturally short period of time (NPS 1994e).

[10] Maps of Yosemite Valley prepared in the late nineteenth century used generic vegetation classifications and crude mapping techniques, and may not be accurate in terms of acreage. These maps may have included all open, nonforested areas (e.g., meadows, grasslands, unvegetated, decomposed granite) as one category.

Contributing factors have been a change in prehistoric fire frequency maintained by American Indians, and manipulations of hydrological patterns such as intentional draining of meadows to facilitate grazing, agricultural use, road and trail construction, drainage diversions, and channelization of surface and subsurface water runoff.

Yosemite Valley Riparian Plant Communities. Riparian zones extend outward from bank edges of the Merced River and its tributaries into adjacent meadow and forest communities. Riparian ecosystems play a critical role in a variety of processes. Situated at the interface between terrestrial and aquatic ecosystems, the riparian zone acts to buffer hydrology and erosional cycles, control and regulate biogeochemical cycles of nitrogen and other key nutrients, limit fire movements, and create unique microclimates for animal species (Rundel and Stuner 1998).

Riparian zones in Yosemite Valley are characterized by broadleaf deciduous trees such as white alder, black cottonwood, and willow species. Riparian areas within the Valley are rich in species diversity and structure. Riparian vegetation is regularly disturbed by the deposition and removal of soil and the force of floodwaters. Plants in this zone colonize newly formed river-edge deposits readily. The distribution of riparian communities varies with soil saturation and frequency of disturbance. For example, big-leaf maple riparian forests grow on moist gravelly soils in protected spots on alluvial soils bordering streams, whereas sandbar willow woodlands occur on point and mid-channel bars that are washed over annually by spring floods (NPS 1994e).

Riparian communities are among the most productive and biologically diverse in Yosemite Valley. For much of the 20th century, these areas were among the most impacted due to their proximity to water and the effects of trampling and the installation and maintenance of above- and below-ground infrastructure, including sewage lift stations, bridges, and underground utility lines. More recently, the National Park Service has initiated ecological restoration projects designed to protect these sensitive communities and riverbanks from unnaturally high rates of erosion, and to encourage the re-establishment of vegetative cover (see the discussion under Bank Erosion in the Water Quality subsection of this chapter). Visitor use is directed to areas that can accommodate heavy use without long-term impacts, such as to point bars and gravel bars along meandering river segments.

Yosemite Valley Upland Plant Communities. Five forest types are found in Yosemite Valley. Mixed coniferous forest is found on the floor of the Valley. Canyon live oak forest, north-facing mixed conifer/canyon live oak talus forest, and south-facing mixed conifer/canyon live oak forest occur on the talus slopes along the sides of Yosemite Valley. A fifth type is the cliff community, characterized by steep granite cliffs and many discrete microhabitats.

Canyon live oak communities grow on both north- and south-facing talus slopes and often form pure or almost pure stands. Fires in this community are infrequent but intense, with a fire return interval of 20 to 50 years on south-facing slopes. Most trees and shrubs in this community crown sprout after fire.

Mixed conifer communities are normally dominated by ponderosa pine and generally grow at elevations of 3,000 to 5,000 feet. This habitat also contains incense-cedar, sugar pine, and occasional California black oaks. The most common understory shrubs are Mariposa manzanita, deerbrush, and bear-clover.

The mixed conifer community is naturally adapted to low-intensity, frequent fires. Nearly 100 years of fire suppression has resulted in a change from open forest to dense thickets of shade-tolerant tree species, including incense-cedar, white fir, and Douglas-fir. Under natural conditions, the return interval for fire is estimated at 8 to 12 years (NPS 1990a). Present conditions, however, often generate fires of much greater intensity than under a natural fire regime. The intensity of the 1990 A-Rock Fire in the Foresta area was partially due to these conditions. Most undeveloped, mixed conifer areas of Yosemite Valley are now managed through a combination of mechanical removal of hazardous fuel and prescribed burning. These treatments simulate the natural and anthropogenic fire regimes of the Valley and help decrease stand densities to more natural levels.

In Yosemite Valley, the extent of the annosus root disease[11] is unusual; there are only a few other large populations of this species of root rot on the west side of the Sierra Nevada. Yosemite has unnaturally dense stands of conifers in former California black oak, meadow, and riparian areas that have a high water table and frequent flooding. The conifer forest in Yosemite Valley may not be sustainable because of these unusually large centers of annosus. Significant annosus infestation centers in Yosemite Valley include former Upper River and Lower River Campgrounds and Yellow Pine Campground, portions of Yosemite Lodge, and most of the Taft Toe area. Existing annosus centers in developed areas can be mitigated by landscaping with species that are not susceptible to infection, such as California black oak, canyon live oak, and big-leaf maple.

Non-native, or introduced, plant species have become established in the mixed conifer zone, although not to the extent they have in meadows and California black oak communities. These species are the result of either deliberate or accidental introductions and are not part of the naturally evolved community. Many of these are indicators of past agricultural activities that occurred throughout the area. Approximately 180 non-native species have been identified in the park, primarily in the chaparral/oak and mid-elevation forests (Fritzke and Moore 1998). In the upland plant communities of Yosemite Valley, non-native species are generally herbaceous and associated with ground disturbance (one-time or recurring). Typical species include European annual grasses and bull thistle.

Park programs to address eradication of non-native vegetation have been successful in reducing populations of non-native species.

Yosemite Valley California Black Oak Plant Communities. California black oaks in Yosemite Valley form pure open stands of large, stately trees with an herbaceous understory. These pure stands are unique to the Valley due to thousands of years of anthropogenic activities, including annual burning and removal of young conifers, and are found at the change in slope between upland colluvial deposits and lower meadow, water-driven alluvial areas. They form a band or ring of oaks around the Valley floor between the upland forest communities and the lower-lying meadow and riparian communities, totaling approximately 126 acres. The black oak acorn was a primary food source of Indians in Yosemite Valley, and most of the large groves continue as culturally important areas today. Black oak stands mixed with ponderosa pine are found throughout the Valley, and areas of black oak with development are found in the east Valley,

[11] Annosus root disease is a widespread native fungus. In pines, the fungus first spreads through the root system, attacking the inner bark and sapwood, killing these tissues. Within two to six years after initial infection, the fungus reaches the root crown and girdles the tree. The tree dies, but the fungus remains active as a saprophytic, wood-decaying organism within roots and the butt of the dead tree. Pines weakened by annosus root disease are often killed by bark beetles. Incense-cedars, however, are not affected by beetles and will stand green for many years until the disease finally weakens the structure enough to cause failure. Cedars are thought to act as a reservoir for annosus root disease because they take so long to die (NPS 1998h).

totaling an additional 280 acres. Black oaks also grow in dense stands on talus slopes near drainages. Certain portions of Yosemite Valley support extraordinary examples of black oak.

California black oak communities in Yosemite Valley have experienced a decline in population size, density, vigor, recruitment rates, and stand structure. The decline has been caused by changes in natural or cultural fire processes, encroachment by conifers, browsing by deer and rodents, and from development and unmanaged visitor use in the early and mid-20th century (Fritzke 1997). Oak woodlands are also some of the most ecologically transformed terrestrial ecosystems in the Sierra Nevada due to alterations of natural processes, development, and introduction of non-native species. The conversion of oak woodlands has also had a substantial effect on wildlife species (UC Davis 1996).

Black oak communities are adapted to frequent low-intensity fires, similar to upland mixed conifer communities. Under natural conditions, the return interval for fire is estimated at 8 to 12 years (NPS 1990a). Non-native plant species have also become established in California black oak communities. Species include annual grasses, black locust, and extensive ground-covering stands of Himalayan blackberry.

Park programs to address eradication of non-native vegetation have been successful in reducing populations of non-native species.

Merced River Gorge and El Portal Vegetation

The Merced River gorge is in the mixed conifer and chaparral/oak woodland zone (Sawyer and Keeler-Wolf 1995). There is a narrow band of riparian vegetation along the river course, which is bordered by a dense mosaic of chaparral and foothill woodland communities on the steep canyon walls. The riparian zone, especially to the south, remains largely untouched by human intrusion (with the exception of the El Portal Road corridor and development in El Portal). Foothill woodland communities include blue oak woodland, interior live oak woodland, foothill pine/oak woodland, interior live oak/chaparral, and several riparian woodland associations.

All of the communities in this area are adapted to frequent natural fires sparked by lightning. Fire suppression has led to increased vegetative density, especially on north-facing slopes where recent fires have been successfully suppressed. The 1990 A-Rock Fire burned the south-facing slope directly above El Portal before it was controlled. Natural fires probably burned every 5 to 10 years in grassy areas, and 25 to 40 years in chaparral areas (van Wagtendonk 1994).

Flooding has also been an important aspect of the development of riparian communities along the Merced River and tributaries intersecting drier adjacent vegetation types of El Portal. Localized seasonal flooding in the fall creates debris flows in tributary channels, engendering a diversity of scour and depositional soils for riparian species. Natural flooding patterns on the Merced River have been influenced by the historic and modern construction of levees and riprap to confine the river. These structures have destroyed riparian vegetation and have limited their re-establishment in some places.

Merced River Gorge and El Portal Oak Communities. El Portal supports numerous stately mature oak trees. Of the eight tree-like species of oak in California, six grow in El Portal. Development in El Portal has been built, in general, while retaining an overstory of native mature oaks. This oak canopy provides shade, scenery, and wildlife habitat. The shrub layer also retains many native elements such as redbud, buckeye, Mariposa manzanita, and yerba santa. Undeveloped areas

often support a grassy understory that consists of mostly non-native grasses along with native wildflowers. Yellow star-thistle, tocalote, and other extremely invasive species have recently become established in part of the understory flora. Historic and current development and landscaping have introduced many other non-native species into this community, including the invasive tree-of-heaven, French broom, and numerous herbaceous lawn grasses. Fruit trees and other landscape trees are also common. Programmatic efforts to reduce or control the spread of invasive species have been in place in Yosemite for several years.

Merced River Gorge and El Portal Riparian Communities. Riparian communities in the El Portal area include a valley oak alliance and a black cottonwood alliance. These communities occur along tributaries of the Merced River, on flat topographical shaded terraces above the Merced River, in backwater channels, and in areas where runoff from upland sites collects in natural depressions. Native ash trees occur in the wetter areas, as well as historic orchard components in some locations. Foothill pines and valley oaks tend to dominate the drier terraces adjacent to riparian sites, with a lower proportion of mature oaks than in the oak communities due to higher moisture levels and shallower soils caused by past flood scouring. An interior live oak/canyon live oak association is found along intermittent and perennial tributaries to the Merced River in the El Portal area. Although not generally considered a riparian vegetation type, this association is considered as such in this document because it appears to be almost entirely restricted to tributary drainages (ESA 2004b).

Wilderness Reaches of the South Fork Vegetation

Vegetation along the South Fork can generally be classified as alpine, subalpine, upper montane, and lower montane mixed conifer. Vegetation is loosely grouped into four categories: meadow, riparian, chaparral, and coniferous and deciduous forests. These segments include nearly a full range of environments typical to the Sierra Nevada.

Wilderness Reaches of the South Fork Meadow Plant Communities. Meadow plant communities along the upper South Fork range from small, isolated alpine meadows at high elevations to moderately sized meadows along the river corridor. Alpine and montane meadows along the South Fork are similar in composition to those described for the upper Merced River zone.

Wilderness Reaches of the South Fork Riparian Plant Communities. The steep gradients along the upper and lower South Fork are not conducive to the establishment of an extensive riparian zone. Typical riparian species—willow, alder, aspen, and maple—are restricted to a narrow fringe along the river. High-elevation tributaries to the upper South Fork are either unvegetated, high-velocity, and rocky in nature or are only sparsely vegetated. Riparian vegetation along the lower reach remains relatively untouched by human intrusion.

Wilderness Reaches of the South Fork Chaparral Communities. Alpine and subalpine chaparral communities along the upper South Fork are similar in composition to those described for the upper Merced River zone. Steeper canyon slopes above the upper South Fork, as well as the steep canyon slopes along the South Fork below Wawona, are dominated by montane chaparral, which contain a variety of manzanitas, ceanothus species such as buckbrush and deerbrush, chinquapin, mountain mahogany, huckleberry oak, and interior live oak. Natural fire return intervals in these communities are about 20 to 30 years, and fires are naturally intense due to the flammability of the shrub species.

Wilderness Reaches of the South Fork Coniferous and Deciduous Forest Communities. Forest communities along the upper South Fork are subalpine, with some elements of montane coniferous and deciduous forests. Coniferous and deciduous forests along the upper and lower South Fork are rich in species composition (both over and understory) and are comparable in conditions to the forest communities described as occurring above Little Yosemite Valley within the upper Merced River zone. High elevations are dominated by whitebark pine, lodgepole pine, red fir, and aspen. The upper reaches of the canyon are narrow and the rock is highly jointed. The forest is relatively sparse through this zone, with most trees and forest species occurring along the jointed granite. Ponderosa pine is dominant at lower elevations, with incense-cedar, sugar pine, and black oak occurring as sub-dominants.

Wawona Vegetation

Vegetation in the central South Fork (Wawona) can generally be classified as upper montane and lower montane mixed conifer. Vegetation is loosely grouped into three categories: meadow, riparian, and coniferous and deciduous forests.

Wawona Meadow Plant Communities. A portion of what once was Wawona Meadow lies within the river corridor. Approximately 44 acres of meadow vegetation were converted into a nine-hole golf course in 1918. The meadow continues to be affected by the golf course and is used as a sprayfield for reclaimed water.

Wawona Riparian Plant Communities. As the river descends and the gradient becomes gentler, riparian vegetation consisting of aspens, willows, and alders becomes more prevalent. Willows often colonize sandbars that are deposited at the margins of or within the river channel. In this area, the riparian corridor resembles the riparian corridor seen along the Merced River as it flows through Yosemite Valley.

Wawona Coniferous and Deciduous Forest Communities. Forest communities in the Wawona area include lower montane coniferous and deciduous forests. Human intrusion in parts of this segment has been ongoing since the turn of the century and has affected forest health and composition. Ponderosa pine is dominant in the Wawona area, with incense-cedar, sugar pine, and black oak occurring as sub-dominants. Some areas in the relatively flat lands along the river may have historically been dominated by black oak under a more natural fire regime, but have since been invaded and co-dominated by ponderosa pine and incense-cedar.

Understory species are often manzanita, deerbrush, and bear clover. This community is naturally adapted to low-intensity, frequent fires; however, 100 years of fire suppression has resulted in a change from an open forest to dense thickets of subordinate species in many areas. Under natural conditions, the fire return interval is estimated at 8 to 12 years (NPS 1990a). Present conditions can generate fires of much greater intensity than those under a natural fire regime. Fire management policy in this segment is affected by the numerous residences, private lands, and historic structures located within the Wawona segment of the corridor.

Wildlife

Data on wildlife presented in this section are descriptive and programmatic in nature and are intended to provide general habitat descriptions, functions, and values in addition to species presence and use of those habitats within the Merced River corridor. Details concerning individual or population locations or size are not included herein and are left for more specific

planning documents. Peer-reviewed scientific studies have been conducted since the 1950s (CDFG 2000), and reasonably accurate descriptions of park fish and wildlife resources have been developed based on field reconnaissance, literature review, the professional knowledge and judgment of park staff, wildlife-habitat relationships models[12] (CDFG 2000), records of observations, published references on Sierra Nevada wildlife, and studies of selected species. In particular, California Wildlife Habitat Relationship models have been used for predicting impacts within the park (Chow et al. 1994).

More complete information is available on species that present a distinct management challenge, for example, bats (Pierson and Rainey 1993), spotted and great gray owls (Wildman 1992), and bears (Harms 1980; Graber 1981, 1996; Graber and White 1983).

Yosemite National Park Regional Wildlife

Yosemite National Park, one of the largest and least-fragmented habitat blocks in the Sierra Nevada, supports a diverse and abundant assemblage of wildlife. Its importance in protecting the long-term survival of certain species and the overall biodiversity[13] of wildlife in the Sierra Nevada was recognized in the reports prepared as part of the Sierra Nevada Ecosystem Project (UC Davis 1996). The Sierra Nevada Ecosystem Project included assessments of the Sierra Nevada headwaters of 23 major river basins in addition to the Merced River, from Eagle Lake in the north to the Mojave River in the south. As part of these assessments, much of the main stem of the Merced River corridor and the South Fork corridor were identified as an aquatic diversity management area (UC Davis 1996).

The Merced River corridor also plays an essential ecological role in linking wildlife habitats across the park's landscape and gradients of elevation; this fact forms an important part of the framework for this analysis. For wildlife populations to be viable, resources and environmental conditions must be sufficient for foraging, resting, cover, and dispersal of animals. Arrangement, types, and amounts of resources must be sufficient for the needs of reproductive individuals on daily, seasonal, and yearly scales. Habitat must also be well distributed over a broad geographic area to allow breeding individuals to interact spatially within and among populations, and a stable, relatively undisturbed riparian corridor supplies a mechanism for this kind of ecological connection.

Mammals

Approximately 85 native mammal species in 6 families inhabit Yosemite. There are 17 species of bats, 9 of which are either state or federal species of special concern (see the Rare, Threatened, and Endangered Species section of this chapter). Many of these bat species are dependent on riparian and meadow habitats for foraging, and large trees or rock crevices for roosting. Ungulates in the park include mule deer. Bighorn sheep formerly populated the Sierra crest but

[12] For terrestrial animals, relationships form the basis for an analytical system developed for Sierra Nevada habitats that is often used to project the effects of habitat changes. The California Wildlife Habitat Relationships program (Mayer and Laudenslayer 1988; USFS 1980) allows biologists to estimate the likely effects on wildlife that could result from modifying an area of wildlife habitat. The California Wildlife Habitat Relationships program has been used extensively by federal and state agencies and private landowners for estimating the effects of changing habitat conditions on wildlife in the Sierra Nevada, including most of the assessments in the Sierra Nevada Ecosystem Project reports identified in this section (see Graber 1996). Since wildlife are mobile and use more than one vegetation type, habitats are classified more simply under the California Wildlife Habitat Relationships system; consequently, there are fewer classifications than are presented in the Vegetation section of this document.

[13] Biodiversity, or biological diversity, is generally accepted to include genetic diversity within species, species diversity, and a full range of biological community types. The concept is that a landscape is healthy when it includes stable populations of native species that are well distributed across the landscape.

are now extinct in the Merced River watershed. Carnivores include black bears, bobcats, coyotes, raccoons, mountain lions, ringtails, weasels, and gray foxes. Yosemite's largest mammal, the grizzly bear, was extirpated from the region and from the state in the 1920s. Other mammal species that survive but are extremely rare are the fisher, wolverine (possibly extinct), and Sierra Nevada red fox.

Birds

Yosemite's wide range of elevations and habitats support a diversity of bird species: 150 species regularly occur in the park, and approximately 80% of these are known or suspected to breed within park boundaries. Bird species familiar to park visitors include black-headed grosbeak, red-winged blackbird, western tanager, and American robin. A majority of Yosemite's bird species migrate from the park in winter, but among the more conspicuous species that remain year-round are the common raven, Steller's jay, whiteheaded woodpecker, and dark-eyed junco.

Several bird species have probably been reduced in Yosemite Valley by centuries of human activity but are present in less disturbed areas. Yosemite Valley meadows are suitable habitat for great gray owls, and the species persists in other meadows, though sightings in Yosemite Valley are rare. Willow flycatchers no longer nest in Yosemite Valley—probably due as much to parasitism by brown-headed cowbirds as to the historical loss of riparian and meadow habitat—but were recorded in Wawona as recently as 1998.

On a wider scale, apparent population declines have been detected in numerous other bird species in the Sierra Nevada, including Yosemite National Park. Possible causes for these declines include grazing, logging, fire suppression, development, recreational use, pesticides, habitat destruction on wintering grounds, and large-scale climate changes. Although the population declines result from decades of development, since the 1980s park management has been aimed at reducing or reversing habitat effects associated with fire suppression, pesticide use, and other factors on park lands.

Reptiles and Amphibians

Compared to most mountain regions of the west, Yosemite has a particularly large number of native reptile and amphibian species: 14 snakes (one poisonous), 7 lizards, 1 turtle, 2 toads, 1 tree frog, 3 true frogs, and 5 salamanders (including newt and ensatina). Most of these species have been found in Yosemite Valley.

Amphibians in Yosemite National Park have suffered population declines similar to those seen in the rest of the Sierra Nevada (Drost and Fellers 1996, Knapp 2003). These declines were noticed in the 1970s but likely began much earlier with the introduction of non-native fish into park watershed. Red-legged frogs likely were found in Yosemite Valley in the past but are now apparently extinct there. Significant factors in their disappearance probably include reduction in perennial ponds and wetlands, and predation by bullfrogs. At higher elevations, mountain yellow-legged frogs and Yosemite toads are still present in a number of areas, but are severely reduced in population and range. A survey of lakes, ponds, marshes, and wet meadows was conducted from 2000 to 2002. This survey found mountain yellow-legged frogs in 282 of 2,655 bodies of water surveyed, and Yosemite toads in 74 of 2,655 bodies of water surveyed. Foothill yellow-legged frogs have disappeared completely from the park, if not the entire Sierra Nevada. Research continues to identify the causes of amphibian declines in the Sierra Nevada; possible causes include habitat loss, non-native fish, pesticides, and diseases.

Fish

Most fish currently found in the Merced River and its tributaries in Yosemite have been introduced. Prior to trout stocking for sport fishing, native fish in Yosemite were probably limited to the rainbow trout and the Sacramento sucker, both of which were present only in the lower portions of the Merced River (i.e., Yosemite Valley and below). The last period of glaciation eliminated all fish from the high country, and waterfalls remaining on all rivers after the glaciers retreated prevented repopulation by upstream migration. Fish native to the Merced River in El Portal and downstream include Sacramento pikeminnow (squawfish), hardhead, California roach, and riffle sculpin.

Although the upper watershed of the Merced River was stocked with a variety of non-native trout in the earlier part of the century, Yosemite streams are subject to tremendous fluctuations in flow; these fluctuations, combined with severe climatic conditions, low nutrient availability associated with snow melt over granitic watersheds, and lack of spawning habitat, have restricted natural sustainability of introduced fish in a majority of Yosemite's lakes. Fishery surveys conducted in the mid-1970s found 62 lakes with self-supporting fish populations and 195 that supported little or no natural reproduction (NPS 1977). A more recent survey of lakes, ponds, marshes, and wet meadows was conducted from 2000 to 2002 (Knapp 2003). This survey found fish present in 245 of 2,655 bodies of water.

Until very recently, trees that fell into the Merced River in nonwilderness areas were considered hazardous to bridges and humans and were removed. This practice deprived fish and other aquatic organisms of important habitat and has altered natural river dynamics. Roads, ditches, utilities, and other structures in meadows have likely altered meadow hydrology, affecting water and nutrient flows into aquatic ecosystems. Fallen trees are now allowed to remain in the river because of their value to aquatic and riparian ecosystems.

Non-Native Wildlife Species

Non-native wildlife includes white-tailed ptarmigan, wild turkey, brown-headed cowbird, European starling, house sparrow, brook trout, brown trout, cutthroat trout, and the bullfrog. Feral pigs have recently been sighted near the park and could establish ranges in some park ecosystems.

Introductions of fishes into the Merced River drainage of Yosemite National Park probably began in the late 1800s with transfers of Lahontan cutthroat trout, coastal rainbow trout, and California golden trout from nearby waters. Rainbow trout is the only trout species native to the Merced River; rainbow trout introduced through stocking from other waters and fish hatcheries have now hybridized with, and/or have displaced, the original strain. Other species of trout not native to California, including brook trout, brown trout, and arctic grayling, have also been introduced into the Merced River drainage. Brown trout seems to have become well established and outnumbers rainbow trout in many areas. Brook trout are found in the main stem and in large numbers in lakes and small streams of the Merced River watershed. Fish introductions in higher elevation lakes and streams, all of which were naturally fishless, have likely severely altered those ecosystems. Such introductions of fish are strongly suspected of being a primary factor in declines of native amphibian species in the Sierra Nevada (Drost and Fellers 1996, Knapp 2003). The National Park Service discontinued fish stocking in Yosemite National Park in 1991.

The sensitive balance of aquatic ecosystems in Yosemite Valley has been severely disrupted by the presence of bullfrogs, which are voracious, non-native predators. Bullfrogs were first noticed in

the Valley in the 1950s. The full impact of bullfrogs on native species in the park is unknown, but bullfrog predation was probably a factor in the disappearance of red-legged frogs from Yosemite Valley. Recent observations suggest that bullfrogs occupy standing and slow-moving water throughout the Valley.

Brown-headed cowbirds have increased in the Sierra Nevada (Laymon 1987), threatening native bird species. Cowbirds are nest parasites that lay their eggs in the nests of other birds, usually songbirds. The cowbird eggs hatch before the eggs of the host species, and the larger, more vigorous cowbird young then eject the eggs or young of the host species or outcompete the host's young for food. This parasitism can have a devastating effect on the populations of some songbird species and is implicated in the disappearance of willow flycatchers from Yosemite Valley and of other riparian species statewide (Laymon 1987). The spread of cowbirds into the Sierra Nevada has been associated with human disturbance and activities; brown-headed cowbirds are common in Yosemite and can be found in large numbers at the park's stables and corrals, campgrounds, and residential areas.

The European starling and house sparrow are two non-native species found in El Portal, Yosemite Valley, and other developed areas that affect native bird species through competition for nest cavities, a limited resource. Both species are known to aggressively evict native bird species from occupied cavities. The existing development in El Portal has likely increased the abundance of both species by providing additional nesting sites and food sources.

Wildlife of the Merced River

A list of wildlife species believed to occur within the Merced River corridor would include nearly all of the wildlife species believed to occur within the park as a whole (NPS 1999q) because the corridor passes through nearly all of the habitat types found within the park. Table IV-1 provides predominant habitat types, along with representative species.

In the broadest sense, the presence and abundance of wildlife species at any site or area depend on the structure of the habitat available in that area. Habitat types broadly correlate with vegetation types (or plant associations/communities) or general stream classifications. For many wildlife species, there is an additional requirement for special habitat attributes, such as cliffs, caves, rocks, lakes or rivers, or other abiotic (nonliving) elements. In addition, many species have explicit habitat requirements for one or more elements of the biotic environment, such as large trees, large snags (standing dead trees), large downed logs, high degrees of canopy closure, or, for fish, pools, riffles, and undercut banks.

As described in the Vegetation section, the vegetation of Yosemite National Park is roughly stratified altitudinally and is affected by local topography. The highest mountain slopes show barren rock walls and herbaceous or shrubby plant life, which give way to open subalpine and montane coniferous forests farther down the canyon, then to more dense lower montane coniferous forest in Little Yosemite Valley. In Yosemite Valley, the vegetation pattern is highly modified and was probably dominated by meadows 150 years ago. From Pohono Bridge downstream, the Merced River gorge functions as a mountain canyon, and the vegetation shifts from lower montane coniferous forest near the Valley to hardwood and chaparral near El Portal. Similar changes occur along the South Fork. These changes in habitat structure correlate broadly with changes in the composition and abundance of wildlife species present in these altitudinal zones.

Table IV-1
Summary of California Wildlife Habitat Relationship Types in the Merced River Corridor

Habitat Code[a]	Habitat Type	Dominant Plant Species	Typical Wildlife Species	Amount of Watershed in Habitat type
BAR	Barren	Lichens, mosses	Mount Lyell salamander, rosy finch, American pipit, rock wren, common raven, Belding's ground squirrel, American pika, yellow-bellied marmot.	8%
DFR[b]	Douglas-fir	Douglas-fir, sugar pine, ponderosa pine	See Sierran mixed conifer habitat type.	<1%
JPN	Jeffrey pine	Jeffrey pine, sugar pine, lodgepole pine, white fir, red fir, incense-cedar	Sagebrush lizard, northern goshawk, red-tailed hawk, golden eagle, mountain quail, Lewis' woodpecker, northern flicker, olive-sided flycatcher, western wood-pewee, Steller's jay, lodgepole chipmunk, golden-mantled ground squirrel, striped skunk, black bear, gray fox, fisher, bobcat, mule deer, black bear.	5%
JUN	Juniper	Western juniper, Jeffrey pine, sagebrush	Sagebrush lizard, western rattlesnake, Say's phoebe, rock wren, common raven, common nighthawk, Townsend's solitaire, pinion mouse, bushy-tailed woodrat, coyote, black bear.	<1%
LAC	Lacustrine	Algae, sedges	Mountain yellow-legged frog, western pond turtle, western aquatic garter snake, eared grebe, great blue heron, bufflehead, spotted sandpiper, Northern river otter, black bear.	1%
LPN	Lodgepole pine	Lodgepole pine, aspen, mountain hemlock	Sagebrush lizard, western terrestrial garter snake, northern goshawk, red-tailed hawk, American kestrel, white-throated swift, Williamson's sapsucker, olive-sided flycatcher, mountain chickadee, pine siskin, deer mouse, long-tailed vole, coyote, ermine, long-tailed weasel, American badger, black bear.	12%
MCP	Montane chaparral	Huckleberry oak, Sierra chinquapin, whitethorn ceanothus, fremont silktassel, bitter cherry	Gilbert's skink, southern alligator lizard, red-tailed hawk, California quail, mountain quail, bushtit, barn swallow, ruby-crowned kinglet, California ground squirrel, Botta's pocket gopher, coyote, California pocket mouse, badger, striped skunk, black bear.	<1%
MHC	Montane hardwood-conifer	Douglas-fir, incense-cedar, ponderosa pine, black oak, big-leaf maple	Western fence lizard, northern alligator lizard, sharp-shinned hawk, Cooper's hawk, calliope hummingbird, red-breasted sapsucker, olive-sided flycatcher, big brown bat, coyote, grey fox, long-tailed weasel, badger, striped skunk, black bear.	<1%
MHW	Montane hardwood	Canyon live oak, black oak, Douglas-fir, California laurel	Northern alligator lizard, red-tailed hawk, American kestrel, flammulated owl, Anna's hummingbird, red-breasted sapsucker, Steller's jay, northern flicker, white-throated swift, big brown bat, California ground squirrel, deer mouse, brush mouse, coyote, gray fox, long-tailed weasel, badger, striped skunk, black bear.	15%
MRI	Montane riparian	White alder, black cottonwood, willow	Relictual slender salamander, Pacific tree frog, sharp-tailed snake, red-tailed hawk, mountain quail, warbling vireo, western screech owl, long-eared owl, belted kingfisher, cliff swallow, black phoebe, American dipper, song sparrow, mountain beaver, black bear.	<1%
PPN	Ponderosa pine	Ponderosa pine, incense-cedar, Douglas-fir, white fir, canyon live oak, black oak, Jeffrey pine, sugar pine	Western fence lizard, western rattlesnake, sharp-shinned hawk, American kestrel, acorn woodpecker, violet-green swallow, barn swallow, yellow warbler, chipping sparrow, California ground squirrel, mountain pocket gopher, coyote, badger, striped skunk, black bear.	19%
RFR	Red fir	Red fir	Western terrestrial garter snake, red-tailed hawk, golden eagle, great gray owl, black swift, olive-sided flycatcher, red-breasted sapsucker, golden mantled ground squirrel, deer mouse, bushy-tailed woodrat, coyote, long-tailed weasel, black bear.	14%

Table IV-1 (continued)
Summary of California Wildlife Habitat Relationship Types in the Merced River Corridor

Habitat Code[a]	Habitat Type	Dominant Plant Species	Typical Wildlife Species	Amount of Watershed in Habitat type
SCN	Subalpine conifer	Mountain hemlock, lodgepole pine, bristlecone pine, oceanspray, willows	Mount Lyell salamander, Yosemite toad, mountain yellow-legged frog, Golden eagle, dusky flycatcher, white-crowned sparrow, Wilson's warbler, golden-mantled ground squirrel, deer mouse, long-tailed vole, yellow-bellied marmot, porcupine, coyote, ermine, black bear.	7%
SMC	Sierran mixed conifer	White fir, Douglas-fir, ponderosa pine, incense- cedar, sugar pine, black oak	Western fence lizard, northern alligator lizard, red-tailed hawk, American kestrel, western wood-pewee, Hammond's flycatcher, ruby-crowned kinglet, big brown bat, long-tailed vole, California ground squirrel, deer mouse, coyote, gray fox, ermine, striped skunk, black bear.	13%
VRI	Valley-foothill riparian	Fremont cottonwood, white alder, willow, California grape	Gilbert's skink, gopher snake, western rattlesnake, green heron, common merganser, red-shouldered hawk, cliff swallow, tree swallow, ash-throated flycatcher, American goldfinch, common muskrat, beaver, brush mouse, coyote, gray fox, mink, striped skunk, black bear.	<1%
WFR	White fir	White fir, sugar pine, incense-cedar	Western fence lizard, northern alligator lizard, sharp-shinned hawk, great horned owl, black swift, Steller's jay, common raven, fox sparrow, dark-eyed junco, big brown bat, Botta's pocket gopher, deer mouse, brush mouse, coyote, ermine, gray fox, striped skunk, badge, black bear.	3%
WTM	Wet meadow	Sedges, rushes, willows	California newt, Yosemite toad, mountain yellow-legged frog, California mountain kingsnake, western aquatic garter snake, Pacific tree frog, mallard, great blue heron, common snipe, great gray owl, northern rough-winged swallow, mountain bluebird, common yellowthroat, California meadow vole, montane vole, western mastiff bat, yellow-bellied marmot, mountain beaver, black bear, ermine.	1%

a Source of original information for California Wildlife Habitat Relationship types and areas within each type within the Merced River basin: www.biogeog.ucsb.edu/projects/snner/basins/merc_gapwhr.html. The maps and data files on which this summary was based have not yet been published.

b California Wildlife Habitat Relationship System, by convention, does not assign this habitat type to the southern Sierra Nevada. The area assigned to this type likely should be assigned to the SMC type.

Overlaid on the overall elevation pattern is a local topographic effect. Where the river flows through low-gradient reaches, the valleys tend to be broad and relatively flat and are dominated by denser and taller forests than in areas with steeper channel reaches. Thus, locations like Little Yosemite Valley, Yosemite Valley, and the Wawona area tend to have taller and more extensive forests than steeper sections. The broad valleys in the flat reaches also tend to be associated with lakes, saturated soils, and wetlands such as meadows. These wetter areas are important wildlife habitat elements and are associated with a number of the sensitive species known to occur in the park (see the Rare, Threatened, and Endangered Species section of this chapter).

Riparian and Associated Habitats

The upper Merced River corridor includes two large lakes, Washburn Lake and Merced Lake, which provide an aquatic California Wildlife Habitat Relationship type called lacustrine habitat. The lakes also provide (especially near their upstream margins) emergent freshwater marshes that may be identified as the wet meadow habitat type. There are additional emergent marsh wetlands associated with the Merced River corridor in Echo Valley and Yosemite Valley. The Merced River corridor downstream from the Valley demonstrates well-developed riparian habitat. This

habitat type is also present above Yosemite Valley, but is less well developed than downstream. As the river approaches the park boundary, it supports a narrow fringe of riparian vegetation.

Riparian and associated habitats are the most valuable and the most vulnerable of all the habitat considered in this evaluation, and many of its species have a special status under park, state, or federal law or policy due to their rarity (see the Rare, Threatened, and Endangered Species section of this chapter). Yosemite toad is a park-endemic species and is known to occur within the upper reaches of the Merced River corridor. Mountain yellow-legged frog and Mount Lyell salamander also occur in wet habitats within the river corridor. There are two known records for the salamander near the corridor (CDFG 2004a). Two special-status species of snail occur in the corridor: the Yosemite Mariposa sideband snail near Clark Point and the Merced Canyon shoulderband snail farther downstream, in the vicinity of El Portal (CDFG 2004a). Special-status birds closely associated with riparian habitats include willow flycatcher and yellow warbler.

Riverine habitat, the area within the waters of the river, is an important habitat type present throughout the Merced River corridor. Even though riverine habitat has no specific vegetation type associated with it, this habitat type is a critical component of the river ecosystem, with direct influence on associated terrestrial habitat types. The riverine environment provides habitat for species such as harlequin duck, American dipper, and river otter, to name a few. In addition, insects with aquatic life stages are highly dependent upon riverine habitats, and, in turn, many bat and bird species are dependent upon these insects.

Fish and Wildlife of the Upper Merced Watershed

The headwaters of the Merced River originate above 10,000 feet within the alpine zone—a zone typified by scant alpine dwarf-shrub, glacial lakes, alpine meadows, and high-velocity tributaries to the Merced River. There are no native fish within the upper Merced River watershed. Birds found in this habitat include water pipit and rosy finch; mammals include Mount Lyell shrew, alpine chipmunk, mountain pocket gopher, and white-tailed jackrabbit. Species that are largely confined to this type are frequently associated with nonliving (physical) attributes of the Sierra Nevada. For example, pikas only find suitable habitat near the uppermost parts of the Merced River basin, using rock crevices and talus slopes.

All species of fish in the upper watershed of the Merced River above Yosemite Valley have been introduced. Rainbow trout and brown trout were commonly stocked in upper watershed lakes beginning in the late 1800s. Other species less commonly stocked include the American grayling, cutthroat trout, brook trout, and golden trout. The cutthroat trout (probably Lahontan cutthroat trout) and golden trout are both special-status species in their native watersheds in other locations of the Sierra Nevada range. Recent surveys indicate that rainbow and brown trout are the most abundant species within the Merced River corridor, but that brook trout are most abundant in the watershed overall. In Washburn Lake, a popular wilderness fishing destination, rainbow trout make up approximately 20% of the lake's fish population, while brown trout make up approximately 80%.

The subalpine zone is characterized by open stands of whitebark pine, western white pine, mountain hemlock, and lodgepole pine. These higher elevation forest types have a sparse understory and experience severe winters. Seasonally, many species from lower elevations share this habitat: mule deer, mountain lion, and species such as the mountain chickadee and the brown

creeper. A few species are endemic: Clark's nutcracker, the possibly extinct wolverine, and Williamson's sapsucker.

As Jeffrey pine becomes more common (below about 7,500 feet), the wildlife habitats support more species and higher populations. The Jeffrey pine forest is more productive than the subalpine forests, largely due to the food value of the pine seeds. The seeds support a more complex small-mammal fauna, which in turn supports two of the Sierra Nevada's most elusive predators—fisher and Sierra Nevada red fox—in addition to raptors including northern goshawks and great gray owl, all species recorded in or near to the Merced River corridor (CDFG 2004a). Bird species common to this zone include Cassin's finch, Townsend's solitaire, Lincoln's sparrow, and common raven. Mammals include Douglas squirrel, northern flying squirrel, golden-mantled ground squirrel, porcupine, and long-tailed weasel.

Descending into Little Yosemite Valley, wildlife habitat in this area is altered with increased human intrusion. Human alteration of habitat is most pronounced between Nevada Fall and the Little Yosemite Valley Backpackers Campground. Species adapted to human disturbance, such as black bears, are relatively common. More reclusive or specialized species are rare or absent. For example, increased human presence on Half Dome has reduced habitat for and had direct impacts on Mount Lyell salamander. Human use may also adversely affect aquatic habitat for Yosemite toad. On the whole, these affected areas represent a small portion of the Wilderness segment of the main stem.

Fish and Wildlife of Yosemite Valley

Yosemite Valley is a broad, U-shaped valley characterized by black oak woodland, lower montane mixed coniferous forest, a vigorous riparian corridor along the Merced River, low-elevation meadows, and areas of development. In Yosemite Valley, the Merced River is broad, shallow, and slow-moving (compared to other systems). Inside Yosemite, there are concentrated areas of human use that have affected wildlife and their habitats, especially in the east Valley. This is also where some of the most valuable and sensitive habitats are located or once existed. Meadow and riparian areas are highly productive, structurally diverse habitats that support high species diversity and provide important linkages between terrestrial and aquatic communities. The long history of development and human use in the Valley has resulted in fragmentation and reductions of these habitats, affecting their quality for wildlife. More recent park efforts, associated with fire management and meadow restoration projects, have begun to make improvements in Valley habitats.

Mammals resident or transient in Yosemite Valley include deer mouse, California ground squirrel, western gray squirrel, broad-footed mole, Botta's pocket gopher, ringtail, raccoon, coyote, bobcat, mule deer, mountain lion, and black bear. The heavy visitation to Yosemite Valley and its relatively high number of resident employees have led to many human/wildlife conflicts. The root of most of these problems is the availability of human food. Improperly stored food and garbage and deliberate feeding alter the natural behavior of wildlife and lead to property damage and threats to human safety. In 2002, over $85,000 in property damage (559 incidents) was caused by black bears in the park (NPS 2002a).

In recent years, sightings of mountain lions in Yosemite Valley have increased. These sightings, coupled with two human fatalities in California from mountain lion attacks in 1994, have caused concern. Lions are attracted to developed areas by unnaturally high prey populations that are

supported by human food sources. Further reduction of lion habitat from development or expanded human presence could affect lion populations and increase the chance of encounters.

The Merced River widens and slows as it passes through Yosemite Valley. In general, habitat is characterized by a relatively wide channel, relatively low flows, and little riffle and pool habitat. Broadleaf deciduous trees such as white alder, black cottonwood, and willow species are dominant cover species. The deposition and removal of soil and the force of flood waters in this reach regularly disturb riparian vegetation. Large woody debris in the channel has been increasing in recent years; due to the current policy of leaving large woody debris in the river, except when debris creates a threat to public safety or park facilities such as bridges. Undercut banks and exposed tree roots provide some refuge for young fish and other small organisms. The river and the floodplain are connected in many areas, but some connections have been affected by development of trails, roads, and campgrounds in the first half of the 20th century.

Fishery resources within Yosemite Valley have historically been low in species diversity. Species native to the Merced River within the Valley probably only included rainbow trout (that migrated into the area from the San Joaquin River) and the Sacramento sucker. Non-native rainbow trout and brown trout have been stocked throughout this portion of the Merced River and currently dominate the fisheries of this area. The Sacramento sucker is still common here, and an occasional brook trout is reported from the area—probably a result of transport from their more favorable habitat in higher tributaries.

Riparian restoration efforts are underway along the banks of the Merced River in the Valley and are likely to have a positive effect on fish populations. In 1997 and 1998, surveys were conducted to examine the effects of riverbank restoration, with special attention to the presence of large woody debris and the association of fish to those areas. Rainbow trout density appeared higher at restoration sites, while the density of browns and suckers was higher at the control sites (USFWS 1999a).

Fish and Wildlife of Merced River Gorge and El Portal

Montane hardwood conifer (mixed conifer) becomes the predominant upland type adjacent to riparian areas at the elevation of Yosemite Valley and below. This type is broadly transitional from the higher, largely coniferous stands and both surrounds and gives way to montane chaparral at its downhill edge. As such, its wildlife community includes species common to higher and lower elevations, leading to high species diversity.

The Merced River gorge is a special case of lower elevation habitat. It is lined with a narrow band of riparian vegetation along the river course, bordered by a dense mosaic of chaparral and foothill woodland communities (chaparral/oak woodland zone) on the steep canyon walls. Birds commonly found in this zone include scrub jay, California towhee, Hutton's vireo, California thrasher, Bewick's wren, plain titmouse, wrentit, Nuttall's and acorn woodpeckers, and red-tailed hawk. Mammals include western harvest mouse, dusky-footed woodrat, spotted skunk, mule deer, and bobcat. More significantly, the rock outcrops and associated crevices of the gorge probably harbor a high density of special-status bat species (e.g., spotted bat, California mastiff bat) (CDFG 2004a). Many of these species are also present in Yosemite Valley. Several bat species, such as Townsend's big-eared bat and Yuma myotis, occasionally use human structures vulnerable to impact (Pierson and Rainey 1993).

Downstream of the Cascades area, the velocity increases as the river enters the gorge, heading toward El Portal. The relatively undisturbed riparian habitat, especially on the south side of the river, and the known presence of Valley elderberry longhorn beetle and adjacent spotted owl habitat contribute to El Portal's biological resources.

The river reach is characterized by steep gradients, large boulders strewn throughout the channel, and frequent pools and cascading waterfalls. The north side of the canyon consists of foothill pine and oak woodland vegetation. There is no floodplain in this reach. Fishes native to the Merced River below El Portal include rainbow trout, Sacramento sucker, Sacramento pikeminnow, hardhead, California roach, and the riffle sculpin. This reach of the Merced River also supports introduced populations of smallmouth bass, rainbow trout, and brown trout.

Fish and Wildlife of the Upper South Fork

The South Fork originates at an elevation of 10,500 feet and flows westward, supporting alpine and montane meadow and chaparral, coniferous, and deciduous forest habitats. These habitats are similar to those described for the upper reaches of the Merced River, although it is worth noting that three of the park's historic observation records for wolverines come from the area near the headwaters and Chiquito Lake.

Fish and Wildlife of the Central and Lower South Fork (Wawona and Below)

At Wawona, the river meanders through a large floodplain meadow. The meadows and the associated riparian habitats—intact vegetation comprising aspens, willows, and alders—support the park's only known population of willow flycatcher.

There is generally less human disturbance along the South Fork, as evidenced by the persistence of not only the flycatcher but wintering great gray owls as well. Stream habitats support a special-status invertebrate, the Wawona riffle beetle.

The South Fork supports self-sustaining populations of introduced brook, rainbow, and brown trout. There is less angler pressure on the South Fork than on the main stem due to difficulty of access and terrain. The significant presence of large woody debris, particularly in the uppermost reaches, dense riparian vegetation, overhanging trees, consistent riffle and pool habitat, waterfalls, and boulders all contribute to the quality of aquatic habitats.

Rare, Threatened, and Endangered Species

The Federal Endangered Species Act of 1973, as amended, requires all federal agencies to consult with the U.S. Fish and Wildlife Service before taking actions that could jeopardize the continued existence of species that are listed or proposed to be listed as threatened or endangered, or could result in the destruction or adverse modification of critical or proposed critical habitat. The first step in the consultation process is to obtain a list of protected species from the U.S. Fish and Wildlife Service.

In addition, Council on Environmental Quality Regulations for Implementing the National Environmental Policy Act (Section 1508.27) also require considering whether the action may violate federal, state, or local law or requirements imposed for the protection of the environment. For this reason, species listed under the California Endangered Species Act or accorded special status (i.e., considered rare or sensitive) by the California Department of Fish and Game are included in this analysis.

Also included in this analysis are park sensitive species. Park sensitive species[14] are those that have extremely limited distributions in the park and may represent relict populations from past climatic or topographic conditions, are listed by the California Native Plant Society, may be at the extreme extent of their range in the park, or represent changes in species genetics. Park resources are included in this analysis because they could be affected (due to proximity to human-use zones, or susceptibility of individual plants or populations to loss from natural or unnatural events), and their existence is considered when evaluating consequences for any proposed management action.

Regional Rare, Threatened, and Endangered Species

The Sierra Nevada contains 33 bird species, 19 mammals, 4 reptiles, and 13 amphibians considered at risk (i.e., are listed as endangered, threatened, or of special concern by the state or federal government), which is roughly 17% of the Sierra Nevada terrestrial fauna (UC Davis 1996). Three species have been extirpated from the range since the time of Euro-American settlement: Bell's vireo, California condor, and grizzly bear. The declines can be attributed to several factors, in varying proportions: habitat loss, disturbance or hunting by humans, environmental toxins, climatic change, and competition from non-native species. However, two of the most charismatic species associated with the park, the bald eagle and the peregrine falcon, are showing signs of recovery. The bald eagle was proposed for delisting on July 6, 1999; the peregrine was formally delisted on August 25, 1999.

The Sierra Nevada is also rich in plant diversity. Of California's 7,000 plant species, about 50% occur in the Sierra Nevada. Of these, more than 400 are found *only* in the Sierra Nevada and 200 are rare. As a group, Sierra Nevada plants are most at risk where habitat has been reduced or altered or when restricted to rare geologic formations and their derived unique soils. This is true in the El Portal area, for example, which supports a number of state-listed rare species that are sustained in a unique contact zone of metamorphic and granitic rock.

Merced River Rare, Threatened, and Endangered Species

Critical Habitat

The U.S. Fish and Wildlife Service designated critical habitat for the California red-legged frog on March 13, 2001 (Federal Register 2001). In July 2002, a federal judge repealed the ruling over 4 million acres of habitat; however, critical habitat Unit 5 (Yosemite Unit) remains intact. This area consists of drainages found in the tributaries of the Tuolumne River and Jordan Creek, a tributary to the Merced River, and in Tuolumne and Mariposa Counties, but does not include the river corridor. The U.S. Fish and Wildlife Service re-proposed critical habitat for the California red-legged frog, including Unit 5, on April 13, 2004 (Federal Register 2004).

Consultation to Date

A *Notice of Intent to Prepare a Supplemental Environmental Impact Statement* for the Revised Merced River Plan was sent to the U.S. Fish and Wildlife Service on August 11, 2004. For this document, an updated species list was obtained from the U.S. Fish and Wildlife Service in October 2004 (USFWS 2004).

[14] The Yosemite National Park sensitive species list applies only to plant species. A separate list for wildlife species has not yet been developed.

The National Park Service prepared a Biological Assessment for the Merced River Plan/FEIS in accordance with Section 7 of the Federal Endangered Species Act of 1973, as amended, and implementing regulations (19 USC 1536[c], 50 CFR 402.14[c]), NEPA requirements (USC 4332[2][c]), and direction provided in the 1988 National Park Service *Management Policies* (NPS 1988a – 4:11). The Biological Assessment was submitted to the U.S. Fish and Wildlife Service for official review and comment in January 2000. A Final Biological Assessment based on the Merced River Plan/FEIS was submitted to the U.S. Fish and Wildlife Service in June 2000. In July 2000, the National Park Service received a letter from the U.S. Fish and Wildlife Service concurring with the determination that the formalization of the Merced River Plan/FEIS would not adversely affect threatened and endangered species. Copies of the Biological Assessment and U.S. Fish and Wildlife Service letter are on file at Yosemite National Park.

An overriding assumption of the Biological Assessment and U.S. Fish and Wildlife Service letter of concurrence was that each site-specific action that could occur within the Merced River corridor would be analyzed as required by the NEPA and the federal Endangered Species Act, and that all federal laws would be complied with during implementation. Since the decision made under this EIS is programmatic, and no specific commitment of resources is made by the decision, the effects would not be expected to change from those noted in the earlier Biological Assessment. Since some site-specific projects within the river corridor may have the potential to adversely affect threatened or endangered species, project-specific assessments and determinations, in accordance with the provisions of the Endangered Species Act and in cooperation with the U.S. Fish and Wildlife Service, would be required for future actions.

Species Considered

Appendix D presents information on federally listed threatened or endangered species; federal species of concern; state-listed threatened, endangered, and rare species; state species of special concern; and species that are locally rare or threatened that are known to be or could be present within the Merced River corridor. This information is based on data provided by the National Park Service, the U.S. Fish and Wildlife Service (2004), and California Natural Diversity Database (CDFG 2004a).

A total of 71 special-status wildlife species and 148 special-status plant species (219 altogether) have been considered in the evaluation of this plan. This includes 8 federally listed species of wildlife; 50 species of wildlife and 17 species of plants listed as federal species of concern and/or federal species of local concern; 13 species of wildlife and 3 species of plants listed by the State of California as rare, threatened, endangered, or species of special concern; and 128 species of plants listed by Yosemite National Park as sensitive. Refer to the Biological Assessment (NPS 2000a) on file at Yosemite National Park for additional information.

Survey Methodologies

Surveys specific to this planning effort to identify individuals or populations of special status species within the corridor have not been performed. Data presented herein are based on field reconnaissance, literature review, the professional knowledge and judgment of park staff, records of observations, published references, and studies of selected species.

Air Quality

The primary factors that determine air quality are the locations of air pollutant sources, the types and amounts of pollutants emitted, meteorological conditions, and topographic features. Atmospheric conditions such as wind speed, wind direction, and air temperature gradients interact with the physical features of the landscape to determine the movement and dispersal of air pollutants.

Climate and Meteorology

The state of California is divided into air basins that are defined partly by their meteorological and topographical characteristics. The portions of the Merced River and South Fork that traverse Yosemite National Park are located within two air basins: Mountain Counties Air Basin and San Joaquin Valley Air Basin. Generally, the uppermost reaches of the Merced River and South Fork lie within San Joaquin Valley Air Basin, and the lower reaches lie within Mountain Counties Air Basin.

The portions of the Merced River and South Fork that traverse the park lie within the Sierra Nevada mountain range, which roughly parallels the eastern boundary of California and extends from the Cascades Range in the north to the Tehachapi Mountains in the south. Cooler climates with more wind are, in general, characteristic of the mountains, as contrasted with the nearby valleys. Mountain climatic zones are characterized by considerable vertical wind motion and by winds and temperatures different from those in the valleys.

While air quality in a given air basin is usually determined by emission sources within the basin, it also can be affected by pollutants transported from upwind air basins by prevailing winds.[15] For instance, the California Environmental Protection Agency concluded that all of the ozone exceedances in 1995 in the southern portion of Mountain Counties Air Basin (i.e., Tuolumne and Mariposa Counties) were caused by transport of ozone and ozone precursors from San Joaquin Valley Air Basin (CARB 1996). Conversely, the park is also a source for transported pollutants, particularly for particulate matter from wildland fire smoke. Air quality in Mountain Counties Air Basin is also significantly affected by pollutant transport from the metropolitan Sacramento area and the San Francisco Bay Area. In contrast, San Joaquin Valley Air Basin is considered both a source and a receptor of pollutant transport.

Air Quality Standards, Plans, and Policies

As a general matter, regulation of air pollution is achieved through both national and state ambient air quality standards and emissions limits for individual sources of air pollutants.

Ambient Air Quality Standards

The federal Clean Air Act requires the U.S. Environmental Protection Agency (U.S. EPA) to identify National Ambient Air Quality Standards (national standards) protective of public health and welfare. U.S. EPA has established national standards for ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter (PM-10 and PM-2.5), and lead. California has adopted

[15] For descriptive purposes, emissions sources are typically categorized as stationary, mobile, or area. Generally, stationary sources refer to emissions sources associated with industrial or commercial processes; mobile sources refer to on-road and off-road motor vehicles; and area sources refer to a wide range of sources that are individually minor but are more substantial in the aggregate. Consumer use of paints and pesticides is an example of an area source. Another category of emissions sources is referred as a "fugitive" source. Fugitive sources refer to those sources that emit pollutants to the atmosphere through some means other than through a smokestack or tailpipe. A vehicle traveling over an unpaved road is an example of a fugitive source of dust.

more stringent standards for most of the criteria air pollutants (referred to as State Ambient Air Quality Standards, or state standards) and has adopted ambient air quality standards for some pollutants for which there are no corresponding national standards. Both sets of standards (national and state) apply throughout California.

Under amendments to the federal Clean Air Act, U.S. EPA has classified air basins, or portions thereof, as either *attainment* or *nonattainment* for each criteria air pollutant, based on whether or not the national standards have been achieved. In 1988, the state legislature passed the California Clean Air Act, which is patterned after the federal Clean Air Act to the extent that areas are required to be designated as attainment or nonattainment (but for the state standards rather than the national standards). Thus, areas in California have two sets of designations: one set with respect to the national standards and one set with respect to the state standards.

The portions of the Merced River and South Fork that flow through Yosemite National Park lie in Mariposa and Madera Counties, which are located in Mountain Counties Air Basin and San Joaquin Valley Air Basin, respectively. Table IV-2 shows the current attainment/nonattainment status of the applicable subregions within these two air basins.

Table IV-2
Air Basin Attainment/Nonattainment Designations

Pollutant	National	State
Mountain Counties Air Basin		
Ozone (1-hour)	Unclassified/Attainment[a]	Nonattainment[a]
Ozone (8-hour)	Nonattainment[b]	Not Applicable
Carbon Monoxide	Unclassified/Attainment	Unclassified[a]
Nitrogen Dioxide	Unclassified/Attainment	Attainment
Sulfur Dioxide	Unclassified	Attainment
Particulate Matter (PM-10)	Unclassified	Nonattainment[c]
Particulate Matter (PM-2.5)	Not classified[d]	Unclassified
Lead	Not classified	Attainment
San Joaquin Valley Air Basin		
Ozone (1-hour)	Nonattainment	Nonattainment
Ozone (8-hour)	Nonattainment	Not Applicable
Carbon Monoxide	Unclassified/Attainment	Unclassified[a]
Nitrogen Dioxide	Unclassified/Attainment	Attainment
Sulfur Dioxide	Unclassified[a]	Attainment
Particulate Matter (PM-10)	Nonattainment	Nonattainment
Particulate Matter (PM-2.5)	Not classified[d]	Nonattainment
Lead	Not classified	Attainment

a County-specific designation. Unless otherwise noted, designations apply to the entire applicable air basin.
b Designation applies to Amador, Calaveras, Mariposa, and Tuolumne Counties only.
c Designation applies to the portion of Mariposa County that lies within Yosemite National Park.
d U.S. EPA has not yet designated areas with respect to the national PM-2.5 standard, but is likely to designate San Joaquin Valley Air Basin as nonattainment for the PM-2.5 national standard based on 2000-2002 monitoring data and the Air Resources Board's initial recommendations to U.S. EPA for area designations. Mariposa County is likely to be designated as an unclassified area. U.S. EPA formal designations are expected by December 15, 2004, using these recommendations and monitoring data from 2001-2003 (CARB 2004a).
SOURCE: CARB 2004b; U.S. Environmental Protection Agency, 2004a.

As shown in table IV-2, the Mountain Counties Air Basin portion of the corridor (i.e., within Mariposa County) is designated as nonattainment for the national 8-hour ozone standard and for the state 1-hour ozone and PM-10 standards, but is designated attainment or unclassified for the

other state and national standards. The San Joaquin Valley Air Basin portion of the corridor (i.e., within Madera County) is designated as nonattainment with respect to the national 1-hour ozone, 8-hour ozone, and PM-10 standards and the state 1-hour ozone, PM-10 standard, and PM-2.5 standard. Based on recent monitoring data, San Joaquin Valley Air Basin will also likely be designated as a nonattainment area with respect to the national PM-2.5 standard.

Air Quality Plans

The federal Clean Air Act and the California Clean Air Act require plans to be developed for areas designated as nonattainment (with the exception of areas designated as nonattainment for the state PM-10 and PM-2.5 standards). Such plans are to include strategies for attaining the standards. Air quality plans and associated control measures that are developed to achieve the national standards are referred to as State Implementation Plans (SIPs).

No air quality plans have been developed in the Mariposa County portion of Mountain Counties Air Basin. Although Mariposa County is designated as nonattainment for the state ozone standard, a plan has not been required under the California Clean Air Act due to the overwhelming influence of pollutant transport on ozone conditions in the county. Also, while the Yosemite National Park portion of Mariposa County is designated nonattainment for the state PM-10 standard, the California Clean Air Act does not impose planning requirements on state PM-10 nonattainment areas. In coordination with the California Environmental Protection Agency Air Resources Board and the Tuolumne County Air Pollution Control District, the Mariposa County Air Pollution Control District has initiated efforts in developing an 8-hour ozone attainment plan that addresses the overwhelming transport of pollutants from the San Joaquin Valley and San Francisco Bay Area. The plan will rely on the measures implemented in those regions to address 8-hour ozone nonattainment.

In the Madera County portion of San Joaquin Valley Air Basin, three air quality plans currently apply, two related to ozone and one related to the national PM-10 standard. The applicable ozone air quality plans include the federal *Ozone Attainment Demonstration Plan* (i.e., the ozone SIP) (San Joaquin Valley Unified Air Pollution Control District 2004) and the *State Ozone Air Quality Attainment Plan* (San Joaquin Valley Unified Air Pollution Control District 2001). The applicable PM-10 air quality plan is the federal *PM-10 Attainment Demonstration Plan* (i.e., the PM-10 SIP). This PM-10 SIP predicts attainment of the national annual PM-10 standard and the national 24-hour-average PM-10 standard by December 31, 2010 (SJVUAPCD 2003). In coordination with the Air Resources Board and other north/central California air districts, the San Joaquin Valley Air Pollution Control District has initiated work on developing the 8-hour *Ozone Attainment Demonstration Plan* for the San Joaquin Valley; the anticipated date for submitting the 8-hour *Ozone Attainment Demonstration Plan* to the U.S. EPA is projected to be June 2007.

General Conformity Rule

Under the federal Clean Air Act Amendments of 1990, federal agencies must make a determination of conformity with the applicable SIP before taking any action on a proposed project. In 1993, U.S. EPA published a rule (referred to herein as the general conformity rule) that indicates how most federal agencies, including the National Park Service, are to determine whether a conformity determination is required, and if so, how to make such a determination (U.S. EPA 1993a). The rule establishes *de minimis* emissions thresholds that are used to determine whether a conformity determination is required. If emissions increases would exceed the applicable *de minimis* thresholds due to a proposed action, then the rule establishes specific

criteria through which a federal agency must demonstrate that the proposed action would conform to the SIP, despite the greater-than-*de-minimis* increase in emissions.

For this project, actions that would occur in Mariposa County would likely be subject to the general conformity rule, given that the county is now a nonattainment area for the national 8-hour ozone standard. Actions in Madera County are currently, and would continue to be, subject to the rule, since the county lies in an area (San Joaquin Valley Air Basin) that has been designated as nonattainment for national ozone and PM-10 standards and that is the subject of an ozone SIP and a PM-10 SIP. With respect to ozone, San Joaquin Valley Air Basin was recently reclassified as an *extreme* nonattainment area. In extreme ozone nonattainment areas, the applicable *de minimis* threshold is 10 tons per year for either volatile organic compounds (VOC) or oxides of nitrogen (NO_x). With respect to PM-10, San Joaquin Valley Air Basin is designated as a *serious* nonattainment area, and the applicable *de minimis* threshold is 70 tons per year of PM-10 and other significant, contributing pollutants identified in the applicable PM-10 SIP.[16]

Prevention of Significant Deterioration

In contrast to air quality plan requirements and the general conformity rule, which relate to nonattainment areas, the federal Clean Air Act also includes provisions designed to prevent industrial growth from causing a significant deterioration in areas designated as attainment. This section of the federal Clean Air Act is known as Prevention of Significant Deterioration (PSD). PSD regulations apply to new or expanded industrial plants (i.e., PSD covers stationary sources, not mobile sources). PSD regulations also establish concentration-based increments that are not to be exceeded due to plant operations. These increments vary depending upon the classification of the area affected by emissions from the plant. For instance, the lowest, or most stringent, increment (least extent of allowable air quality degradation) applies to *Class I* areas, which are to be kept in especially pristine condition. Yosemite National Park is a Class I area, as are other national parks and national wilderness areas. The El Portal Administrative Site is located within a *Class II* area, in which less stringent standards apply.

Visibility Protection

Under PSD, the federal Clean Air Act establishes the following national visibility goal: "prevention of any future, and the remedying of any existing, impairment of visibility in Class I areas which impairment results from man-made air pollution." To further this goal, U.S. EPA recently established regional haze regulations (U.S. EPA 1999a). By addressing regional haze, these new regulations take a comprehensive approach to improving visibility because regional haze reflects the various contributions of a multitude of emissions sources (including mobile, stationary, and area) spread over a wide geographic area. The ultimate goal of the new regulations is to restore natural visibility conditions at Class I areas, such as Yosemite National Park, within 60 years. Under the regulations, all states will be required to develop implementation plans that demonstrate reasonable progress towards this goal.

National Park Service Air Quality Plans and Policies

As a general matter, the National Park Service seeks to perpetuate the best possible air quality in parks to (1) preserve natural resources and systems; (2) preserve cultural resources; and (3) sustain visitor enjoyment, human health, and scenic vistas (NPS 2000f). Vegetation, visibility, water quality, wildlife, historic and prehistoric structures and objects, cultural landscape, and

[16] Ambient PM-10 concentrations reflect the directly emitted PM-10 emissions as well as secondary products of photochemical reactions involving emissions of VOC, NO_X, and oxides of sulfur.

most other elements of a park environment are sensitive to air pollution and are referred to as air quality-related values.

The guiding goal of the Air Resources Management section of the National Park Service's *Natural Resources Management Reference Manual 77* (NPS 2004d) is the preservation, protection, and enhancement of air quality and air quality-related values of units of the National Park System by ensuring compliance with the requirements of the federal Clean Air Act and the National Park Service Organic Act. To accomplish this goal, the major objectives include (1) ensuring that facilities and activities within parks minimize air pollutant emissions through Best Management Practices and, at a minimum, comply with Clean Air Act requirements, including federal, state, and local regulations; (2) acquiring information and tools needed to document air quality conditions in parks, evaluate trends, identify resources that may be or are affected by air pollutants, determine cause and effect relationships, and estimate changes that might result from increasing or decreasing pollution levels; and (3) using available information to remedy existing and prevent future air pollution effects on park resources and values, including participating in federal and state regulatory development and stationary-source permitting processes, as required by the Clean Air Act (NPS 2004d).

At Yosemite National Park, the *General Management Plan* calls for markedly reducing traffic congestion within Yosemite Valley to reduce the exposure of visitors to the fumes and odors associated with motor vehicle exhaust (NPS 1980a/b). The *General Management Plan* also calls for the National Park Service to limit unnatural sources of air pollution to the greatest extent possible.

Air Quality Monitoring Data

Federal, state, and local agencies operate a network of monitoring stations throughout California to collect data on ambient concentrations of air pollutants. Table IV-3 summarizes recent monitoring data from the monitoring stations in the project vicinity. Three of the stations are in Yosemite National Park (Turtleback Dome, Merced River, and Yosemite Valley Visitor Center) and one is outside of the park in the Sierra National Forest (Jerseydale). The Merced River, Yosemite Valley Visitor Center (in Yosemite Village), and Jerseydale stations are approximately 4,000 feet above sea level, and Turtleback Dome is approximately 5,300 feet above sea level. As shown in table IV-3, exceedances of state and national standards for ozone and PM-10 are recorded on occasion within the park and in the park vicinity.

Ozone

Ozone is a reactive pollutant that is not emitted directly into the atmosphere, but is a secondary air pollutant produced in the atmosphere through a complex series of photochemical reactions involving VOC and NO_x. VOC and NO_x are known as precursor compounds for ozone. Significant ozone production generally requires ozone precursors to be present in a stable atmosphere with strong sunlight for approximately 3 hours. Ozone is a regional air pollutant because it is not emitted directly by sources but is formed downwind of sources of VOC and NO_x under the influence of wind and sunlight. Short-term exposure to ozone can irritate the eyes and cause constriction of the airways. Besides causing shortness of breath, ozone can aggravate respiratory diseases such as asthma, bronchitis, and emphysema. Exposure to ozone is also associated with a wide range of vegetation effects, such as visible foliar injury, growth reductions and yield loss in annual crops, growth reductions in tree seedlings and mature trees, and effects that can have impacts at the forest stand and ecosystem level (U.S. EPA 1997).

Table IV-3
Recent Ozone and PM-10 Concentration Data for Yosemite National Park and Vicinity

Pollutant	State Standard	National Standard	Pollutant Concentration by Year[a]				
			1999	2000	2001	2002	2003
Ozone Monitoring Data							
Station: Yosemite National Park – Turtleback Dome							
Highest 1-hour average, ppm [a]	0.09	0.12	**0.10**	**0.12**	**0.11**	**0.11**	**0.14**
Days over state standard			4	3	3	15	6
Days over national standard			0	0	0	0	1
First highest 8-hour average, ppm [a]	NA	0.08	**0.09**	**0.10**	**0.10**	**0.10**	**0.10**
Fourth highest 8-hour average, ppm [a, b]			**0.09**	**0.09**	**0.09**	**0.09**	**0.09**
Days over national standard			4	6	4	24	10
Station: Yosemite National Park – Merced River							
Highest 1-hour average, ppm [a]	0.09	0.12	ND	ND	ND	0.08	0.08
Days over state standard			-	-	-	0	0
Days over national standard			-	-	-	0	0
First highest 8-hour average, ppm [a]	NA	0.08	ND	ND	ND	0.08	0.07
Fourth highest 8-hour average, ppm [a, b]			ND	ND	ND	0.07	0.06
Days over national standard			-	-	-	0	0
Station: Sierra National Forest – 6440 Jerseydale (approximately 12 miles west of Wawona)							
Highest 1-hour average, ppm [a]	0.09	0.12	**0.16**	**0.12**	**0.12**	**0.11**	**0.13**
Days over state standard			13	9	3	12	13
Days over national standard			1	0	0	0	1
First highest 8-hour average, ppm [a]	NA	0.08	**0.11**	**0.10**	**0.10**	**0.10**	**0.10**
Fourth highest 8-hour average, ppm [a, b]			**0.10**	**0.09**	**0.09**	**0.09**	**0.09**
Days over national standard			21	14	7	19	27
Particulate Matter (PM-10) Monitoring Data							
Station: Yosemite Village – Visitor Center							
Highest 24-hour average (state/national), μg/m3 [a, c]	50	150	**75/82**	**89/98**	**277/312**	**72/76**	**58/66**
Estimated days above state standard[d]			ND	ND	37	18	6
Estimated days above national standard[d]			0	0	6	0	0
Annual Arithmetic Mean (state/national), μg/m3 [a, c, e]	20	50	ND/27	ND/26	**30**/33	**26**/29	**21**/23
Estimated days above state standard[d]			ND	ND	37	18	6
Estimated days above national standard[d]			0	0	6	0	0

a ppm = parts per million; μg/m3 = micrograms per cubic meter.
b The ozone standard is attained when the fourth highest 8-hour ozone concentration in 1 year, averaged over 3 years, is equal to or less than the standard.
c State and national statistics may differ for the following reasons: (1) state statistics are based on California-approved samplers, whereas national statistics are based on samplers using federal reference or equivalent methods; (2) state statistics are based on local conditions, whereas national statistics are based on standard conditions; and (3) state criteria for ensuring that data are sufficiently complete for calculating valid annual averages are more stringent than the national criteria.
d PM-10 is usually measured every sixth day (rather than continuously, like other pollutants). "Estimated days" mathematically estimates how many days concentrations would be greater than the level of the standard had each day been monitored.
e Effective July 5, 2003, the state standard was lowered from 30 μg/m3 to 20 μg/m3.
NOTE: NA = Not applicable. ND = No data available. Values shown in **bold** type exceed the applicable standard.
SOURCE: CARB, *Air Quality Data Statistics 1999–2003*, http://www.arb.ca.gov/adam/welcome.html (2004c).

Table IV-3 shows that ozone concentrations in the park and vicinity exceed the state standard between 3 and 9 days per year. With respect to national ozone standards, both the national 8-hour-average standard and the 1-hour-average standard currently apply. However, 1 year following the effective date of the designation for the 8-hour-average ozone national standards, the 1-hour standard will be revoked in full (U.S. EPA 2004b). The 8-hour designations became effective on September 30, 2004.

As of September 30, 2005, the 8-hour national ozone standard will be the only national standard that applies. Elevated ozone concentrations typically occur during the summer, with most of the exceedances of the state standard in July, August, and September and exceedances in May, June, and October occur less frequently. As discussed previously, ozone concentrations in Yosemite National Park are largely a function of pollutant transport from San Joaquin Valley, Sacramento, and, to a lesser extent, the San Francisco Bay Area. The principal sources of ozone precursor emissions in San Joaquin Valley include on-road motor vehicles, oil and gas production, farming operations, and pesticide use. On-road motor vehicles account for approximately 24% and 42% of VOC and NO_x, respectively, in San Joaquin Valley Air Basin (CARB 2004d). VOC emissions in the San Joaquin Valley are expected to decrease by approximately 17% and 18% from 2000 to 2010 and 2020, respectively, based on the most recent emissions inventories and forecasts published by the Air Resources Board. NO_x emissions are expected to decrease more dramatically, by approximately 29% and 48% from 2000 to 2010 and 2020, respectively (CARB 2004e). This forecast decrease in ozone precursors largely reflects the continuing beneficial effect from state and federal motor vehicle emissions control standards and programs. Within the park, emissions of ozone precursors are generated by such sources as wildland fires, motor vehicle traffic, and gasoline- and diesel-powered equipment.

Particulate Matter (PM-10 and PM-2.5)

PM-10 consists of particulate matter that is 10 microns or less in diameter (a micron is 1 one-millionth of a meter), and PM-2.5 consists of particulate matter 2.5 microns or less in diameter. Both PM-10 and PM-2.5 can be inhaled into the air passages and the lungs and can cause adverse health effects. Particulate matter in the atmosphere results from many kinds of dust- and fume-producing industrial and agricultural operations, combustion, and atmospheric photochemical reactions. For instance, in Mariposa County, the principal sources of direct emissions of PM-10 include entrainment of dust through vehicle travel over paved and unpaved roads (approximately 78%), residential fuel combustion (approximately 10%), and wildfires (approximately 7%) (CARB 2004f). However, PM-10 and PM-2.5 concentrations also reflect secondary pollutant formation derived from photochemical reactions involving VOC, NO_x, and sulfur oxides. As described above in connection with ozone, on-road motor vehicles are a principal source of regional VOC and NO_x emissions. Stationary sources, principally fuel combustion, contribute approximately 77% of the regional emissions inventory of sulfur oxides.

Table IV-3 shows that exceedances of the state 24-hour-average PM-10 standard occur, on average, 20 days per year in Yosemite Village. Exceedances of the less stringent national standard of 150 micrograms per cubic meter were recorded in 2001 only. PM-2.5 data have been collected at Turtleback Dome as part of the visibility network established under the Interagency Monitoring of Protected Visual Environments (IMPROVE) program.[17] IMPROVE data from

[17] The IMPROVE network was established in 1987, prior to the establishment of a PM-2.5 standard; for this reason, data from IMPROVE monitoring stations do not comply with the new federal reference method for measuring PM-2.5 and thus cannot be used for compliance purposes (e.g., in determining attainment or nonattainment) (U.S. EPA 2000). Nonetheless, IMPROVE data do provide a rough indication of PM-2.5 concentrations in Yosemite National Park.

Turtleback Dome indicate that PM-2.5 concentrations are lowest during winter and highest during summer. Over the 1994 through 1998 period, the 90th percentile, 24-hour-average concentration (i.e., 90% of the values are lower and 10% are higher) ranged from 4.2 micrograms per cubic meter during winter to 14 micrograms per cubic meter during summer. In contrast, the new 24-hour-average PM-2.5 standard is 65 micrograms per cubic meter. The average of the annual averages during that period was 4.3 micrograms per cubic meter; in contrast, the new annual-average PM-2.5 standard is 15 micrograms per cubic meter.

Under some conditions, concentrations of PM-10/PM-2.5 in the park reflect pollutant transport from upwind areas, such as San Joaquin Valley Air Basin, while under other conditions, ambient concentrations reflect local sources such as campfires, entrainment of dust from vehicle movement over paved roads (particularly from wintertime sanding of roads for traction), and prescribed fires. Regional emissions of PM-10/PM-2.5 and their precursors (VOC, NO_x, and sulfur dioxide) within San Joaquin Valley are expected to decrease over the next decade or so, largely due to reductions in emissions anticipated to result from state and federal motor vehicle emissions control standards and programs. Local emissions of PM-10/PM-2.5 would continue to be proportional to the number of campsites, woodstoves, and fireplaces; the level of construction-related activity; the extent of vehicle travel on park roads; and the frequency and extent of prescribed fires.

Visibility-Reducing Particles and Gases

Visibility impairment occurs as a result of the scattering and absorption of light by particles and gases in the atmosphere. Both primary and secondary formation of particles contribute to visibility impairment. Primary particles, such as elemental carbon from diesel and wood combustion or dust from certain industrial activities or natural sources, are emitted directly into the atmosphere. Secondary particles that are formed in the atmosphere from primary gaseous emissions include sulfate from sulfur dioxide emissions, nitrates from NO_x emissions, and organic carbon particles formed from VOC emissions. The only primary gaseous pollutant that directly reduces visibility is nitrogen dioxide, which is the brown-colored gas readily visible during periods of heavy air pollution.

Visibility conditions are commonly expressed in terms of three mathematically related metrics: visual range, light extinction, and deciviews. Visual range is the maximum distance at which one can identify a black object against the horizon and is typically described in miles or kilometers. Light extinction, which is inversely related to visual range, is the sum of light scattering and light absorption by particles and gases in the atmosphere and is expressed in terms of inverse megameters, with large values representing poorer visibility. Unlike visual range, the light extinction coefficient expresses the relative contribution of one particulate constituent (e.g., sulfates or nitrates) versus another to overall visibility impairment. The deciview metric was developed because changes in visual range and light extinction are not proportional to human perception. For example, a 5-mile change in visual range can be either very apparent or not perceptible, depending on the baseline level of ambient pollution. The deciview metric provides a linear scale for perceived visual changes over the entire range of conditions, from clear to hazy, analogous to the decibel scale for sound. Under many scenic conditions, a change of 1 deciview is considered to be perceptible by the average person. A deciview of zero represents pristine conditions.

Current visibility impairment in Yosemite National Park ranged from 4.6 deciviews for the clearest 20% of days during the 1990 to 1999 period to 22 deciviews for the haziest 20% of days

during that period (NPS 2002b). In contrast, the corresponding range of deciview values was 3.9 (clearest 20%) to 13.9 (haziest 20%) and 13.6 to 31.8 in Rocky Mountain National Park and Great Smoky Mountains National Park, respectively. Yosemite National Park visibility for the clearest 20% of days is much better than the National Park Service average, whereas visibility for the haziest 20% of days is about average. On the haziest days in Yosemite National Park, sulfates are responsible for approximately half of the visibility impairment. Nitrates, organic carbon, elemental carbon, and crustal matter are responsible for the remainder in roughly equal measure.

Noise

Introduction

By definition, noise is human-caused sound and is considered to be unpleasant and unwanted. Whether a sound is considered unpleasant depends on the individual listening to the sound and what the individual is doing when the sound is heard (i.e., working, playing, resting, sleeping). While performing certain tasks, people expect and, as such, accept certain sounds. For instance, if a person works in an office, sounds from printers, copiers, and typewriters are generally acceptable and not considered unpleasant or unwanted. By comparison, when people are resting or relaxing, these same sounds are not desired. The desired sounds during these times are referred to as *natural quiet*, a term used to describe ambient (outdoor) natural sounds without intrusion of human-caused sounds. Natural quiet can be essential in order for some individuals to achieve a feeling of peace and solitude.

Natural sounds within Yosemite National Park and adjacent to the Merced River are not considered to be noise. These sounds result from natural sources such as waterfalls, flowing water, animals, and rustling tree leaves. Noise within the park results from mechanical sources such as motor vehicles, generators, and aircraft, and from human activities such as talking and yelling.

Existing Noise Sources

Motor Vehicles

Noise results from automobiles, recreational vehicles, and trucks (motor vehicles) accessing the park via El Portal Road, Wawona Road, Big Oak Flat Road, and Tioga Road. Near the Yosemite Valley Visitor Center, noise results from vehicles on Northside Drive, Southside Drive, and roadways to and from camping areas. Noise from motor vehicles is obviously loudest immediately adjacent to the roadways but, due to generally low background sound levels, can be audible a long distance from the roads. Atmospheric conditions (e.g., wind, temperature, humidity, rain, fog, and snow) and topography (e.g., canyon walls) can significantly affect the presence or absence of motor vehicle noise in areas of the Merced River corridor. Logically, motor vehicle noise will be loudest where and when activity levels are the greatest and nearest to receptors in the area.

Aircraft

As part of a report to the U.S. Congress (NPS 1994f), the National Park Service conducted a visitor survey in Yosemite National Park. Of the visitors surveyed, 55% reported hearing aircraft sometime during their visit. The report notes that recognition of noise from aircraft was highly variable from location to location and, logically, that impacts were greater when visitors removed themselves from automotive transportation and areas where other visitors were present. In Yosemite, a majority of the complaints came from wilderness trail users. Measurements made in 1993 at four locations within the park (Rafferty Creek, the Soda Springs area in Tuolumne

Meadows, Mirror Lake, and Glacier Point) indicated that aircraft were audible 30% to 60% of the time during each of the measurement periods (6 hours at each site). Most overflights are associated with high-altitude jet aircraft. The National Park Service also uses aircraft in its management activities. These aircraft are generally helicopters that are used for firefighting, search and rescue, medical, law enforcement, and other special operations (NPS 1993a).

Other

Other mechanical sources of noise within the park and near the Merced River include roadway construction equipment, generators, radios, and park maintenance equipment (i.e., mowers and chainsaws). The frequency of use and the location of these sources vary both by season and reason for use.

Regulatory Standards

Generally, the federal government sets standards for transportation-related noise sources that are closely linked to interstate commerce, such as aircraft, locomotives, and trucks; for those noise sources, state governments are preempted from establishing more stringent standards. The state governments set noise standards for transportation-related noise sources that are not preempted from federal regulation, such as automobiles, light trucks, and motorcycles. Noise sources associated with industrial, commercial, and construction activities are generally subject to local control through noise-related plans and policies.

National Park Service Noise-Related Plans and Policies

An important part of the National Park Service mission is to preserve and/or restore natural resources, such as natural soundscapes within the National Park System. Intrusive noises are of concern because they sometimes impede the National Park Service's ability to accomplish this mission. As a general matter, the National Park Service seeks to preserve, to the greatest extent possible, the natural soundscapes of parks. Natural soundscapes exist in the absence of human-cause sound. The natural soundscape is the aggregate of all the natural sounds that occur in parks, together with the physical capacity for transmitting natural sounds. The National Park Service also seeks to restore degraded soundscapes to the natural condition wherever possible, and will protect natural soundscapes from degradation due to noise (undesirable human-caused sound)(NPS 2000g).

National Park Service Director's Order 47, *Soundscape Preservation and Noise Management*, promulgated under the authority of the National Park Service Organic Act, became effective on December 1, 2000. The purpose of Director's Order 47 is "to articulate National Park Service operational policies that will require, to the fullest extent practicable, the protection, maintenance, or restoration of the natural soundscape resource in a condition unimpaired by inappropriate or excessive noise sources" (NPS 2000g). Specifically, Director's Order 47 addresses the problem of excessive/inappropriate noise levels and directs park managers to (1) measure baseline acoustic conditions; (2) determine which existing or proposed humanmade sounds are consistent with park purposes; (3) set acoustic management goals and objectives based on those purposes; and (4) determine which noise sources are affecting the park and need to be addressed by management. Director's Order 47 also requires park managers to (1) evaluate and address self-generated noise, and (2) constructively engage with those responsible for noise sources that affect parks to explore what can be done to better protect parks while giving appropriate recognition and weight to the vital missions of other government agencies (such as the Federal Aviation Administration) and respecting the rights of park neighbors. Finally,

Director's Order 47 requires the development of a reference manual to provide comprehensive guidance to region and park staff on soundscape preservation and noise management.

National Park Service Reference Manual 47, *Soundscape Preservation and Noise Management*, prepared in response to Director's Order 47, provides: (1) technical guidance on soundscape management planning, including direction on the preparation of soundscape preservation and noise management plans (referred to as soundscape management plans); (2) direction on the measurement of sound characteristics to be applied in soundscape management planning; (3) technical guidance on education opportunities; (4) technical guidance on noise prevention and mitigation; and (5) direction on interagency planning.

The *General Management Plan* calls for markedly reducing traffic congestion within Yosemite Valley to reduce the exposure of visitors to the noise associated with motor vehicles (NPS 1980a). The *General Management Plan* also calls for the National Park Service to limit unnatural sources of noise to the greatest extent possible.

Background Sound and Noise Levels

Sound levels adjacent to the main stem and South Fork of the Merced River vary by location and also by season (the volume of water in the rivers being lower in the fall and higher in the spring). Noise levels are influenced by the number of visitors to the park and by the proximity of mechanical noise sources.

Sound and noise levels are measured in units known as decibels (dB). For the purpose of this Revised Merced River Plan/SEIS, sound and noise levels are expressed in dB on the A-weighted scale (dBA). This scale most closely approximates the response characteristics of the human ear to low-level sound. Human hearing ranges from the threshold of hearing (0 dBA) to the threshold of pain (140 dBA). Environmental sound or noise levels typically fluctuate over time, and different types of noise descriptors are used to account for this variability. One of these descriptors is the energy-equivalent level (L_{eq}), which is the equivalent steady-state level that, in a given period, reflects the same acoustic energy as the actual time-varying level during the same period.

Sound-level measurements were obtained as part of the analysis for the original Merced River Plan/FEIS at various locations adjacent to the Merced River (from the headwaters of the Merced River to the base of Vernal Fall), within Yosemite Valley, and in the Wawona area. Measurements were obtained with a Larson Davis dosimeter (Model 700). The dosimeter was calibrated with a Larson Davis sound-level calibrator. At each measurement location, observations of the background level were made over a period ranging from 1 to 5 minutes. In addition, observers noted the sources contributing to the background level and noted any sources that caused intrusive levels above the typical background sound level.

Sound levels at the highest elevations of the Merced River corridor (between the Merced and Triple Peak Forks) measured 35 dBA. Also in the headwaters area, approximately 2 to 2.5 miles southeast of Washburn Lake, sound levels ranged from 39 to 41 dBA, with the influence of aircraft noise (the maximum observed levels with the aircraft were 43 and 56 dBA). At and near Washburn Lake, sound levels ranged from 31 to 36 dBA, with very little influence of sound from the river. At a lower elevation, between the soda springs and Washburn Lake, sound levels on the trail ranged from 35 to 42 dBA. In the Bunnell Cascades and the soda springs areas, sound levels ranged from 54 to 56 dBA. These sound levels primarily resulted from river water washing over

granite cascades in both areas. Away from the river, in the Little Yosemite Valley Campground area, sound levels measured 40 dBA (in an area with no human activity). Near the waterfalls (Vernal and Nevada), sound levels varied from 61 to 76 dBA, with some influence from people talking during each measurement period.

Within Yosemite Valley, sound levels ranged from 44 to 47 dBA along the Lower Yosemite Fall Trail, with maximum observed levels of 66 dBA when people passed the monitor on the trail. Notably, there was no water in Yosemite Creek when the monitoring was performed. At Swinging Bridge, sound levels measured 50 dBA, with noise from people constituting the greatest source of sound within the area. At Sentinel Bridge, sound levels measured 59 dBA. This area experiences noise from vehicle traffic, but speeds are generally slow. Overall, the greatest source of sound was the numerous buses traversing the bridge. Near Happy Isles, sound levels measured 59 dBA, with most of the sound resulting from people on the trails and using facilities nearby. Within the camping area (Upper Pines Campground), sound levels varied from 32 dBA when human activity levels were at the lowest (early in the morning) to 55 dBA when activity levels increased during the day.

West of the Valley Visitor Center area, the river was calm in El Capitan Meadow and no people were present during the monitoring. Measured sound levels within this area were 39 dBA. At Devils Elbow, water was flowing through the river, but the sound of the river was minimal due to the lack of rocks and rapids. Sound levels in this area were 44 dBA, with a maximum observed level of 67 dBA when a bus passed on nearby Northside Drive. In the Cascades area, measured sound levels were 49 dBA, with a recorded maximum level of 63 dBA when a bus passed on Northside Drive.

In Wawona, sound levels were measured in the middle of the old Wawona bridge on Wawona Road, and west of the covered bridge near the Pioneer Yosemite History Center. Sound levels in these areas were 50 and 44 dBA, respectively, with maximum observed levels of 59 dBA near the bridge.

Cultural Resources

Overview of the Human Occupation of the Merced River Corridor

American Indians

The area now comprising Yosemite National Park has been inhabited by people for thousands of years. Some preliminary evidence from the El Portal area indicates people may have been living in the region as long as 9,500 years ago. The park area contains hundreds of archeological sites, representing the duration of human occupation of the park. There is evidence of technological change through time, a highly developed trade network, at least one population replacement, and resource management through the use of fire.

When Euro-Americans first entered Yosemite Valley in 1851, the Indians living there were most likely a mixture of Southern Sierra Miwok, Mono Lake Paiute, and Central Sierra Miwok. The upland areas of the Merced River drainage were frequented by Southern Sierra Miwok, possibly Mono Lake Paiute, and at least traversed by Western Monos and possibly Chukchansi Yokuts. El Portal was inhabited by Miwok people as well. The Wawona area was home to Miwok people, and perhaps some Western Mono and Chukchansi Yokuts.

The Mariposa Indian War of 1851, triggered by the influx of Euro-American miners, ranchers, farmers, and merchants taking Indian lands since 1848, resulted in a call for volunteers to pursue the Indians. Some Indians escaped, but many were taken to the Fresno River reservation. The battalion that formed, known as the Mariposa Battalion, was the first group of non-Indians to enter Yosemite Valley. Their route passed through a portion of the South Fork of the Merced River canyon. Some Indians were taken prisoner and led out of Yosemite Valley; some escaped and returned to Yosemite Valley before reaching the Fresno River. Later expeditions proved no more successful for the battalion, and the Indians remained in Yosemite Valley. Although federal Indian agents were authorized to negotiate treaties with Indians in the Yosemite area, these (and many of the other California Indian treaties) were never ratified by the U.S. Congress, thus leaving Indian tribes landless and without rights as sovereign governments.

After 1851, as awareness of Yosemite Valley grew, hotels and other travel-related amenities were developed. Beginning in the late 19th century, American Indian descendants of some of the original populations in Yosemite Valley found employment with these enterprises and continued to live in ancestral villages. The employment opportunities in Yosemite Valley also drew Indian people from other surrounding areas. Management of the Valley was taken over by Euro-American institutions, and American Indian interests were subject to decisions made without their influence. Customs changed as Indian people built nontraditional houses, vacated old village sites, and built new villages. These changes were due in part to efforts by Euro-Americans to centralize the Indian people as a tourist attraction and control their activities. The small groups that came together in these latter settlements combined cultural practices, traditional arts, and beliefs. The last Indian village in Yosemite Valley was closed in 1969, and the structures were razed.

American Indians in El Portal fared slightly better, where they continued to dwell for some time as Euro-Americans began to settle there. During the late 1800s, one of the first Indian homesteaders settled on the south side of the river. In addition, Indians continued to dwell in the area of a prehistoric village site until the turn of the century, and elsewhere in the area thereafter.

With the development of Yosemite Valley Railroad, local mining and logging operations, and the opening of the Hotel Del Portal, many American Indians found employment. These adaptations to Euro-American lifeways instigated changes in Indian customs and culture in El Portal as well as in Yosemite Valley.

Indian people continue to live in and around the park, and many are employed by the National Park Service, the concessioner, or other local businesses. At least seven Indian tribes claim traditional associations with Yosemite National Park, and the National Park Service has entered into various agreements with the American Indian Council of Mariposa County, Inc., the official organization representing the Southern Sierra Miwuk Nation. Individuals from most of these tribes continue to maintain cultural associations with lands and resources in Yosemite National Park through cultural and religious practices.

Euro-Americans

The following summary was derived from *Yosemite, the Park and its Resources: A History of the Discovery, Management, and Physical Development of Yosemite National Park, California* (NPS 1987b).

Yosemite Valley

During the mid-1850s and 1860s, the natural scenery of Yosemite Valley was brought to America's attention through journal articles written by Thomas Starr King in the *Boston Evening Transcript* and by James M. Hutchings in his *California Magazine*. A heightened awareness of the Valley landscape was also provided through the works of artists such as Thomas Ayres, Albert Bierstadt, and Carleton Watkins. Painted, photographic, and literary images of Yosemite's beauty drew people to the area.

Hutchings organized the first tourist excursion to Yosemite Valley in 1855. By 1860, entrepreneurs had constructed hotels to capitalize on what would become a thriving tourist trade. Homestead claims were filed, orchards were planted, and Yosemite Valley became a residential base for many families. Hutchings became a permanent resident of Yosemite Valley in 1864 and constructed several structures, including a cabin on Yosemite Creek. In 1864, President Abraham Lincoln and the U.S. Congress set aside the Big Tree Grove (Mariposa Grove) and Yosemite Valley as a public park to preserve the monumental scenic qualities of the area. Yosemite Valley and the Mariposa Grove were to be managed by the governor of California and his eight appointed commissioners, chaired by Frederick Law Olmsted.

By 1870, the establishment of visitor hotels in Yosemite Valley had created a need for fresh local produce and livestock. James Lamon, Yosemite Valley's first Euro-American homesteader, became one of the largest producers of commercial agricultural products in Yosemite Valley. Remnants of two of his orchards still exist, as well as an orchard planted near the site of Hutchings Sawmill. With the introduction of crops and livestock came fences, outbuildings, and other developments that detracted from the beauty of Yosemite Valley.

Introduced vegetation also became a concern. In 1888, Olmsted outlined a policy for management of the Valley and presented it in the *San Francisco Examiner*. Cultivation of crops was to be restricted to areas that had already been plowed; natural meadows were to be preserved; and tree cutting was to be permitted only under the supervision of a landscape gardener.

Due to the early conservation movement led by people such as John Muir and Robert Underwood Johnson, the U.S. Congress passed an act establishing Yosemite National Park in 1890. This act brought protection to the lands and resources within the watersheds of the Tuolumne and Merced River systems. The park was managed by cavalry troops sent from the Presidio in San Francisco. By 1906, the State of California relinquished its rights of control over the Yosemite Valley and Mariposa Grove grant lands, ceding them to the federal government.

Major H. C. Benson, acting superintendent from 1905 until 1908 under the Department of the Army, stated in his 1907 annual report that, "[s]ome definite general plan should be devised for the beautifying of the valley and making it the most beautiful park in the world. All bridges and buildings constructed in the future should conform to a definite plan, suited to existing conditions. All roads should be laid out according to a plan fully worked out by a competent landscape gardener; nothing should be done in the way of expending money which does not tend to carry out these ideas. All small buildings, practically shacks, should be replaced by stone buildings, and all bridges, when replaced, should be either of stone or concrete." Many bridges and roads were, in fact, built by the U.S. Army Corps of Engineers between 1905 and 1915 (Carr 1998).

One of the birthplaces of the nationwide conservation movement was Yosemite National Park. This movement coalesced in the formation of the Sierra Club, which has had major effects on the National Park System. In 1903, the Sierra Club built the LeConte Memorial Lodge in Yosemite Valley (named for Joseph LeConte, one of the group's founders). Parsons Memorial Lodge (named after a former outing director of the Sierra Club) was built in Tuolumne Meadows in 1915. Both of the structures served as focal points for Sierra Club activities and are now designated as National Historic Landmarks, used for interpretive and educational functions.

By 1930, the park managers had outlined areas of particular concern, including activities that encroached on meadows, such as Indian Field Days at Leidig Meadow and the parking areas at Stoneman Meadow. The committee recommended that a landscape map be prepared to record the areas occupied by forests, woodlands, chaparral, and meadows. They also wanted to document the historic distribution of natural landscape types from photographs and records.

Beginning in 1933, many of the people who had worked in the park were completing projects for the Public Works Administration under John Wosky, another prominent National Park Service figure. The creation of the Public Works Administration made many individuals available for work in the parks. The Civilian Conservation Corps also completed an extensive range of projects in Yosemite National Park, including construction of roads, trails, bridges, fire roads, fire buildings, fire lanes, fire trails, comfort stations, and campgrounds. Additional projects included river and creek bank stabilization, revegetation, landscaping, and debris cleanup.

Merced River Gorge

The Euro-American history of the Merced River gorge began in the 1870s, when James A. Hennessey of El Portal built and maintained a trail between El Portal and Yosemite Valley through the gorge. The Coulterville and Yosemite Turnpike Company constructed the Coulterville Road, which entered the Merced River canyon just west of the Cascades area and continued east to Yosemite Valley. In 1907, after 2 years of construction, the Yosemite Valley Railroad Company completed the El Portal Road between the rail terminus at El Portal and Yosemite Valley.

The Yosemite Hydroelectric Power Plant and associated structures (including the diversion dam) were constructed during 1917-1918 to provide electrical power to Yosemite Valley. Water was diverted from the Merced River into a wooden penstock that paralleled El Portal Road and dropped into the power plant, where electricity was generated. The electricity was then conducted along 11-kilovolt overhead power lines from the power plant to Yosemite Valley. This complex is listed in the National Register of Historic Places, significant for engineering. Five residences were constructed in the Cascades area to provide housing for individuals responsible for maintaining and operating this system. This hydropower system is no longer in use, and many elements of it (including the dam and five houses) have been removed in consultation with the State Historic Preservation Officer and Advisory Council on Historic Preservation (NPS 1986).

El Portal

The first documented non-Indian to settle in the El Portal area was James Savage, who established a trading post at the confluence of the South Fork and main stem of the Merced River, several miles below present-day El Portal. Other miners and traders arrived in the area during the next several decades, and in the early 1870s James A. Hennessey developed a small ranch and orchard in the present-day Trailer Village area. Hennessey began packing produce to some of the Gold Rush boomtowns east of the Sierra Nevada. A segment of the pack route named for him is still called Henness Ridge. Hennessey sold his farm in 1889; the farm and orchard remained productive for many years to come.

Barium deposits were discovered near present-day Rancheria Flat in the 1880s. In 1907, the Yosemite Valley Railroad completed its rail line to the park's western boundary, where the company established a railhead named El Portal. The rail line, which operated until 1945, resulted in the development of significant tourist, timber, mining, and cement industries in the El Portal area. El Portal began to function as a crucial gateway to Yosemite, where tourists had to stay for the night before finishing the journey into the Valley. The development of El Portal occurred in tandem with the park, as visitation continued to increase.

Following completion of the rail line, overnight tourist facilities developed in El Portal, beginning as a tent structure and eventually leading to the construction of Hotel Del Portal. Hennessey's Ranch began supplying produce there, as well as to hotels at Glacier Point and Yosemite Valley. The timber industry also expanded when an incline for the Yosemite Lumber Company, which brought timber from the Wawona area, was added to the Yosemite Valley Railroad operations. Similarly, barium mining became a lucrative industry. These industries, as well as the railroad itself, contributed to the growth of El Portal as the economy of the area grew and the operations there required more people to support it. Many structures representative of these enterprises remain as historic properties today.

Archeological Resources

To date, approximately 6% of park lands have been inventoried for archeological resources, and over 1,100 archeological sites have been documented. Most of the inventories focus on lower elevation developed areas and road corridors; however, some wilderness areas have been surveyed. In most cases, inventories have been conducted in support of park development, fire management, or restoration projects as part of the environmental and historic preservation planning and compliance processes. The most recent comprehensive overview of archeological resources and their information value is presented in *Archeological Synthesis and Research Design, Yosemite National Park, California* (Hull and Moratto 1999). The synthesis summarizes the results

of past archeological research, and presents research questions and methodologies for furthering understanding of prehistoric and historic lifeways in the Yosemite region.

In general, archeological sites are important for the information they can provide regarding prehistoric and historic lifeways. Associated American Indian tribes attach significance to prehistoric and historic sites for their religious and cultural value as tangible links to their heritage. Prehistoric sites in Yosemite generally contain some of the following: flaked and ground stone tools, waste from tool manufacture, food processing features, fire hearths, structural remains, human burials, and rock art. Historic archeological sites provide important information not available in written records, such as early building construction techniques, lifestyles of early settlers, trade and procurement of goods and materials, and interactions with native peoples. Historic sites include structural remains, waste dumps, work camps, and remains of industrial activities such as logging and mining.

Wilderness Areas

Very little archeological inventory has been conducted in the upper reaches of the Merced River drainage; however, some archeological resources have been recorded. Cavalry trails (to patrol for trespass) and hunting have been documented. Little Yosemite Valley, in particular, was used heavily by Indian people, stockmen, and later by recreationists. A branch of the old Mono Trail, the east-west link across the Sierra Nevada, passed through Little Yosemite Valley and afforded Indian people a pleasant stopping place. Remains of at least two villages are evident. Little Yosemite Valley also was one of the few places where the Merced River could be crossed at high water, a crossing made possible by a huge logjam that still exists today (NPS 1987b).

The remains of the Archie Leonard homestead (collapsed cabin and park boundary fence) also exist in Little Yosemite Valley, and the eastern portions (above the original Yosemite Grant) were grazed. A High Sierra Camp was established along Sunrise Creek in 1924 as a stopping point along the way to Merced Lake. A primary activity for camp visitors was climbing Half Dome; this continues to be the focus for most visitors camping in Little Yosemite Valley today. Resources associated with these activities include tree blazes, historic camps, and trash scatters (NPS 1990c). Above Little Yosemite Valley, the upper reaches of the Merced River drainage (as well as the majority of the upper South Fork drainage) seem to have been much less used.

Yosemite Valley

Yosemite Valley was designated an archeological district and was listed in the National Register of Historic Places in 1976. Early archeological surveys of Yosemite Valley focused on prehistoric or historic Indian sites rather than historic-era resources representative of homesteading, visitor, and National Park Service facilities. The entire Yosemite Valley has been surveyed for prehistoric resources, except for wet meadows, areas of impenetrable vegetation, and some talus slopes. Due to changes in groundcover and vegetation patterns, it is likely that more previously undocumented, prehistoric resources exist in Yosemite Valley. Over the past 15 to 20 years, historic resources have been more consistently inventoried than in the past. Some historic-era archeological deposits have been documented, and areas of known historic development are documented on historic base maps.

The archeological district consists of over 100 known sites significant for their ability to yield important information about prehistoric lifeways. The prehistoric and protohistoric sites contain milling stations (granite boulders with mortar cups or milling slicks, the most common feature

documented to date); midden soils; artifact scatters (including obsidian waste flakes, obsidian and ground stone tools); soapstone vessel fragments; dietary faunal remains; rockshelters; pictograph panels; human burials; artifact caches; house floors; fire hearths; and rock alignments. Historic archeological sites contain trash deposits, building foundations, privy pits, utilities, human burials, and landscape features such as ditches, roads, rock alignments, non-native plants, and trails. These historic sites are related to early National Park Service administration, homesteading, U.S. Cavalry, and tourism.

Individual sites in the archeological district vary by type, size, depth, complexity, length of occupation, variety of remains, and potential to yield important scientific information. Recent archeological research (Hull and Moratto 1999) provides guidance in assessing the research potential of these sites. Important research domains identified include paleoenvironment, cultural chronology, economic patterns, settlement patterns, demography, and social organization. Sites are considered significant when they contain important information that relates to these areas of inquiry.

Although, the majority of archeological sites in Yosemite Valley retain a relatively high degree of integrity and therefore maintain their eligibility for listing on the National Register of Historic Places, many sites have been disturbed by human activity and natural processes (Hull and Kelly 1995). Visitor use has the most widespread impact, although its effect is not as serious as other types of impacts. Due to the scarcity of easily buildable land, several archeological sites were damaged by construction of facilities and utilities. Much of the road system was developed in the early 1900s. Other visitor accommodations, such as The Ahwahnee and Camp Curry, were constructed around 100 years ago. Many roads, hotels, and other visitor accommodations were constructed since 1957, and preservation of cultural resources did not begin in earnest in Yosemite until the creation of the National Historic Preservation Act in 1966.

Merced River Gorge

Archeological resources in the Merced River gorge include historic and prehistoric sites. The historic sites are associated with development and use of this canyon as a travel corridor and include rock quarries, dumps, the remains of two work camps, a few unidentified structural foundations, and the Coulterville Road blacksmith shop in the talus west of Cascades where a forge was built to serve travelers along this road. Four prehistoric American Indian archeological sites are located in and adjacent to the Cascades area. These sites are likely seasonal villages and contain features such as mortar rocks, midden soil, lithic scatters, and rockshelters (NPS 1987b).

El Portal

The El Portal archeological district (listed in the National Register in 1978) contains 17 known sites. The area has been surveyed for prehistoric archeological resources, and areas with potential for historic archeological resources have been identified on historic base maps. Additionally, given changes in ground cover and vegetation over time, the area may reveal additional archeological material in the future.

Prehistoric and historic sites are composed of a variety of artifacts and features. The prehistoric sites represent village settlements and contain milling stations, artifact scatters, house floors, fire hearths, human burials, and deep cultural deposits. There are also historic archeological deposits representative of the ranching, mining, and railroad era. The historic sites contain trash scatters, privy pits, building foundations, rock alignments, fencelines, and cemeteries.

Archeological research (Hull and Moratto 1999) indicates that resources in El Portal may represent some of the earliest human occupation of the Merced River corridor, dating back approximately 9,500 years. The El Portal archeological resources include a complex and extensive village site, which was continuously inhabited to some degree until the early 1900s. This site contains a complex of milling stations, house floors, obsidian debitage, deep cultural deposits, and human burials. It also contains a historic component, with debris scatters, rock alignments, a borrow pit, and possible privy pits.

One extensive prehistoric site containing several known human burials with associated funerary objects is located within El Portal as well. The site contains cultural deposits, obsidian flakes and tools, beads, and shell ornaments. While much information has already been gleaned from this site, it has not been investigated in full. Both of the El Portal sites represent the seasonal migrations of people from the high country during the winter and are an integral part of broader settlement patterns within the Merced River watershed. Numerous other, less investigated, but equally important prehistoric sites exist in the area and contribute to the rich archeological district (Riley 1987).

There are also historic sites in El Portal that may contain the best-preserved archeological resources from the early historic periods associated with American Indian cultural change. Such evidence can be found at a large, predominantly historic site on the south side of the river, where Johnny Wilson (associated with the Southern Sierra Miwuk Nation) established a family farm in the late 1800s. This site represents the settlement of the first American Indian homesteader in the area. An orchard, structural foundations, and a cemetery remain, in addition to a prehistoric component. The site contains important archeological deposits directly associated with Indians living today (Davis-King 1998).

There is much archeological evidence of historic activities in El Portal, including those associated with the early development of El Portal as a gateway to the park. An extensive historic site consists of the remnants of Hennessey's Ranch, established in 1873. Remnants of the site include an orchard and rock walls as well as a prehistoric component of bedrock mortars. The ranch originally was home to an extensive farm that supplied produce to gold rush boomtowns throughout the Sierra Nevada and later to the Hotel Del Portal, contributing to the early development of the area.

At the turn of the century, the Yosemite Valley Railroad brought tourists and led to the creation of the Hotel Del Portal, a stopover on the way into the Valley. The railroad also provided transport for mining and timber industries throughout its lifetime. Many historic debris scatters, building foundations, mining and railroad remnants, and other archeological features remain from this era.

Although development in the early and mid-20th century has altered the landscape and affected archeological deposits in many places, a great deal could be learned from the remaining resources. Despite the loss of some information, the original extent and complexity of the sites, especially the prehistoric village sites, indicate that valuable information is still available. Archeological resources in El Portal represent an important source of data on the historic development of the area as a national park, as well as on the cultural transition experienced by American Indian communities during Euro-American settlement. In addition, these resources are exceptional in their significance to the local American Indian community.

Wawona

The prehistory of the Wawona area is similar to that of the park as a whole. However, most occupation seems to have occurred somewhat earlier than occupation of Yosemite Valley. There has been less use in more recent times (Hull and Moratto 1999).

The Wawona area has been designated an archeological district and was listed in the National Register in 1979. There are at least 72 sites within the district boundaries that contain both historic and prehistoric resources. The district was determined eligible for the National Register under Criterion D because it yields or is likely to yield information important in prehistory or history. The significance of the district lies in its ability to provide information pertaining to subsistence strategies, seasonal use of specific ecological zones, demographic patterns, and both historic Miwok, Western Mono, and Chukchansi Yokuts and pre-Miwok, Western Mono, and Chukchansi Yokuts occupation of the area (NPS 1978).

Traditional Cultural Resources

Traditional cultural resources consist of features of the landscape that are linked by members of a contemporary community to their traditional ways of life. As more specifically defined by the National Park Service, traditional cultural resources are any ". . . site, structure, object, landscape, or natural resource feature assigned traditional, legendary, religious, subsistence, or other significance in the cultural system of a group traditionally associated with it" (NPS 1991b). A traditional cultural property is a traditional cultural resource that is eligible for inclusion in the National Register of Historic Places.

American Indians continue their traditional cultural associations with park lands and resources. While little formal research has been conducted to inventory and document traditional resources important to Indian people, Yosemite Valley and El Portal are currently the focus of such a study. Incidental information exists for the Wawona and El Portal areas, but virtually no information has been documented for the wilderness areas. Cultural affiliation studies are underway for both the northern and southern portions of the park; information about places and traditional uses should be forthcoming from these studies. A parkwide ethnographic overview was prepared during the 1970s, but needs to be updated based on new information. Some ethnohistory studies, mostly focusing on Yosemite Valley and El Portal, have also been conducted.

The National Park Service consults with Indian people about management of park lands, especially regarding undertakings and park resources of concern to their heritage. Some of the primary concerns are access to park areas; management of plant materials for food, medicinal, and utilitarian purposes; protection of archeological and burial sites; and interpretation of Indian culture and prehistoric and historic lifeways. Federal law requires the National Park Service to consult on the basis of government-to-government relations with federally recognized Indian tribes. The National Park Service also consults with tribes that are not federally recognized. The National Park Service has entered into an agreement with the American Indian Council of Mariposa County, Inc. for purposes of traditional practices and the establishment of an Indian Cultural Center at the site of the last historic Indian village in Yosemite Valley, west of Camp 4. The National Park Service is also in the process of working with Indian people in developing agreements and/or plans for construction monitoring and for discovery and treatment of American Indian human remains, burial objects, sacred objects, and objects of cultural patrimony.

Wilderness Areas

Although some traditional cultural resources have been documented in wilderness areas, little is known about continuing traditional uses (especially within the Merced River corridor). It is likely that these upper elevation areas were used mostly for east-west travel and trade, with seasonal occupation of some areas such as Little Yosemite Valley. Wilderness trails and specific localities in the wilderness are regularly used for contemporary Indian practices.

Yosemite Valley

A traditional cultural resources study of Yosemite Valley identified and documented cultural and natural resources associated with American Indian occupation and use of Yosemite Valley (Bibby 1994). American Indians still living in the region provided oral history and assisted in the location of resources. The specific areas evaluated extended from Pohono Bridge to Mirror Lake and Happy Isles and included all historic areas of human habitation, sites of traditional and contemporary spiritual value, marked and unmarked graves, and areas of past and present resource gathering and food processing. Resources included bedrock mortars and plant materials, such as California black oak groves and individual trees, grasses, mosses, sedges, and mushrooms. Most sites and features are historic, and tradition indicates that many have long histories of use. While specific sites have been identified, the whole of Yosemite Valley is considered a traditional cultural resource by local American Indians. Currently, a Traditional Use Study is being conducted by the park; both the current study and the traditional cultural resources evaluation recommend that Yosemite Valley be designated a traditional cultural property and listed as such in the National Register of Historic Places.

In addition, the National Park Service has consulted with American Indian groups claiming affiliation with land and resources in Yosemite Valley. These are primarily the Southern Sierra Miwuk Nation (American Indian Council of Mariposa County, Inc.), the Central Sierra Me-Wuk, and the Mono Lake Paiute (Mono Lake Indian Community). Chukchansi Yokuts and Western Mono groups may have cultural ties to Yosemite Valley.

Merced River Gorge

While there is no traditional cultural information or direct historical data related to the American Indian occupations at the Cascades area and near Pohono Bridge, these sites were not locales of isolated human activity. The people using these sites would most likely have traveled through these areas between Yosemite Valley and the lower elevations of the Merced River canyon. In the 1980s, a fragment of a Miwok basket was discovered in the rock talus above Cascades. At the western extent of Cascades is a large boulder that figures in a Miwok origin story (NPS 1998b). Human remains have also been recovered from this area. The Southern Sierra Miwuk Nation, and possibly the Paiute and Central Sierra Me-Wuk, are associated with lands and resources in the Merced River gorge.

El Portal

The traditional cultural resources found in El Portal exist in a riparian ecosystem, which is in a state of constant flux. The National Park Service researched the family ties and the resources in the area and maintains a database of known gathering areas. Oral history and information from ethnohistoric research (Bates and Wells 1981; Davis-King 1998) indicate that several individuals and families have traditional ties to this area. Redbud, willow, sourberry, white and black oak, wild grape, manzanita, blue elderberry, sedges, watercress, wild onion, and white sage are known

to be culturally significant in El Portal; at least nine of these areas are recognized and protected by the National Park Service. Similar to Yosemite Valley, the entire El Portal area is considered to be a traditional use area by members of associated Indian tribes.

In addition to plant resources of cultural significance to Indian lifeways, there are three known American Indian cemeteries in El Portal, two of which were used in historic times and are the burial places for ancestors of some local Indian families. These burials have strong religious and cultural significance. Geological features of traditional spiritual importance such as views to Eagle Peak to the north are also part of the traditional cultural resources in El Portal. The Southern Sierra Miwuk Nation has the closest cultural ties to lands and resources in El Portal. Paiute and Central Sierra Me-Wuk also have some association with these lands and resources. The National Park Service consults American Indian community members regarding projects that may affect these resources.

Wawona

No formal inventory of traditional cultural resources has been undertaken for the Wawona area. A cultural affiliation study is underway that will identify places, tribal groups, and families associated with the Wawona area. It is likely that cultural practices occur in Wawona. As in El Portal and Yosemite Valley, ancestors of local Indian people are buried in the historic cemetery at Wawona. The Southern Sierra Miwuk Nation has the closest cultural ties to lands and resources in Wawona. North Fork Mono and Chukchansi Yokuts also have some association with these lands and resources.

Historic Sites, Structures, and Landscapes

Comprehensive investigations of historic sites, structures, and landscape resources have been undertaken for Yosemite Valley and El Portal. The National Park Service has established a nationwide cultural landscape inventory database, and to date, 65 of Yosemite's landscapes have been entered into this database. For other areas, information is taken from overview documents (e.g., NPS 1987b) and specific inventories (e.g., the Wilderness Historic Resource Surveys).

According to the *Director's Order 28 Cultural Resources Management Guidelines* (NPS 1991b), a cultural or historic landscape is:

> . . . a reflection of human adaptation and use of natural resources and is often expressed in the way land is organized and divided, patterns of settlement, land use, systems of circulation, and the types of structures that are built. The character of a cultural landscape is defined both by physical materials, such as roads, buildings, walls, and vegetation, and by use reflecting cultural values and traditions.

Cultural landscapes are the result of the long interaction between people and the land, and the influence of human beliefs and actions over time upon the natural landscape. Shaped through time by historical land use and management practices, as well as politics and property laws, levels of technology, and economic conditions, cultural landscapes provide a living record of an area's past, a visual chronicle of its history. The dynamic nature of modern human life contributes to the continual reshaping of cultural landscapes, making them a good source of information about specific times and places but at the same time rendering their long-term preservation a challenge.

Wilderness Areas

In the upper South Fork river corridor, known historic resources consist of segments of herder and cavalry trails. Other resources may exist, such as structures associated with early stockmen. In the main stem of the Merced River corridor, known historic resources (documented in the List of Classified Structures, National Register nominations, or through Wilderness Historic Resource Surveys) consist of the John Muir Trail, remains of the original Yosemite Grant boundary fence, the ruins of the Leonard homestead, the Merced Lake High Sierra Camp, and (just outside the river corridor), the Merced Lake Ranger Station. Other resources may exist (e.g., blazed trees, trash scatters, etc.), especially those associated with early stock grazing above the original Yosemite Grant boundary.

Yosemite Valley

The Yosemite Valley Historic District was nominated for listing on the National Register of Historic Places. This nomination recognizes the national level of historical significance of Yosemite Valley as a cultural landscape, from Indian settlement to 1942. The boundaries for the historic district extend from Pohono Bridge to Mirror Lake and Happy Isles and encompass a number of historic trails. The determination of eligibility provides an in-depth analysis of Yosemite Valley as a single entity, describes the Valley's cultural significance and characteristics, and lists historic resources that contribute to the landscape's significance. The cultural landscape of Yosemite Valley is nationally significant under National Register criteria A and C.

Although prehistoric and traditional cultural resources are referenced in the Yosemite Valley Historic District nomination, they are not included as part of the nomination. Archeological resources are described in the existing archeological district nomination for Yosemite Valley (1976) and a separate nomination addressing traditional cultural properties of Yosemite Valley will be prepared in consultation with the California State Historic Preservation Officer and associated American Indian tribes.

Under Criterion A, the cultural landscape of Yosemite Valley is associated with the following events that have contributed to a number of broad cultural patterns in our history: (1) outdoor recreation, tourism, and conservation; (2) early state and national park development; (3) western expansion and exploration; (4) American Indian cultural property; and (5) development of the environmental conservation movement.

Under Criterion C, the cultural landscape of Yosemite Valley features nationally significant examples of architecture, including the Rangers' Club, The Ahwahnee, and the LeConte Memorial Lodge, all of which are National Historic Landmarks. Yosemite Village is a nationally significant work of landscape architecture (although portions have been altered), specifically of early 20th-century American town planning.

The geophysical characteristics of Yosemite Valley have shaped patterns of human use since the earliest days of Indian settlement. As a result, the Valley's cultural landscape is significant for its role in the exploration and settlement of the west, as well as for its architecture, art, landscape architecture, recreation, and conservation. The historical importance of the Yosemite Valley landscape derives from the fact that countless generations of local tribal groups, and later untold millions of park visitors, have infused the Valley's natural features with great cultural significance. Social groups as different as the Miwok and the U.S. Congress have recognized and celebrated the value of Yosemite Valley.

The cultural processes of defining sacred space, of turning land into landscape, and of making a wild place into a public park have made Yosemite Valley one of the most culturally significant natural places in America. Thus, the significance of the Yosemite Valley cultural landscape cannot be described or assessed apart from its significance as a natural landscape. Landscapes depend on unity for their emotional effect, and at Yosemite this unity combines the pastoral and the awesome, the natural and the cultural, the past and the present. The Valley's cultural landscape encompasses cliff walls, meadows, the river and streams, as well as roads, trails, and buildings.

Many historic sites and structures within Yosemite Valley have been singled out for their significance and are either National Historic Landmarks or are listed in the National Register of Historic Places. Historical resources in Yosemite National Park were identified and evaluated in 1979 in the *Cultural Resources Management Plan* (NPS 1979a) and in the memorandum of agreement (SHPO et al. 1979) among the California State Historic Preservation Officer, the National Park Service, and the Advisory Council on Historic Preservation and its accompanying correspondence. A subsequent *Historic Resources Study* (NPS 1987b) and other project-specific reports identified and evaluated structures and sites not addressed in those earlier documents.

Several historic sites, structures, and districts throughout the Valley were nominated for the National Register prior to the Yosemite Valley Historic District nomination of 2004. These properties are significant on their own merits as well as contributing to the Yosemite Valley Historic District. The Yosemite Village Historic District (nominated in 1974) consists of several structures and facilities representing the residential and administrative core of Yosemite Valley. All phases of National Park Service architecture are present in Yosemite Village, from structures designed and built by the U.S. Army to examples of Rustic and Mission 66 architecture. The Ranger's Club was nominated for listing as a National Historic Landmark in 1987, and as an early (1921) example of the Arts and Crafts–inspired Rustic style in the park, set the tone for future building in the area.

The Ahwahnee, which was deemed a National Historic Landmark in 1977, was built in 1927 to provide first-class service and attract wealthy and influential visitors to Yosemite Valley. The hotel was designed by Gilbert Stanley Underwood to harmonize with the nearby rugged Valley walls. LeConte Memorial Lodge was nominated for listing as a National Historic Landmark in 1987 and is one of the focal points for the Sierra Club in Yosemite Valley. It was constructed by the Sierra Club in 1903 in honor of Joseph LeConte, one of its founding members. In 1919, it was moved from its original location, adjacent to Camp Curry, to its present location south of the river between Curry Village and Sentinel Bridge.

The Camp Curry Historic District includes the Mother Curry Bungalow and the Foster Curry cabin; the original registration building; several bungalow units; and canvas tent cabins. The camp itself dates from 1899, with changes and additions through the early 1920s. The tent cabins constitute the most significant and intact tent cabin complex left in the National Park System. Other structures not associated with the development of original Camp Curry still retain historical integrity and are considered contributing elements in the developed landscape.

Camp 4 was listed in the National Register of Historic Places in 2003 under Criterion A for its association with the growth and development of rock climbing as a recreational/entertainment activity in Yosemite Valley. While camping is important as a recreational activity and land use in the historical context of the Yosemite Valley cultural landscape, the individual campgrounds themselves do not retain historical integrity and therefore are not considered contributing

resources to the Yosemite Valley Historic District. However, Camp 4 is significant as a historic site for other reasons. From 1947 through 1970, Camp 4 was a meeting ground for the pioneers of climbing. It served as a place of training, ascent planning, information and equipment exchange, and camaraderie, and remains an internationally recognized, important focal point for climbers in Yosemite Valley.

In addition, eight granite-faced, concrete-arched, two-lane vehicle bridges were constructed along the Valley Loop Road between 1922 and 1933. Six of the bridges—Ahwahnee Bridge, Clark's Bridge, Pohono Bridge, Sugar Pine Bridge, Happy Isles Bridge, and Stoneman Bridge—cross the Merced River, while two others, Yosemite Creek Bridge and Tenaya Creek Bridge, cross these creeks. Each bridge is listed in the National Register of Historic Places.

Merced River Gorge

Based on a cultural resources inventory completed in support of the reconstruction of El Portal Road, the National Park Service, in consultation with the State Historic Preservation Officer, determined that the Merced Canyon Travel Corridor is a significant historic property and is eligible for listing in the National Register of Historic Places. The primary element of this corridor is El Portal Road, which was originally constructed as a wagon road in 1905 and was substantially reconstructed in 1925. The road includes hand-laid stone parapet guardwalls and drainage catchment structures. Following consultation with the State Historic Preservation Officer and the Advisory Council on Historic Preservation, the majority of these features were removed as part of the El Portal Road Reconstruction Project. Other properties within the corridor include rock quarries, historic trash scatters, sections of pre-1925 roadbed, historic work-camp sites, and the Arch Rock Entrance Station complex (eligible for the National Register as an individual property), which consists of a ranger residence/office, entrance kiosk, parking lot, and restroom building.

The Merced Canyon Travel Corridor determination of eligibility document (NPS 1997m) describes the important landscape characteristics of this property: " . . . the views of the Merced River Canyon, the use of natural materials, and purposeful design of situating the travel corridor in sympathy with the natural landscape."

Among the historic resources in the gorge, most of which have now been removed, are the structures and features associated with the Yosemite Hydroelectric Power Plant (also known as the Cascades Powerhouse). Structures associated with the hydroelectric system and included with the historic property listing were the diversion dam, the intake, the screens and screenhouse, the penstock, the surge tank, the powerhouse and equipment, the 11-kilovolt distribution line into Yosemite Valley, and five Cascades residences and garages, constructed between 1917 and 1924. In consultation with California SHPO and the ACHP, many of these structures were removed in 2003-2004 as part of river restoration projects, including the dam and screenhouse. The five Cascades residences associated with the dam were also removed as a *General Management Plan* action.

El Portal

A preliminary cultural landscape study conducted in El Portal revealed one potentially eligible cultural landscape: Old El Portal (NPS 2004p). This landscape is potentially eligible under Criterion A because of its association with the industry and settlement of Yosemite National Park, and under Criterion C because it embodies landscape characteristics associated with small

railroad communities. Landscape characteristics such as land-use patterns, circulation patterns, vegetation, and views are still relatively intact (NPS 2004p).

The Old El Portal cultural landscape encompasses the historic town that was initially developed in the beginning of the 20th century with the arrival of the Yosemite Valley Railroad. El Portal was permanently inhabited by park, railroad, mining, and timber industry personnel and their families. Additionally, El Portal was the railroad terminus and transfer station for park visitors heading to Yosemite Valley. This land-use pattern combining a company town and a steady flow of tourists has continued in El Portal for the past century.

A draft El Portal historic base map has been prepared (NPS 1997v), based on primary and secondary sources (maps, photographs, oral history, and memoirs). Historic documents identify the locations of ranches, facilities associated with the Yosemite Valley Railroad, American Indian homes, tungsten and barite mining resources and facilities, and commercial, resort, and lodging facilities. Many of these exist today as archeological sites or landscape features.

Properties in El Portal that are either listed in or are eligible for listing in the National Register of Historic Places include the Bagby station house (now used as the Yosemite Association headquarters), water tanks, and turntable; Hetch Hetchy Railroad engine number 5; Yosemite Valley Railroad caboose number 15; Murchison house and office; three National Lead Company residences in Rancheria Flat; and a store, a school, the El Portal Market, the El Portal Hotel (now used as the Yosemite Institute headquarters), and three railroad residences, all in the Village Center of Old El Portal. Some of these structures are privately owned but located on federal land.

Wawona

A cultural landscape study of the Wawona area, focusing on Washburn Company holdings (including the National Historic Landmark Wawona Hotel Complex), is underway. The most significant of the historic structures in Wawona is the Victorian hotel complex, at the site of the earlier Clark's Station. The hotel complex includes seven structures and is significant for its architectural features as well as for its historical associations with early California commerce and the landscape painter Thomas Hill. The complex includes the Pavilion (former Hill's Studio), Little White (Manager's Cottage), Little Brown (Moore Cottage), Long White (Clark Cottage), Long Brown (Washburn Cottage), the Wawona Hotel, and the annex. The complex was designated a National Historic Landmark on May 28, 1987. The Wawona Golf Course, in operation since 1918 and overlying the eastern portion of Wawona Meadow, is also associated with the hotel complex.

This resort complex once encompassed many other facilities necessary to support such a remote facility. Other structures include the Covered Bridge, the Gray Barn, the Slaughterhouse, and the Laundry, now used as a wagon repair shop. Other facilities exist today as archeological or landscape features, including the Washburn Ditch, the remains of Stella Lake, the foundations from Washburn Company employee residences, dumps, remains of cow and horse pasturage, a split-rail fence encompassing most of the southern Wawona Meadow, a remnant orchard, and many other features.

The Chowchilla Mountain Road, which was originally constructed in the late 1800s, is also located in Wawona. This road linked Wawona with the Mariposa area and followed earlier toll trails into the area. Galen Clark's homestead is adjacent to the Wawona Golf Course and includes

a planted stand of giant sequoias, a former well, and possibly the archeological remains of his home. There also are remnants of cavalry activity in Wawona, which may potentially be eligible for listing in the National Register (NPS 1987b).

The Pioneer Yosemite History Center, on the banks of the South Fork, contains many structures relocated from other areas of the park. Four of the buildings are listed in the National Register, including the Hodgdon homestead cabin, Chris Jorgenson Studio, the Acting Superintendent's headquarters, and the Yosemite Transportation Company office. The George Anderson Cabin is also eligible for listing.

Several Civilian Conservation Corps structures (e.g., the National Park Service maintenance complex and ranger office) and three residences constructed immediately after the Wawona land purchase in 1932 still exist in this area.

Visitor Experience

Recreation

Recreational opportunities abound in Yosemite National Park in developed and wilderness areas alike; however, the types and quality of activities vary considerably between these two areas. Recreational opportunities are made more memorable because of the natural beauty of Yosemite Valley, Wawona, El Portal, and wilderness environments. These areas offer a wide range of recreational experiences, including backpacking, camping, sightseeing, fishing, swimming, picnicking, climbing, day hiking, bicycling, rafting and kayaking, horseback riding, skiing, golf, photography, quiet contemplation, and nature study. The availability of one or more of these opportunities varies by location, particularly within the main stem and South Fork of the Merced River corridors. Although the park is proposing to conduct a new visitor study in 2005, this discussion is based on the existing information from the visitor use study conducted in 1992 (Gramann 1992).

Recreational uses are managed by the National Park Service in a variety of ways, which are stipulated in the 1999 Superintendent's Compendium. Though not identified specifically below, special events such as weddings or ceremonies on the main stem and South Fork segments of the river require a special use permit. These recreational opportunities and current management regulations are grouped by river segment in table IV-4 and further described below.

Table IV-4
Recreational Opportunities Typical within the Merced River Corridor

River	Park Area	Recreational Opportunities
Main Stem	Wilderness	Backpacking/hiking, camping, High Sierra Camp experience, stock use, fishing, swimming/wading, nature study, photography, cross-country skiing, snowshoeing, solitude
	Yosemite Valley	Walking/hiking, picnicking, camping, climbing, cross-country skiing, ice skating, fishing, photography, swimming/wading, nature study, stock use, sightseeing, rafting, kayaking, interpretive programs, bicycling, art classes
	Gorge	Picnicking, climbing, fishing, swimming/wading, photography, sightseeing, nature study
	El Portal	Whitewater rafting/kayaking, fishing, swimming/wading, picnicking
South Fork	Wilderness	Backpacking/hiking, camping, stock use, fishing, swimming/wading, nature study, photography, cross-country skiing, snowshoeing, solitude
	Impoundment	Hiking, sightseeing, photography
	Wawona	Hiking, picnicking, camping, cross-country skiing, fishing, photography, swimming/wading, nature study, stock use, sightseeing, rafting, interpretive programs, golfing
	Below Wawona	Hiking, fishing, whitewater kayaking, solitude

Camping

Camping throughout Yosemite National Park is regulated differently, depending on whether the activity occurs in the developed or wilderness areas. Public camping in the river corridor is provided at six campgrounds, including Wawona Campground on the South Fork, and North Pines, Backpackers, Upper Pines, and Lower Pines Campgrounds and Camp 4 adjacent to the Merced River in Yosemite Valley. Camping is available on a year-round basis in both Wawona and the Valley. (Other campgrounds in the Valley damaged during the 1997 flood have since been closed, including Upper and Lower River Campgrounds and the northwest end of Lower Pines Campground.)

There are no developed campgrounds on National Park Service land in El Portal, although there are campsites along the river just west of the El Portal Administrative Site on U.S. Forest Service–administered land.

Several camping options are available, including drive-to (i.e., car or recreational vehicle) and walk-in campgrounds, a horse camp, and group and backpackers campsites. The Backpackers Campground in the Valley is intended for use by wilderness permit holders the night before entering and/or the night after leaving the wilderness. Visitor camping in the frontcountry is permitted only in designated campgrounds.

In the wilderness, backpackers can use campsites clustered in the Little Yosemite Valley Campground (a popular spot for hikers continuing to Half Dome), Moraine Dome Campground, and Merced Lake Backpackers Campground. In much of the wilderness, backpackers choose their own sites for camping, typically away from other campers. Wilderness regulations require backpackers to camp at least 100 feet from rivers and lakes. The National Park Service has established restrictions for frontcountry and wilderness camping. Frontcountry camping is permitted only in designated campgrounds and campers are allowed to stay for no more than 30 days per calendar year (7 consecutive days in the Valley, and 14 consecutive days in other park campgrounds). Camping is permitted within 100 feet of a waterbody in established campgrounds. Overnight parking on park roads is prohibited. The 1999 Superintendent's Compendium establishes check-in and check-out times, limitations on the number of people and cars per site, and proper wastewater disposal protocol.

Wilderness campers must obtain and carry wilderness permits and are subject to the trailhead quota system between May 15 and September 15. Groups are limited to 15 people and 25 stock per wilderness party. Restrictions apply to camping near specified waterbodies, park roads, and at the base and summit of climbing routes. Additionally, wilderness campers are required to dispose of wash water 100 feet from waterbodies.

Sightseeing

According to a study of visitors exiting the park, about 90% of visitor groups reported sightseeing as an activity their parties participated in while in the park (Gramann 1992). Sixty percent of visitor parties took photographs, and more than half reported nature study as an element of their trip. Sitting or standing quietly, absorbed in thought or in awe of one of Yosemite's majestic views, was found to be basic to the park experience. Artistic pursuits and wildlife viewing were also important to the enjoyment of the park. Of all the awe-inspiring destinations in Yosemite National Park, Yosemite Falls is the most famous, most accessible, and most popular; the falls are visited by more than 2 million people each year. Spectacular views of Yosemite Valley and the

Merced River corridor can be seen from Glacier Point, Washburn Point, and other vista points along the Valley rim.

Fishing

Fishing is a popular activity in the park, particularly in the wilderness lakes within the Merced River and South Fork drainage basins, in Yosemite Valley, and the El Portal Administrative Site. Brown trout, rainbow trout, brook trout, and smallmouth bass are sufficiently common for routine fishing. Brown trout are most abundant in the river corridor and the larger lakes during the fall, while rainbow trout are more abundant during spring runoff when the current is fast and the water is cold. Brook trout can be found in smaller numbers in waters in the higher elevations.

Fishing in Yosemite National Park is regulated under state sport fishing regulations and specific park fishing regulations prohibiting the use of live bait and barbed hooks. The entire 81 miles of the Merced River within the park and El Portal Administrative Site is designated as catch-and-release waters for rainbow trout. A bag limit of five brown trout is enforced (NPS 1999b).

The Merced River between Parkline and Forest Road bridge, also known as the El Portal reach, has been designated as a Wild Trout Fishery by the California Department of Fish and Game because of the favorable growing season and conditions of the river in this stretch (CDFG 2004b). The popularity of angling is growing in the El Portal reach due to these favorable fishing conditions. Because anglers typically work the river as they walk upstream, there are only a few well-known fishing areas, including west of the wastewater treatment plant in El Portal, the Sand Pit, near the Highway 140 bridge, across the road from the El Portal Market, and near the confluence with Crane Creek. The California Department of Fish and Game continues to stock trout species in the Merced River just below Foresta Road bridge; these fish populations move upstream and have the potential to make it all the way to Yosemite Valley (NPS 2004x).

Commercial fly-fishing guide services are permitted along the Merced River within the El Portal Administrative Site and the park, between the Foresta Road bridge on the west and the confluence with Yosemite Creek on the east in Yosemite Valley. Fly-fishing is most popular in late September and early October during the caddis fly hatch (NPS 2004r). Fly-fishing is least popular during the warmest summer months because of the difficulty in finding fish and the harm to the fishery that can occur when the water levels drop and the water warms up.

On the South Fork, most fishing (primarily for brown and rainbow trout) takes place downstream of the water intake and impoundment area in Wawona.

The headwater areas of both the main stem and South Fork rivers have mountain ponds and alpine lakes as well as snowmelt and ephemeral streams within their boundaries. Fishing in the wilderness lakes is a popular activity for visitors, particularly Merced Lake High Sierra Camp, where fishing takes place in Washburn and Merced Lakes. Wilderness lakes support relatively good brown and rainbow trout populations.

Swimming

Swimming and wading in the Merced River corridor is popular during the summer. About 25% of summer visitors swim during their visit (Gramann 1992). The National Park Service does not officially designate swimming areas. The park encourages visitors to avoid fast-moving water and unsafe pools above waterfalls. In the Valley, swimming is a popular activity in the Merced River,

Tenaya Creek, and at Mirror Lake. Most sections of the river in Yosemite Valley are within easy access from lodging areas, roads, campgrounds, and day-use areas. Many of these areas are heavily used, particularly where they are adjacent to developed campgrounds and upstream or downstream of certain bridges, such as Stoneman and Swinging Bridges. Two public pools (at Yosemite Lodge and Curry Village) and a guest pool at The Ahwahnee are also used during the summer months.

In the wilderness, swimming is enjoyed in certain reaches of the Merced River downstream of various cascades, including Bunnell Cascade. Swimming also takes place in the vicinity of Moraine Dome and in the many lakes in the upper Merced River corridor, particularly in Merced Lake and Washburn Lake.

During the summer, visitors and residents alike swim along the Merced River gorge. The river between Pohono Bridge and the intersection of the El Portal and Big Oak Flat Roads is a popular swimming location, despite a lack of appropriate access in many places. There are also numerous swimming holes along the Merced River within the gorge, some more accessible than others.

In El Portal, Patty's Hole is a well-known swimming location just west of the El Portal Market. The January 1997 flood washed out a number of trees that had shielded this segment of the river from Highway 140, thus increasing public awareness of and accessibility to the swimming area.

In the South Fork, swimming is common in the vicinity of Swinging Bridge, alongside the Wawona Campground, and near the picnic area east of the campground. In recent years, swimming has also become more popular through the town of Wawona. Access to the river downstream of Swinging Bridge is somewhat limited due to private property along the river. Pools also exist in the upper reaches of the South Fork and are used by wilderness visitors.

In accordance with the 1999 Superintendent's Compendium, the National Park Service prohibits jumping and diving from any park bridge. Swimming or bodily contact with water is not allowed in the vicinity of the impoundment associated with, and 100 yards upstream of the Wawona Impoundment as it is a source of drinking water for the Wawona community. There are no swimming restrictions in Yosemite Valley, the Merced River gorge or El Portal.

Picnicking

Picnicking in Yosemite Valley is enjoyed in places adjacent to the river, on benches near the visitor center, in shady spots along wilderness trails, , or in picnic areas. Many visitors use a picnic area during their visit to the park (Gramann 1992). There are four designated picnic areas (providing grills, picnic tables, etc.) in Yosemite Valley: Cathedral Beach, Sentinel Beach, El Capitan, and Swinging Bridge. Church Bowl, near Yosemite Village, has only picnic tables and serves as an informal picnic site. There is a picnic area at the Cascades and also a small picnic area at the Arch Rock Entrance Station. Some picnickers make use of outdoor seating associated with concessioner food service facilities. In Wawona, the picnic tables near the Pioneer Yosemite History Center and the Wawona Campground are heavily used for picnicking.

Picnicking is prohibited in closed Valley campgrounds, open Valley campgrounds (except between October 15 and the campgrounds' closing date) and in the Wawona Campground during the reservation period. After October 15, picnickers must yield campground sites to visitors wishing to camp. As stated in the 1999 Superintendent's Compendium, the park intends to allow

picnicking with as little restrictions as possible, as long as littering, wildlife feeding, and food storage do not become problematic.

Climbing

Yosemite Valley's granite walls draw thousands of climbers each year for both day and multi-day climbs. The primary concessioner offers a mountaineering school in the Valley. Camp 4, which is near popular climbing routes and features, serves as an unofficial climber's camp. The camp is also shared by other park users and is the Valley's only first-come, first-served walk-in campground. Climbers often stage their trips (equipment preparation and parking) in turnouts near the start of their climbs. Because of the proximity of popular climbing walls to Valley roads and turnouts, climbing observation has also become a common visitor activity.

Rock climbing is also common within the Merced River gorge. Most climbing takes place at Steamboat Bay and the Cookie (east of the Arch Rock Entrance Station) in the spring and fall when higher elevations are inaccessible because of inclement weather. Other popular spots in the gorge include Arch Rock and Pat and Jack Pinnacle in the Cascades Day-Use area. Some visitors enjoy rock climbing or mountaineering on the cliff walls and domes in the upper reaches of the main stem and South Fork.

The National Park Service restricts climbing in areas where endangered bird species (peregrine falcons) nest. In addition, the 1999 Superintendent's Compendium placed restrictions on the types of equipment that may be used when developing climbing routes. Climbers on multi-day ascents must also containerize and properly dispose of human waste.

Day Hiking

Forty-four percent of summer visitors arriving in their own cars and 32% of bus passengers reported day hiking while in the park. Many park visitors hike throughout the entire year (Gramann 1992).

Visitors have access to Yosemite Valley trails that range from a short stroll to the base of Lower Yosemite Fall to an ambitious 17-mile round-trip day hike to the top of Half Dome. Thirty-five miles of hiking trails are available on the Yosemite Valley floor; many of these trails are shared with stock users and/or bicyclists. Several walking loops are available in the east Valley, and there are two loops in the west Valley: (1) between Swinging Bridge and El Capitan Bridge, and (2) between El Capitan Bridge and Pohono Bridge. Day hikers can circumnavigate the Valley using the Valley Loop Trail, which is shared by stock. A trail network provides multiple routes between the Happy Isles/Mirror Lake area and Yosemite Village. Self-guiding interpretive trails can be found at Mirror Lake and in the Indian Village of Ahwahnee behind the Yosemite Valley Visitor Center. A multi-use paved trail (shared by pedestrians and bicyclists) links Yosemite Lodge to the Happy Isles area on both sides of the Merced River. Paved trails (the multi-use trails and roads closed to private vehicles) in the Valley are approved for use by visitors with pets. Heavy and multiple uses often create congestion on paved trails, especially in Yosemite Village. Several trails have wayside exhibits to interpret features encountered along the way.

There are comparatively fewer day hiking opportunities in Wawona. Some trails parallel or lead to destinations along the river; a trail loops around Wawona Meadow; and several trails lead to the wilderness, the Mariposa Grove of Giant Sequoias, and other popular day hiking destinations.

Few visitors hike in the El Portal area, though day hiking is more common along the old Foresta Road and just west of El Portal along Incline Road.

Popular day hikes include destinations along trails shared by backpackers (e.g., the Mist and John Muir Trails to Vernal and Nevada Falls, the Four Mile Trail between Yosemite Valley and Glacier Point, and the Upper Yosemite Fall Trail in Yosemite Valley; and the Chilnualna Falls Trail in Wawona).

Though no restrictions have been established for day hiking in the wilderness, groups entering the wilderness are limited to 15 per group when traveling on established trails and eight per group when traveling off-trail more than one-quarter mile. Group size is limited to 15 or when staying in the wilderness overnight. Groups traveling with stock are limited to 25 head of pack and saddle stock per party (NPS 1999b).

Bicycling

Bicycling is a common means of enjoying and exploring Yosemite Valley. Visitors can use approximately 12 miles of paved bicycle trails that provide access to all the major developed areas in the Valley. Bicycles are available for rent in Yosemite Valley; approximately 29,600 were rented in Yosemite Valley in the summer of 2003, with August the peak month for use in all years (NPS 2004u). Additionally, many visitors bring their own bicycles to the Valley, particularly overnight visitors.

Wayside exhibits can be found along bicycle paths and at popular destinations. Bicycling is restricted to designated paved trails and roads and is not allowed on pedestrian or unpaved trails. Some road segments—Happy Isles Loop and the road to Mirror Lake—are closed to most vehicle traffic and provide relatively safe bicycle access. However, no bicycle trails exist in the west Valley, where bicyclists must share the often-crowded Northside and Southside Drives with motorists.

Bicycling is much less common in other areas of the park, due primarily to the lack of paved trails. Bicycling is prohibited in the wilderness.

The 1999 Superintendent's Compendium limits the number of bicyclists that can travel in a group on park roads to 30 cyclists. Bicycles are prohibited on all trails and bridle paths in meadows. Bicycles are permitted on park roads open to the public for vehicle traffic and paved bicycle paths, as well as on the Meadow Loop, Eleven Mile, and Four Mile fire roads in Wawona.

Nonmotorized Watercraft

During the summer in Yosemite Valley, visitors can rent rafts through the primary concessioner at Curry Village if water levels are sufficient. Rafting has been popular in the Valley since the 1980s, and all rafting is self-guided. In the summer of 2003, approximately 13,700 rafts were rented by visitors from the Curry Village raft rental stand (NPS 2004u). Limited rafting occurs on the South Fork between Swinging Bridge and Wawona Campground. In this reach, the river's gradient is relatively flat.

Rafting regulations have been implemented to protect river habitat and provide for visitor safety in the Valley. In general, park management encourages visitors to launch and remove rafts at sandbars

and beach locations. (Rafting regulations can be found in the 1999 Superintendent's Compendium [NPS 1999b].)

The concessioner must use designated areas for launching and removal of nonmotorized watercraft. There is a raft launch site on the downstream side of Stoneman Bridge, where the river typically has slow-moving water during the summer. Concessioner nonmotorized watercraft are not permitted past the Sentinel Beach Picnic Area.

The presence of large woody debris in the channel poses potential risk to rafters, and park and concessioner staff attempt to warn visitors engaged in rafting activities of this hazard.

Whitewater rafting and kayaking occur in the El Portal reach for both commercial outfitters and private boaters. This reach of the river is generally considered to be Class III rapids. Certain sections can be Class V, depending on the flow rate, which attracts boaters from across the state. No commercial rafting operations are permitted upstream of the Foresta Road bridge; however, there are no regulations on where private boaters may enter the water or when they can run the river. Launch sites for private boaters are located across from the El Portal Market and at a site adjacent to the Highway 140 bridge. The National Park Service does not regulate private boater recreation due to low use levels.

A memorandum of understanding among the National Park Service, the U.S. Forest Service, and the U.S. Bureau of Land Management stipulates that commercial rafting operations will be managed by the Bureau of Land Management on the Merced River, which includes the Red Bud launch site located immediately west of the Foresta Road bridge (BLM 1990b). The Red Bud launch site is heavily used for commercial rafting operations and is located at the western edge of the El Portal Administrative Site. Eight commercial rafting companies have permits for the Merced River between the Foresta Road bridge and downstream to Briceberg Bridge. Through permitting, the Bureau of Land Management regulates the number of commercial rafters that may enter the water with a company and the number of times a day a company may bring a group down the river. Approximately 2,000 paying customers enter the Merced River aboard a boat that leaves from the Red Bud launch site each year, typically in May and June (NPS 2004q).

Commercial rafting operations are restricted at the Red Bud launch site when water flow rates are above 3,000 cubic feet per second. Because the Merced River is used seasonally due to the absence of dams, the highest use of the river is directly correlated with the heaviest runoff periods, typically April through mid-July (NPS 2004q).

The National Park Service has restricted the use of nonmotorized watercraft in the Merced Wild and Scenic River to the main stem and South Fork in Yosemite National Park. The 1999 Superintendent's Compendium places restrictions on the length of the segment of river that can be floated in the Valley (specifically, between Stoneman Bridge and Sentinel Beach Picnic Area) and on the times floating is permissible (between 10 a.m. to 6 p.m. Pacific Standard Time). In addition, floating is prohibited when the Sentinel Bridge water level gauge reads 6.5 feet or higher and when the combined ambient air temperature and water temperature is less than 100 degrees Fahrenheit.

Stock Use/Stables

In the summers of 1990 and 1991, about 9% of parties arriving in their own vehicles and about 3% of bus parties reported horseback riding as an activity in which some members of their group participated while in the park (Gramann 1992).

Both commercial and private stock uses are found in Yosemite Valley and in Wawona. Commercial stock use and boarding are available through the concessioner at the stable located in the east Valley. Stock boarding is available in Wawona at the concessioner's stable, and a horse camp near the Wawona ranger office is available for visitors who wish to camp with their stock.

According to the 1989 *Wilderness Management Plan* and the 1999 Superintendent's Compendium, permitted stock animals in Yosemite National Park include horses, mules, burros, and llamas. Stock are allowed on all park trails, with the exception of those signed *closed to stock* or *foot trail only*.

In the Valley, stock are permitted on all unpaved foot trails; however, closures apply to stock on heavily used trails such as the Mist Trail. Additionally, bicycle paths, tram roads, shuttle bus routes, Mirror Lake Loop road in Yosemite Valley, and the Four Mile fire road in Wawona are specifically closed to stock. Loose herding and grazing is prohibited in frontcountry areas, and established frontcountry campsites must be cleaned daily (i.e., manure and uneaten fodder removed). Watering facilities must be used when provided.

In the wilderness, overnight parties are limited to 25 head of stock and 15 people. Off-trail or cross-country travel with stock is prohibited; however, an exception is made for leading stock to watering, rest, or camping locations one-quarter mile off the trail. No new stock trails are allowed to be established, and stock parties must travel in single file. Grazing is permitted, except within four miles of trailheads or roadways. It is prohibited to tie stock to trees within 100 feet of a waterbody (NPS 1999b).

The primary concessioner offers stock trips in Yosemite Valley, as well as to the Yosemite Wilderness from various locations, including Yosemite Valley, Wawona, and Tuolumne Meadows. In the Valley and in Wawona, available trips include a 2-hour ride, a half-day trip, and a full-day trip (see table IV-5). Two-hour trail rides are by far the most popular, with over 11,000 people participating in 1998 (Yosemite Concession Services 1999). These rides also offer an opportunity for individuals with mobility impairments to experience the wilderness.

Table IV-5
Concessioner Stock Use

Location	Guided Trail Ride	Frequency
Valley	2-hour trips	4 trips per day
	half-day trips	2 trips per day
	full-day trip	1 trip per week
Wawona	2-hour trips	3 trips per day
	half-day trips	1 trip per day
	full-day trips	depends on interest

About 2,500 trips annually are led up the Vernal and Nevada Falls corridor. About 14,000 trail ride trips originate each year from the Valley concessioner's stable. Additionally, concessioner stock are used to guide overnight pack trips and for freight trips (six mules, three times per week, or approximately 137 trips per year) to supply the Merced Lake High Sierra Camp.

Tennis

In Yosemite Valley, tennis is played on courts at The Ahwahnee, but both the 1992 *Concession Services Plan* and 2000 *Yosemite Valley Plan* prescribed their removal. A tennis court is also available at the Wawona Hotel.

Golf

Golf is available in Wawona at the historic Wawona Golf Course (established in 1918). The length of time the course is open varies year by year, depending on weather conditions, but the course is generally open when the Wawona Hotel is operating, between June and October. On average, 25 to 34 groups of four people golf per day. This golf course accommodates approximately 9,000 people per year (NPS 2004w).

During the golfing season, only authorized golfing parties are permitted to use the golf course due to the dangers associated with being hit by golf balls, as stipulated in the 1999 Superintendent's Compendium.

Winter Activities

Many activities are available for park visitors during the winter, including cross-country skiing, alpine or downhill skiing, snowboarding, tubing/sledding, ice skating, and snowshoeing. Most cross-country ski routes follow summer trails or traverse the open meadows. At elevations of 4,000 feet, Yosemite Valley and Wawona sometimes have snow for long periods; however, snow at lower elevations, such as in El Portal is rare. Ice skating is available at a concessioner-operated rink at Curry Village and is enjoyed in the winter by both visitors and residents. Yosemite Valley serves as a primary lodging center for visitors pursuing winter recreation in wilderness and other areas, particularly the Badger Pass downhill and cross-country ski area. Some cross-country skiing also takes place on Wawona Meadow and the golf course.

The National Park Service prohibits certain types of snow play in certain areas of the park, such as prohibiting snow play or skiing on roads that are open to vehicle traffic, as stipulated in the 1999 Superintendent's Compendium. The Superintendent may designate certain parking areas and roadways during winter months as allowable areas for skiing, snowshoeing, and sledding such as the Glacier Point Road and the Tioga Pass Road.

Orientation and Interpretation

Orientation

The National Park Service provides visitors with published information regarding Yosemite National Park in many different formats. These include Yosemite National Park's web site, official park mailings, and e-newsletter updates. Information is also distributed at entrance stations and visitor centers, including the free *Guide to Yosemite National Park*, the *Yosemite Today* newspaper (published bi-weekly in summer, monthly during the remainder of the year), a free park brochure/map, handouts on self-guided nature trails, and supplemental education

materials and fact sheets. (A translation of the park brochure is available in German, French, Spanish, and Japanese.) This range of information provides travel information and directions to the park, important information to be aware of when planning visits (i.e., seasonal weather conditions and road closures), activities and special events in the park, lodging and campground reservation information, information on park planning projects, and a variety of maps and graphics to provide orientation to the park's roads, features, facilities, services, and trails. It also serves as a primer on Yosemite's natural and cultural history and scenic beauty. Park staff offer a wide range of media (e.g., the orientation audio-visual program at the Yosemite Valley Visitor Center) and interpretive programs to assist visitors in understanding the park's natural history and resources. The park's primary concessioner also provides information on lodging and other visitor services on their web site, as well as interpretive programs at guest lodges and the High Sierra Camps. In addition, park partners such as the Yosemite Association collaborate with the National Park Service to provide evening programs and information about park events and natural history.

Yosemite National Park operates two visitor centers, two wilderness centers, the Nature Center at Happy Isles, and the Pioneer Yosemite History Center. Yosemite Village and Tuolumne Meadows each have a visitor center and a wilderness center. Both centers at Tuolumne Meadow, the Nature Center at Happy Isles, and Pioneer Yosemite History Center are open during the summer. The Yosemite Valley Visitor Center is open year-round and provides visitors with wilderness trip planning information. These facilities and sell park guidebooks and other resources to help orient visitors to the park. Additional information on park facilities and visitor services is available from seasonal information centers at Wawona and Big Oak Flat, and from registration staff at campgrounds and lodging facilities. Commercial bus operators also provide orientation and information to visitors being transported to and from the park. Visitors can also gain information from interpretive wayside exhibits throughout the park.

Interpretation

Park interpreters and volunteers serve a primary natural and cultural resource preservation role in the park. Interpreters connect people to the meaning and significance of the park by conveying information and educational programs to visitors and park employees about the history and function of park ecosystems and the relationship between various park resources.

Interpretation and information on the Outstandingly Remarkable Values and the natural, cultural, and historical importance of Yosemite National Park is provided through a variety of sources. These sources include educational/school programs, field seminars, evening programs and ranger-led walks, audio-visual presentations at park visitor centers, interpretive wayside exhibits, cultural history museums, tram tours, park open houses (primarily a tool to provide information about park planning projects), and published materials available at entrance stations, visitor centers, and campground and lodging registration desks.

A wide range of interpretive programs and materials are available to the public (see table IV-6). Programs cover a wide variety of topics, including geology, astronomy, botany, wildlife, trees, hydrology, cultural history (American Indian, Buffalo Soldiers, settlements, and modes of transportation), Junior Ranger programs, wilderness, fire, and climbing. Programs range in duration from less than 1 hour to all-day hikes and multiday seminars and residential field science experiences. Interpretive hikes venturing into the Yosemite Wilderness aim to support wilderness management by increasing visitor understanding of park resources and management concerns.

Table IV-6
Interpretive Programs

Organization	Programs Offered in Various Locations		
	Yosemite Valley	Yosemite Wilderness	Wawona
National Park Service	▪ Ranger-led walks, talks ▪ Self-guided nature trails ▪ Interpretive performances, slideshows, audiovisual programs ▪ Nature Center at Happy Isles ▪ Museum, visitor center, and trail exhibits ▪ Indian Village of Ahwahnee ▪ Interpretive publications	▪ Ranger-led day walks ▪ Multi-day ranger-guided High Sierra Camp loop trips that include a stop at the Merced Lake High Sierra Camp	▪ Environmental Living Program ▪ Stage Coach Living History Program ▪ Stable ▪ Ranger-led walks, talks ▪ Wawona Campground ▪ Pioneer Yosemite History Center
Delaware North Companies Parks and Resorts at Yosemite	▪ Photo walks ▪ Valley tours ▪ Yosemite Art Center ▪ Interpretive talks, slideshows, audiovisual programs ▪ Tram/bus tours	▪ Guided wilderness trips	▪ Interpretive talks, slideshows, audiovisual programs
Yosemite Association	▪ Interpretive publications ▪ Art classes and educational seminars ▪ Yosemite Theater presentations	▪ Educational seminars	▪ Educational seminars
Yosemite Institute	▪ Educational field-science programs for school-age children and adult groups	▪ Guided wilderness trips	NA
Sierra Club	▪ Interpretive walks and talks ▪ LeConte Memorial Lodge ▪ Interpretive exhibits ▪ Library	NA	NA
The Ansel Adams Gallery	▪ Art exhibits ▪ Photo walks and classes ▪ Film presentation	NA	NA

Interpretive staff are also responsible for producing informational materials and handouts for distribution at visitor centers and through the park public information office.

Interpretive programming is available at many locations and facilities throughout the park, including the following:

- Ranger-led walks, guided tours, and evening programs take place at various locations in Yosemite Valley, Wawona, Glacier Point, Tuolumne Meadows, and El Portal. Walks typically depart from visitor centers or key features. Evening programs typically take place at campground amphitheaters, amphitheaters at Yosemite Lodge, Curry Village, and the High Sierra Camps and the visitor center at Yosemite View Lodge in El Portal. The National Park Service and Delaware North Companies (DNC) Parks and Resorts at Yosemite have teamed up to provide open air tram tours in Yosemite Valley.
- Yosemite Theater performances take place in the auditorium at the Valley Visitor Center and feature live music and dramatic presentations relating to Yosemite's human and natural history.
- The Yosemite Museum offers programs on American Indian culture that feature demonstrations of traditional skills and storytelling at the Indian Village of Ahwahnee (the interpretive village behind the Yosemite Museum).
- The gravesites of prominent Yosemite settlers and Indian families in the Yosemite Cemetery provide another glimpse into Yosemite history.

- The Museum Gallery also presents resident "Experience Your America" and rotating exhibits from the Yosemite Museum collection; its research library is open to the public and contains historic photographs and written documentation on all facets of Yosemite National Park.
- In the spring, summer, and fall, the Yosemite Art Center offers free outdoor art classes with visiting artists in a variety of media, and The Ansel Adams Gallery offers Yosemite-related photography exhibits as well as photography walks and workshops.
- The Yosemite Association offers day hikes and multi-day educational adventures throughout the park. Many courses are offered for college credit.
- In addition, various individuals and tour guide operators are granted permits to provide interpretive and other outdoor adventure trips in the park.

Interpretive wayside exhibits are located on trails, at important features, and at roadside turnouts throughout Yosemite Valley. The Sierra Club leads interpretive walks in coordination with the National Park Service (many of which are geared especially for children), and operates the LeConte Memorial Lodge, a historic structure that houses exhibits and a library. The Nature Center at Happy Isles provides hands-on exhibits for children and adults. The Pioneer Yosemite History Center at Wawona is a collection of historic buildings relocated from other areas of the park that is used to interpret the early history of Yosemite's settlers and evolution of the park preservation idea. A living history program is offered in the summer and an overnight environmental education program for school groups is provided each spring.

Visitor Services

Camping in the Wilderness

The main stem of the Merced River provides some of the most popular camping opportunities in Yosemite's wilderness. As much as 20% of wilderness use originates from the John Muir Trailhead at Happy Isles. The majority of the backcountry wilderness camping occurs in the designated campgrounds at Little Yosemite Valley, Moraine Dome Campground, and the Merced Lake Backpackers Campgrounds. The National Park Service allows for significant dispersed camping within the river corridor. Users must comply with backcountry permit and leave-no-trace conditions, and generally must camp at least 100 feet from any water source and at least 4 miles from populated areas, except in the Designated Overnight zones, where they must camp in the campgrounds listed above. In addition, wilderness campers are encouraged to use existing fire rings and campsites. These campgrounds were established to concentrate high levels of use and minimize potential impacts.

Camping in Developed Areas

There are many locations in the park to camp in designated, frontcountry campgrounds with amenities such as restroom facilities with flush toilets and running water, and trash and recycling collection. Campgrounds within the main stem and South Fork of the Merced River corridor include Upper Pines, Lower Pines, North Pines, and Camp 4 in Yosemite Valley, and Wawona Campground in Wawona. There are no designated campgrounds in the Merced River gorge or El Portal.

Upper Pines Campground

Located in east Yosemite Valley, Upper Pines has 240 sites. The 10 restrooms in the campground are connected to the Yosemite Valley sewer collection system. A recreational vehicle (RV) dump station is located at the entrance to Upper Pines Campground.

Lower Pines Campground
Located in the east Valley to the west of Upper Pines, Lower Pines has 78 sites. The three restrooms in the campground are connected to the Yosemite Valley sewer collection system.

North Pines Campground
Located in the east Valley to the north of Lower Pines across the Merced River, North Pines has 86 sites. The four restrooms in the campground are connected to the Yosemite Valley sewer collection system.

Camp 4
Located in the west Valley to the north of the Yosemite Lodge, Camp 4 has 37 sites. The one restroom facility in the campground is connected to the Yosemite Valley sewer collection system.

Backpacker's Campground
Located to the north of North Pines (across Tenaya Creek), Backpacker's Campground has 30 sites and allows only visitors with wilderness permits to stay, either the day prior to their departure into the Wilderness or the evening of their return from the Wilderness. The one restroom facility is connected to the Yosemite Valley sewer collection system.

Yellow Pine Administrative Campground
Located to the west of Sentinel Beach Picnic Area, Yellow Pine serves as the primary volunteer campground for National Park Service and park partner volunteers, and contains four group sites. The two restroom facilities are vault toilets that are not connected to the Yosemite Valley sewer collection system.

Wawona Campground
Located northwest of the Wawona Hotel and Golf Course along the South Fork of the Merced River, the Wawona Campground has 99 sites. The six restroom facilities in the campground are connected to a septic system that is not part of the Wawona sewer collection system.

About 27% of parties arriving via private vehicle in the summer of 1990 and 1991 reported camping while in the park. Of these, about 15% were RV users. There have been slight decreases in tent camping and slight increases in RV camping in other seasons at Wawona Campground (Gramann 1992).

About 37,000 reservations are made for Valley campgrounds each year, of which roughly 33,000 are for dates between May and September.

Overnight Lodging Accommodations
Overnight lodging is available in Yosemite Valley at four concessioner-operated facilities: Yosemite Lodge, Housekeeping Camp, Curry Village, and The Ahwahnee. Concessioner-operated lodging is also available in Wawona at the historic Wawona Hotel. In addition, private lodging accommodations available within the corridor consist of the Yosemite View Lodge in El Portal and many independently owned, small-scale operations in Wawona. Lodging is also available to wilderness visitors in the Merced River corridor at the Merced Lake High Sierra Camp, a potential addition to the Yosemite Wilderness.

During the summer, lodging rooms and campsites in Yosemite Valley are 100% occupied on weekends and on most weekdays. In the Valley, a total of 1,262 lodging units provide a range of lodging accommodations.

Yosemite Lodge

Yosemite Lodge, an area of about 40 acres, contains 245 motel and cottage units. (Pine and Oak Cottages as well as cabins with and without baths that were damaged by the January 1997 flood have been removed.) In addition, there is a main lodge and registration center, two restaurants and a cafeteria, a bar and lounge, a gift and general merchandise store, a specialty gift shop, bike rental, swimming pool, and postal station.

Housekeeping Camp

Currently 266 units are available for use by visitors at Housekeeping Camp. Each unit (one-half of a duplex structure) can accommodate 6 people, with a total of 12 people per structure. Food preparation is allowed in Housekeeping Camp, thereby increasing its popularity with visitors. Also available in the complex are a small camp store, a laundry, and a shower facility.

Curry Village

The Historic District at Curry Village, an area of about 50 acres, offers a total of 628 units, including cabins with and without private baths, tent cabins, and rooms in Stoneman Lodge. Food service is available in the cafeteria and from fast-food outlets. Other facilities include a grocery and gift shop, a swimming pool, a post office, a mountain sport shop for camping supplies and equipment, concessioner stable operations, and information and registration buildings. An ice rink operates in the winter, and raft and bicycle rentals are provided at the same location in the summer.

The Ahwahnee

The Ahwahnee, a 12-acre National Historic Landmark, provides 123 deluxe hotel rooms and cottages. Visitor services include a dining room, a snack shop, a gift shop, and a bar and lounge.

Wawona Hotel

The historic Wawona Hotel provides 104 hotel rooms. Visitor services include a dining room and lounge, a golf shop and snack bar, a swimming pool, and a tennis court. On the grounds is the historic Thomas Hill's Studio, which is operated by the National Park Service in summer months and functions as a Wawona Information Station.

Merced Lake High Sierra Camp

Of the five High Sierra Camps in Yosemite National Park, the Merced Lake High Sierra Camp is the largest and the most remote in terms of road access.[18] It is located on the east end of Merced Lake at 7,150 feet and has a capacity to serve up to 150 guests. Its water source is the Merced River. The Merced Lake High Sierra Camp is open only during the summer months, with opening and closing dates dependent on weather conditions. While many guests have returned here year after year, most guests are first-time visitors to the camp as well as to the wilderness.

Some overnight visitors arrive via stock from other High Sierra Camps. Twenty-two tents are located on site, each of which can accommodate two to four people. Two of these tents are used

[18] In 1984, the High Sierra Camps were designated as potential additions to the Yosemite Wilderness under the California Wilderness Act. This act mandates that "lands designated as potential wilderness additions shall be managed by the Secretary in so far as practicable as wilderness until such time as said lands are designated as Wilderness."

to house employees, and one is set aside for wranglers traveling with stock. Showers and flush toilets are available, and a dining hall accommodates 70 people. The camp also serves meals to backpackers who are passing through. All refuse is packed out by stock, and solids from the septic system are flown out by helicopter. Helicopters are also used to transport certain supplies and to respond to medical emergencies.

Food, Retail, and Services

While in the Valley, about 35% of visitors arriving in the park via private vehicle eat at a sit-down restaurant, 30% eat at a fast-food establishment, 30% buy groceries, 15% purchase books, 30% shop for souvenirs, and 15% shop for clothes. For bus passengers, these percentages all increase, with the exception of grocery shopping (Gramann 1992).

Yosemite Valley

Yosemite Village, which encompasses approximately 90 acres, is considered the central location for day-visitor services in Yosemite Valley. Many facilities are located at this site, including the Yosemite Valley Visitor Center, the Yosemite Museum and Research Library, the Wilderness Center, the main Yosemite National Park U.S. Post Office, the Ansel Adams Gallery, the Yosemite Art Activity Center, Degnan's Deli and gift shop, the Village Store complex, Housekeeping store, an ATM and check cashing facility, and a concessioner garage that is open to visitors. In addition, National Park Service administrative offices, concessioner headquarters, the U.S. Magistrate's Office, and concessioner employee housing are located in Yosemite Village.

A medical and dental clinic is located in the northeast end of Yosemite Village, although it is outside of the river corridor. The clinic provides general medical/dental and emergency services to visitors, employees, and residents. It also operates an ambulance to respond to medical emergencies throughout the park.

The Yosemite Lodge, Curry Village, and The Ahwahnee provide food and retail services. A shower and a store are located at Housekeeping Camp, and a snack stand is located at Happy Isles.

El Portal Administrative Site

There are limited visitor services in El Portal, consisting of a post office, a small grocery store, and a gas station; other visitor services are provided on private land.

Wawona

Similar to El Portal, the limited visitor services in Wawona within the river corridor include the Wawona Campground, the Wawona Hotel and Golf Course, a gas station and grocery store, the Wawona stables, U.S. Post Office, and the Pioneer Yosemite History Center. Other visitor services are available on private lands, such as cabin rentals and a small grocery store.

Wilderness Experience

The Yosemite Wilderness offers an escape from humanmade structures, crowds, artificial light, and noise (with the exception of planes overhead), and allows visitors to experience solitude, natural quiet, and spectacular scenery. The vast wilderness also allows visitors to explore and discover the incredible natural beauty of the many geologic features, tributaries, and lakes of the Merced River basin, and the many species of plants and animals contained within. Many visitors find that they can hike for considerable lengths of time without encountering other people in the

wilderness. The remote areas of the wilderness provide outstanding opportunities for solitude and a primitive and unconfined type of recreation. This is the basis of a wilderness experience.

The Wilderness

The Yosemite Wilderness was established by the California Wilderness Act of 1984. The area is generally defined by the Tuolumne River and Merced River basins, with lands ranging in elevation from 2,900 feet below Hetch Hetchy to 13,114 feet at the summit of Mt. Lyell. Of Yosemite National Park's 761,266 total acres, 704,624 acres (95%) have been designated Wilderness, and another 927 acres (0.1%) are potential additions to the Yosemite Wilderness. Glacial activity reformed the landscape, carving as many as 350 lakes, along with hundreds of ponds and wetland areas. The wilderness also includes hundreds of miles of intermittent streams that drain into the Tuolumne and Merced Rivers.

The Yosemite Wilderness occurs in two large blocks north and south of the Tioga Road. National Park Service Visitor Protection staff who work in the Wilderness District are responsible for backcountry patrols, which include checking backcountry permits, monitoring the number of backcountry campsites and their condition, informing backcountry hikers of wilderness regulations, providing emergency medical services and aid in search and rescue efforts, and generally providing information about the park's natural and cultural resources. Wilderness District employees work primarily to provide service to wilderness visitors and to protect park resources and patrol the wilderness area on foot, skis, or horseback.

Wilderness Access

The wilderness area is generally accessed by almost 800 miles of marked and maintained backcountry trails throughout the park. Overall use and access to the wilderness within the Merced River corridor is controlled by trailhead quotas implemented through a wilderness permit system administered by the National Park Service. Trailhead quotas have been established to reduce resource impacts and to increase opportunities for solitude. In addition to the trailhead quotas, the park monitors campsite and trail impacts under the Wilderness Impact Management System, which began in the 1970s. In comparison to the developed areas, visitor use is significantly less in wilderness areas.

Wilderness use statistics have been calculated for several years. Most visitors to the wilderness were from California (78%), with 18.6% from out of state, 0.4% from Canada, and 3% from other countries (NPS 1993e). Most wilderness permit holders' trips originate at one of the many trailheads in the Valley. For 2003 and 2004, the average group size was 2.95 people. Of the 13,415 permits issued in 2003, about 95% (12,544) were for groups of less than six. Only 362 permits (4%) were issued for groups greater than nine people. The average stay for groups in the wilderness is approximately 2.5 days.

Use of the Yosemite Wilderness has decreased over the last few years and appears to be linked primarily to environmental conditions. In 1996, 49,735 people obtained wilderness use permits for a total of 143,801 nights. These figures decreased to 45,948 and 114,133, respectively, the following year. In 1996, the snowpack was 110% of average, three significant rockfalls closed major trails, and the largest fire in Yosemite's history burned over 62,000 acres of wilderness in the late summer. In 1997, the January flooding of the Valley resulted in a three-month closure of the entire park. The following year (1998), the snowpack was 160% of average; the melt came late in the season and was very gradual. Many hikers were deterred by snow-covered trails; use figures

(drawn from wilderness permits only) dropped to 38,151, while the number of nights decreased to 91,821.

Multiple trails originate from the Yosemite Valley floor and lead to the wilderness. Backpackers often begin their hikes into the wilderness along the Mist and John Muir Trails, which parallel the Merced River and Vernal and Nevada Falls. Wilderness travelers also use the Yosemite Falls Trail on the Valley's northern rim, and the Four Mile Trail on the Valley's south rim, which provides access to Glacier Point. Approximately 6% of summer visitors backpack during their visit to Yosemite, and up to 25% of overnight users initiate trips into Yosemite's wilderness and beyond from the Valley floor. Additional trails skirt the perimeter of Yosemite Valley above the Valley floor. Hikers on these trails frequently value the solitude and greater number of pristine and inspiring views that are available in the wilderness. The human-built environment may still dominate many views into the Valley from the rim trails; however, backpackers who continue into the upper reaches of the river corridor will find minimal development. The ratio of day visitors to wilderness visitors begins to change as trails increase in elevation. Of the trails in the Merced River corridor that originate in the Valley, the Vernal/Nevada Falls trails are most commonly used to access the wilderness. Access to the South Fork high country is most often from adjacent National Forest land or from Wawona.

Camping is generally allowed anywhere in the wilderness provided it is at least 100 feet from any waterbody. Camping is discouraged in sensitive areas (i.e., meadows, other areas with fragile vegetation) or on the top of geologic features, especially during inclement weather. In some areas, there are no-camping or no-fire zones. No-camping zones include all areas within one mile of public access roads and within four trail-miles of Yosemite Valley, Tuolumne Meadows, Wawona, and Hetch Hetchy. Campfires are generally allowed below 9,600 feet, although restrictions exist in certain areas (due to the availability of dead and downed wood). Toilets and food storage devices have been installed in most designated campgrounds, with the exception of Moraine Dome. The control of human waste is among the most critical management issues in the wilderness. Other practices designed to minimize or eliminate impacts are either recommended or required as part of wilderness permit regulations.

The High Sierra Camps are among the areas legislated as *potential Wilderness additions* in the California Wilderness Act. This designation was applied to those areas in wilderness where an existing use precluded full Wilderness designation. The U.S. Congress anticipated that if the operation of such facilities were terminated, the site would be restored and the area designated as Wilderness.

The Yosemite Wilderness has 69 trailheads starting within the park, and 48 trailheads on U.S. Forest Service lands, that together provide access to almost 800 miles of marked trails. These trails are maintained seasonally by National Park Service backcountry trail crews with the help of the California Conservation Corps and Youth Conservation Corps members. The development of volunteer or social trails continues to be problematic, as these trails lead to trampling of vegetation and cause erosion.

Most marked and maintained wilderness trails are open to private and commercial stock use. However, stock are generally not allowed more than one-quarter mile off marked and maintained trails, and only then for feeding and watering. Hikers in groups of eight persons or less are allowed to use cross-country routes and are encouraged to practice minimum-impact techniques.

Social Resources

Land Use

Land Management Zones

The 1980 *General Management Plan* divided land within Yosemite National Park into four primary zones and six subzones based on management objectives, resource significance, and legislative constraints. The *General Management Plan* zoning is broad-based and was meant to give general guidance for future implementation of specific plans.

Management zones for the Merced River corridor were developed and adopted in the Merced River Plan. The zones were developed to protect and enhance the Outstandingly Remarkable Values within each river segment. Specifically, the Merced River Plan places an emphasis on integrating protection and enhancement of natural and cultural resources identified as Outstandingly Remarkable Values with the protection and enhancement of recreation Outstandingly Remarkable Values. The management zones describe appropriate types and levels of development and use in each area.

The management zones for the Merced River corridor fall into three general categories: (1) Wilderness zones, (2) Diverse Visitor Experience zones, and (3) Developed zones. Within each of these three categories, individual subzones provide for certain levels and types of visitor experiences, resource conditions, facilities, and uses.

The management zones are organized along a continuum of allowed impact intensity. Wilderness zones generally prescribe the least amount and intensity of visitor use and facility development, leaving the landscape mostly natural and protecting the values reflected in the Wilderness segment Outstandingly Remarkable Values. Diverse Visitor Experience zones allow for a low-to-high range of visitor use and low-to-moderate range of facility development. While emphasizing protection and enhancement of natural and cultural resource-related Outstandingly Remarkable Values, they provide the diverse recreational opportunities also identified as Outstandingly Remarkable Values. Developed zones occur in limited areas in scenic and recreation Outstandingly Remarkable Values. These zones allow for the most intensive visitor use and/or more developed facilities. The developed areas encourage concentration of higher-impact activities in areas better able to withstand heavy use or at locations that are already developed, thereby enabling better protection of Outstandingly Remarkable Values in other areas.

Each zone prescribes the maximum level of activities and facilities. In practice, lower levels of visitor use and facilities may be provided than are described in the zoning prescriptions. For example, areas zoned for overnight lodging may be used for less-developed activities such as walk-in camping or could include protected natural areas. The management zones, which are delineated on the zoning maps, allow future managers to direct development within the management zone. Within a given management zone, some areas may be used for higher-intensity facilities or activities, while other areas within the same management zone are left natural and open. Management zoning provides overall guidance for decision-making over the long term. Zoning does not attempt to predict or prescribe every conceivable use or facility decision.

Category 1: Wilderness Zones

There are four management zones within the Wilderness Zone Category:

- Zone 1A: Untrailed
- Zone 1B: Trailed Travel
- Zone 1C: Heavy Use Trail
- Zone 1D: Designated Overnight

Approximately 34 miles of the main stem and 19 miles of the South Fork of the Merced Wild and Scenic River corridors flow through designated Wilderness and are managed under the guidance and requirements of the 1964 Wilderness Act and the California Wilderness Act of 1984. As such, these segments are managed to preserve an environment in which the natural world, along with the processes and events that shape it, are largely unchanged by human use, and to allow for various forms of exploration in an environment primarily free of modification. Access limits are imposed to control human-induced change, and management actions such as education, regulation, and restoration will occur as appropriate to protect natural and cultural resources and designated Outstandingly Remarkable Values. Visitor use and enjoyment is encouraged as long as such use does not result in levels of human impact that compromise wilderness and river values. Visitors encounter a variety of opportunities for solitude, primitive and unconfined recreation, and physical challenge. The presence of park staff is limited and focused on locations of heavy use such as camping areas.

The Wilderness zones are managed to protect the natural hydrologic and ecologic processes of the Merced River and its immediate environment. Other than trails and designated overnight areas, the Wilderness zones exhibit natural conditions, with high-quality riparian, meadow, and aquatic habitats. There is high diversity of native plant and animal species and relatively minimal disturbance and human impact in these zones. The Merced River remains free of impoundments, and natural processes, such as deposits of woody debris into the river, occur without human interference. Water quality in the area is very high.

The Wilderness zones emphasize the protection of natural resource Outstandingly Remarkable Values, such as biological, geologic, and hydrologic values. By limiting use and development, the Wilderness zones also protect and enhance cultural, scenic, and recreation Outstandingly Remarkable Values, which identify prehistoric sites, spectacular views, and opportunities for solitude and primitive recreation among the important values of the Wilderness segments of the Merced River corridor.

Zone 1A–Untrailed. The Untrailed zone is primarily free of signs of modern human presence, with extremely high opportunity for solitude due to the remoteness of the area and lack of trails. Management activities in this zone are minimal, thus allowing resources and natural processes to exist in their most pristine state. The Untrailed zone is managed with very low tolerance for resource degradation from visitor use, and management action can be taken to change visitor use patterns if such degradation occurs.

Visitor experience is primarily based on hiking through often difficult terrain. There are no formal trails or directional markers in this zone. There are few, if any, human encounters, and wilderness skills and knowledge are necessary to safely navigate these areas. Natural and cultural resources can be observed, but there are no formal interpretation or visitor accommodations.

This area provides substantial opportunities for scientific study of natural processes in undisturbed conditions.

The difficulty of access characterized by the Untrailed zone serves to limit visitor use, thereby protecting and enhancing biological, geologic processes/conditions, hydrologic processes, cultural, scenic, and scientific Outstandingly Remarkable Values. Opportunities for solitude, primitive and unconfined recreation, and enjoyment of natural river sounds are among the recreation Outstandingly Remarkable Values prominent in this zone.

Zone 1B–Trailed Travel. The Trailed Travel zone is characterized by light to moderate use focused on marked and maintained trails. Opportunities for solitude range from moderate to high. There is some management presence to accommodate resource protection and visitor use. The Trailed Travel zone is managed with very low tolerance for resource degradation from visitor use, and management action can be taken to change visitor use patterns if such degradation occurs.

Most visitors experience this area by hiking, although a small percentage of visitors traditionally use pack animals and can continue to do so. Visitor encounters are infrequent, except in areas common for campsites and at key trail junctions. While there are opportunities for challenge and adventure, the well-marked and maintained trails allow visitors with a diversity of hiking abilities to experience the wilderness.

Through limitations on development and access, the Trailed Travel zone protects and enhances biological, geologic processes/conditions, hydrologic processes, cultural, scenic, and scientific Outstandingly Remarkable Values. Opportunities for solitude, primitive and unconfined recreation, and enjoyment of natural river sounds are among the recreation Outstandingly Remarkable Values prominent in this zone.

Zone 1C–Heavy Use Trail. The Heavy Use Trail zone is characterized by high levels of use on marked and maintained trails and associated areas. Due to high use levels, opportunities for solitude at peak times are more limited on trails in this area. In some locations, sections of paved or rocked trails and fencing direct visitor use away from sensitive ecosystems. The Heavy Use Trail zone is managed with a low tolerance for resource degradation from visitor use, and management action can be taken to redirect use if such degradation occurs.

Most visitors experience this area by hiking, although a small percentage of visitors have traditionally used pack animals and can continue to do so. Encounters with other visitors can be frequent during certain periods of the day or at key trail junctions, vistas, and other high use locations. The well-marked and maintained trails allow for visitors with a diversity of hiking abilities to experience the wilderness.

Through limitations on development, the Heavy Use Trail zone protects and enhances biological, geologic processes/conditions, hydrologic processes, cultural, scenic, and scientific Outstandingly Remarkable Values. While opportunities for solitude are lower than in the less-traveled Untrailed and Trailed Travel zones, this zone provides ready access to wilderness hiking and backpacking near the Merced River.

Zone 1D–Designated Overnight. The Designated Overnight zone is characterized by the heaviest overnight use of all areas of the Wilderness zones. Designated overnight areas are centered at destination locations with facilities for resource protection and visitor use, specifically at the

Little Yosemite Valley Campground, Moraine Dome Campground, Merced Lake Campground, and the Merced Lake High Sierra Camp (a potential Wilderness addition). Opportunities for solitude range from low to moderate, depending on the season. Social interaction is common. The presence of National Park Service staff is moderate to high in order to prevent or mitigate most adverse impacts. The Designated Overnight zone is managed with a low tolerance for resource degradation due to visitor use. Facilities such as signs and fencing can be used to prevent unacceptable impacts. Campsites are located away from any sensitive natural or cultural areas, including meadows, streams, lakes, and historic and archeological sites, to minimize impacts.

Most visitors experience this area by hiking and/or staying overnight. Small percentages of visitors use pack animals and can continue to do so. Visitor encounters with others are frequent during much of the hiking season. The well-marked trails and facilities allow for diverse users to experience the wilderness.

The Designated Overnight zone concentrates visitor facilities in a localized area, thereby allowing for higher protection and enhancement of biological, geologic processes/conditions, hydrologic processes, cultural, scenic, and scientific Outstandingly Remarkable Values outside this zone. This zone also ensures that historic structures such as the High Sierra Camp can remain for continued use or for interpretive purposes. Signs, fencing, and other features can be used to direct visitors away from sensitive biological and cultural Outstandingly Remarkable Values, as necessary.

Category 2: Diverse Visitor Experience Zones

Four management zones are defined for the Diverse Visitor Experience management zone:

- Zone 2A: Open Space
- Zone 2A+: Undeveloped Open Space
- Zone 2B: Discovery
- Zone 2C: Day Use
- Zone 2D: Attraction

The Merced River corridor serves as an important recreational resource, providing opportunities for nature study, hiking, picnicking, swimming, fishing, and other activities for many of the nearly 4 million people who visit Yosemite National Park each year. The Merced River corridor also serves as a continuous visual element of the landscape, setting off significant features such as waterfalls, granite domes, and peaks.

Natural resource management in these zones strives to protect and enhance the natural functioning of ecological and hydrological systems while accommodating moderate levels of visitor use. The Category 2 zones are designed to protect and enhance biological, hydrologic processes, geologic processes/conditions, scenic, cultural, and scientific Outstandingly Remarkable Values, as well as recreation Outstandingly Remarkable Values. This is achieved by maintaining, wherever possible, the integrity of an overall ecological unit (such as a meadow, woodland, or wetland), while allowing for some human alteration of the landscape. Riparian, aquatic, and meadow communities in the river corridor play a particularly critical role in a variety of ecosystem processes and also contribute to the cultural landscape. Restoration of the ecological and hydrological systems in these areas focuses on enhancing the diversity and stability of natural functions. Resource degradation is minimized by the careful design and siting of

facilities that direct visitor and administrative activities to locations able to withstand heavy use. Monitoring of visitor impacts on natural and cultural resources helps ensure adaptive and timely management responses to potential resource degradation.

The Diverse Visitor Experience zones are managed to protect and enhance the hydrologic and ecologic processes of the Merced River and its immediate environment. Riparian areas and meadows remain largely intact and support diversity of native vegetation and wildlife species. However, localized areas can be developed with trails, roads, and parking areas and a greater amount of resource protection features (e.g., fencing and boardwalks) to allow for visitor access. Higher levels of resource impacts, such as trampling and soil erosion, and more resource protection features might be expected in limited areas within the Day Use and Attraction zones (described below) to accommodate large numbers of visitors. The free flow of the river remains primarily unimpeded. Water quality in the area is high.

The Diverse Visitor Experience zones protect cultural Outstandingly Remarkable Values, such as historic structures and prehistoric sites, by directing visitor access to areas able to withstand heavy use. Restoration of natural features such as wetlands and meadows will also restore the cultural landscape. Interpretation of historic resources is allowed in these zones to provide visitor education opportunities.

The Category 2 zones also protect and enhance recreation Outstandingly Remarkable Values, which emphasize the value of providing diverse recreational opportunities for visitors. The lower-intensity zones—Open Space and Discovery—provide opportunities for quiet enjoyment of the river corridor, while the Day Use and Attraction zones accommodate higher levels of use at park destinations.

2A–Open Space. The Open Space zone is characterized by relatively undisturbed natural areas that receive only incidental or casual use. Maintenance of these conditions allows for the protection and enhancement of the biological, hydrologic processes, scenic, cultural, and scientific Outstandingly Remarkable Values while providing access to diverse visitor activities.

The visitor experience in this zone is self-directed, with few visitor or management encounters, which contributes to the diversity of experiences specified in the recreation Outstandingly Remarkable Value. The Open Space zone is managed with very low tolerance for resource degradation from visitor use to protect and enhance biological, hydrologic processes, scenic, cultural, and scientific Outstandingly Remarkable Values. Visitation levels may be controlled by parking limitations and by the lack of shuttle bus stops. These limits on use and facilities allow natural areas to remain relatively unimpaired and receive continued protection, restoration, and enhancement.

The Open Space zone has limited trails and interpretive facilities. These direct visitors away from hazardous areas and sensitive Outstandingly Remarkable Values, such as unique wetlands, and promote understanding of natural processes. These areas are generally quiet with limited facilities. The areas can be relatively easy to access or require considerable walking and skill to access. Though not directly accessible by vehicles or from parking areas, noise from nearby vehicles could affect visitor experiences in this zone.

Resource protection activities in this zone include preservation of cultural resources and restoration of natural processes impacted by contemporary development, restoration of natural

flood cycles and river channel dynamics to sustain native plant and wildlife species, and use of fire management practices called for in the park's *Fire Management Plan* (NPS 2004b) to enhance biological and hydrologic processes Outstandingly Remarkable Values. This zone also encourages the protection and enhancement of cultural Outstandingly Remarkable Values, including archeological sites, by limiting development and access. Restoration of natural resources such as wetlands and meadows also contributes to the restoration of the cultural landscape.

2A$^+$–Undeveloped Open Space. The Undeveloped Open Space zone is managed as de facto wilderness, primarily free from signs of human presence due to its inaccessibility. This zone protects those areas outside designated Wilderness that have limited or no trail access, such as the area west of the Wawona Campground along the South Fork. While Undeveloped Open Space areas remain in pristine condition, visitors can experience some human influence due to noise from nearby roads. Typical activities include hiking, rock climbing, swimming, nature study, and fishing. Access requires considerable effort because of lack of trails.

This zone is managed in a similar manner as the Untrailed zone (1A) by protecting and enhancing biological, geologic processes/conditions, hydrologic processes, cultural, scenic, and scientific Outstandingly Remarkable Values through limitations on development and access.

2B–Discovery. The Discovery zone is characterized by relatively quiet natural areas where visitor encounters are low to moderate, which contribute to the diversity of experiences specified in the recreation Outstandingly Remarkable Value. However, during high-use periods, some concentrated use and more frequent visitor encounters can occur on trails that link destination points through the Discovery zone. The Discovery zone is managed with low tolerance for resource degradation from visitor use, thus emphasizing the protection and enhancement of biological, hydrologic processes, scenic, cultural, and scientific Outstandingly Remarkable Values. The zone also emphasizes low-intensity visitor uses, which contribute to the spectrum of river-related activities specified in the recreation Outstandingly Remarkable Values. Limits on use and facilities allows natural areas to remain relatively unimpaired when they are not close to one of the few access roads. Areas in the Discovery zone can be used by individuals or smaller, organized groups. Access to these areas can require a moderate level of physical exertion, although some locations would be served by an access road and parking turnouts.

Within the Discovery zone, visitors are likely to experience a variety of resources, including distant and close-range scenic views as well as opportunities to wade, swim, or fish in the river and to observe wildlife and plants. If resources begin to show an impact from the use levels, resource protection measures can be used, such as fencing and signs to direct travel from sensitive resources, well-marked trails and boardwalks, recycling and trash containers, relocation of shuttle bus stops in this or adjacent zones, or other measures as needed.

Resource protection activities in this zone include restoration of natural processes affected by past or current human use, restoration of natural flood cycles and river channel dynamics to sustain native plant and wildlife species, and use of fire management practices called for in the *Fire Management Plan* (NPS 2004b) to enhance biological and hydrologic processes Outstandingly Remarkable Values. This zone also encourages the protection and enhancement of cultural Outstandingly Remarkable Values, including archeological sites, by limiting development and access. Restoration of natural resources such as wetlands and meadows also contribute to the restoration of the cultural landscape.

2C–Day Use. The Day Use zone is intended to be applied to popular park destinations, where visitors could spend significant periods of time enjoying the park resources in a relatively accessible setting. The Day Use zone enhances opportunities for visitors to enjoy more intensive recreational activities near the Merced River and supports a range of active recreational opportunities such as swimming, picnicking, and rafting, which contributes to the diversity of experiences specified in the recreation Outstandingly Remarkable Value. Visitors can expect moderate to high numbers of encounters with other park users and crowding on certain peak days. Large groups can use these areas. Day Use areas may be accessible by automobile, shuttle bus, and bicycle, with interpretive trails or other marked trails leading to waterfalls, beaches, and scenic views. To accommodate heavier and more concentrated activity, facilities such as parking areas, restrooms, fencing of sensitive areas, picnic tables, and recycling and trash receptacles are allowed in this zone.

Resource protection activities in this zone are comparable to those described in management zones 2A and 2B. However, due to the larger volume of visitors, the Day Use zone is managed with moderate tolerance for resource degradation from visitor use in specified areas. To protect and enhance cultural, biological, and hydrologic processes Outstandingly Remarkable Values, more extensive resource protection measures may be needed to direct visitor use away from sensitive resources. Examples include boardwalks adjacent to meadows or fencing to prevent trampling and overuse. By encouraging higher visitor use in the Day Use zone, adjacent Open Space and Discovery zones experience the desired lower visitor use for these areas. Some Day Use areas also protect historic resources, such as continued use of the Wawona Golf Course.

2D–Attraction. The Attraction zone is applied to main park features that attract large numbers of visitors, such as viewing areas for Bridalveil Fall. Due to the high number of visitors, this zone is managed with moderate tolerance for resource degradation in specified areas, not to exceed established standards. The visitor experience in this zone is highly structured, with well-marked and often paved trails or other trails to guide visitors, which contributes to the diversity of experiences specified in the recreation Outstandingly Remarkable Value. Visitors can expect a high level of encounters with other visitors in these moderately to very busy areas. Attraction areas can be accessible by automobile, shuttle bus, bicycle, and/or trail.

To accommodate high visitor use, substantial facilities such as restrooms, parking lots, bus access and parking, and picnic tables can be provided at the entry point of the attraction area or another appropriate site. Facilities are concentrated within the attraction area to minimize the extent of development and impacts. As a result, many areas within an Attraction zone have a well-used trail but minimal developed uses away from the entry hub or access point. Trails can be paved, fenced, and well-signed to reduce potential resource impacts. Visitor use in sensitive areas is formalized and concentrated to avoid resource damage.

By encouraging higher visitor use in the Attraction zone, adjacent Open Space and Discovery zones experience the desired lower visitor use for these areas. This zone also ensures that visitors have the opportunity to enjoy the park's most popular features, some of which are designated scenic, recreation, or cultural Outstandingly Remarkable Values (e.g., views of granite domes or the Wawona Covered Bridge).

Category 3: Developed Zones

Three management zones are defined within the Developed zones:

- Zone 3A: Camping
- Zone 3B: Visitor Base and Lodging
- Zone 3C: Park Operations and Administration (includes day-visitor parking)

Carefully designed and located facilities are needed to meet the diverse needs of the many people who visit Yosemite National Park each year. The use of limited Developed zones provides sites for the facilities that enable the park to support its year-round visitor and employee populations and serve the needs of visitors. These include lodging, utilities, housing, and transportation facilities. Most of the Developed zones are located in areas that are currently, or that were previously, altered by development.

The purpose of the Developed zones is to direct high-impact activities and facilities to areas better able to withstand heavy use and/or already developed locations in order to further protect and enhance the hydrologic processes, biological, geologic processes/conditions, cultural, scenic, scientific, and recreation Outstandingly Remarkable Values in other parts of the corridor. The facilities allowed for in the Developed zones, such as campsites, lodging, day-visitor parking, operational facilities, and utilities are necessary to properly accommodate park visitors, many of whom are coming to experience the scenic, recreation, and other Outstandingly Remarkable Values of the Merced Wild and Scenic River.

While these zones can absorb the most concentrated visitor and administrative use, resource impacts are minimized through design and siting of facilities, and the application of mitigation and restoration measures. These measures can include temporary or permanent fencing to reduce or exclude use in sensitive resource areas, revegetation with native species, and/or the prevention of the establishment of non-native species. Visitor use is managed to reduce the potential impacts of concentrated use.

Higher levels of resource impacts (e.g., through the development of parking and other facilities) are tolerated in specified areas within the Developed zones. In development areas, with more users and types of uses, more site hardening and other management actions are needed in order to maintain riparian areas, meadows, archeological sites, and other resources. While high-quality riparian habitat and meadows are not found in the Developed zones, use in these zones is managed to prevent degradation or interference with the natural functions of adjacent zones. The free flow of the river remains primarily unimpeded, except for existing development such as historic bridges in Yosemite Valley and riprap along the El Portal Road.

3A–Camping. The Camping zone provides visitors with opportunities for both vehicle-access (including drive-to) camping and walk-in camping. Drive-to camping areas includes campsites with adjacent parking, thereby providing convenient access to various facilities. Support facilities such as picnic tables and restrooms are provided at camping areas. The Camping zone primarily supports the recreation Outstandingly Remarkable Values by ensuring access to diverse recreation activities near the Merced River. Most areas designated as Camping zones have been previously developed, including historic resources such as Camp 4, which are preserved under this zone. By concentrating relatively high-impact development in localized areas, this zone helps to protect and enhance natural and cultural Outstandingly Remarkable Values in the zone as a whole and in other parts of the river corridor.

Walk-in camping provides an opportunity for visitors to camp away from vehicles but retain access to facilities such as restrooms, water, and picnic tables. Campsites are accessed by relatively

short and well-marked trails with directional and informational signs. In walk-in camping areas, visitors have the opportunity to engage more directly with the natural environment of the Merced River corridor without the visual impacts of entry roads, parking lots, vehicles, or other major facilities.

While the Camping zone allows for both drive-to and walk-in camping, the less-intensive walk-in camping is directed to more sensitive areas (e.g., North Pines), while drive-to camping is directed to areas better able to withstand heavy use (e.g., Upper Pines). In both drive-to and walk-in camping areas, visitor encounters are moderate to high in the relatively dense clusters of campsites. The Camping zone is managed with moderate to high tolerance for resource impacts in localized areas. While a certain level of hardening for parking sites and trampling by campers is expected, use is directed away from sensitive areas. River access is provided via marked and potentially hardened trails to direct visitors to areas better able to withstand heavy use, such as annually (or regularly) flooded gravel bars.

3B–Visitor Base and Lodging. The Visitor Base and Lodging zone includes areas developed for visitor overnight use and support facilities, and services such as orientation facilities, eating establishments, gift shops, and equipment rental. Most areas designated as Visitor Base and Lodging zones have been previously developed, including historic resources such as The Ahwahnee, Wawona Hotel, and LeConte Memorial Lodge, which are preserved under this zone. The visitor can expect a bustling atmosphere in these areas, with high incidence of visitor encounters during peak-use times. Facilities and lodging areas are easily accessible by shuttle bus, automobile, trail, and bicycle.

With its relatively intense level of development, a higher degree of resource impacts may be tolerated in localized areas within the Visitor Base and Lodging zone. Future projects in this zone will be designed to minimize the footprint of developed areas and to protect and restore adjacent natural and cultural resources. River access is provided via marked and potentially hardened trails to direct visitors to areas most able to withstand heavy use, such as annually (or regularly) flooded gravel bars. Structures such as fences, boardwalks, or walls can be provided to reduce impacts on riparian areas from casual river access generated by nearby lodging facilities.

The Visitor Base and Lodging zone primarily supports recreation Outstandingly Remarkable Values by providing for visitor uses facilitated by development such as visitor centers, museums, and lodging, which enable visitors to access the park and learn about its natural and cultural resources. Additionally, by concentrating relatively high-impact development in localized areas, this zone helps to protect and enhance natural and cultural Outstandingly Remarkable Values in the zone as a whole and in other parts of the river corridor.

3C–Park Operations and Administration. The limited use of the Park Operations and Administration zone provides locations for facilities that support the efficient functioning of the park. Many areas designated as 3C have been previously developed, including historic resources such as the Chapel in Yosemite Valley, which is preserved under this zone. The Park Operations and Administration zone also provides opportunities for the management of private vehicles and public transit in the park, as well as interpretive centers that help visitors learn about the park's natural and cultural resources. Visitor use and experience of these zones is limited. These areas are relatively busy, with heavy impacts from vehicles, and are managed with a high tolerance for resource impacts in localized areas. New facilities will use sustainable design and construction

principles to protect adjacent natural and cultural resources and would be subject to the criteria and considerations.

The Park Operations and Administration zone protects and enhances the recreation Outstandingly Remarkable Value of the Merced River by providing space for necessary park operations as well as for day-visitor parking. At the same time, centralized operations (including facilities and utilities) make it possible to keep development out of more sensitive segments and zones, thereby protecting those areas from possible impacts to their Outstandingly Remarkable Values.

River Protection Overlay. In addition to the management zones described above, the Merced River Plan also adopted a River Protection Overlay adjacent to the Merced River (NPS 2000c). The River Protection Overlay[19] is intended to apply the requirements of the Wild and Scenic Rivers Act, including the protection and enhancement of the Outstandingly Remarkable Values and the preservation of the free-flowing condition of the river, at a higher standard than that of the underlying management zones.

The areas immediately adjacent to the river channel, along with the river channel itself, are particularly important to the health and proper functioning of the river ecosystem. These areas allow for the main channel to link with backwater areas, tributaries, and groundwater systems; provide for increased channel diversity; and contribute sources of needed nutrients and woody debris to the river. In most circumstances, trees or other large woody debris falling into the river are recognized as part of the natural processes and will be left in the river to aid in the recovery of aquatic and riparian habitat. Additionally, the areas immediately adjacent to the river channel can help protect surrounding development from potential flood damage and can be used to filter runoff water draining into the river.

Rivers are dynamic systems. As the movement of the river channel shifts over time, so would the specific areas included within the River Protection Overlay. Regardless of the location of the water's edge on any given day throughout the year, the River Protection Overlay is measured from the ordinary high water mark, as defined by the U.S. Army Corps of Engineers in 33 CFR 328.3:

> The line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

The width of the River Protection Overlay is determined by site topography and vegetation and includes the area needed to encompass riparian and adjacent upland vegetation and habitat. In areas above 3,800 feet, the River Protection Overlay includes the river channel and extends 150 feet on both sides of the river measured from the ordinary high water mark; and in areas below 3,800 feet includes 100 feet on both sides of the river measured from the ordinary high water mark. (On the main stem of the Merced River, the 3,800-foot elevation point occurs near the Cascades Powerhouse. On the South Fork, the 3,800-foot elevation point occurs approximately 1 mile downstream of Squirrel Creek.) Generally, a wider band is required along the river in the

[19] National Park Service staff developed the technical framework for the River Protection Overlay in a series of internal workshops beginning in 1993 and continuing into 1999. Staff reviewed technical studies by various agencies, including the U.S. Forest Service and the U.S. Fish and Wildlife Service. Many of these studies confirmed the importance of ensuring the contribution of inputs to the river from upland vegetation as a guide for setting the width of riparian protection areas.

flatter, open valleys, while a narrower buffer provides adequate protection in the steeper, V-shaped river gorges of the lower elevations. This transition occurs approximately at the 3,800-foot elevation mark in the Merced River gorge below Yosemite Valley on the main stem of the Merced River, and downstream of Wawona on the South Fork. Approximately 70 miles of the river has a 150-foot River Protection Overlay, including Yosemite Valley and Wawona. Approximately 11 miles of the river has a 100-foot River Protection Overlay, including the El Portal Administrative Site.

Projects occurring within the bed or banks of the river and that affect the free-flowing condition of the river are considered water resources projects under the Wild and Scenic Rivers Act and must also go through a Section 7 determination process. Within the River Protection Overlay, future actions shall be consistent with the following conditions:

1) Nonessential facilities (including, but not limited to, riprap, levees, diversion walls, impoundments, bridges, bridge abutments, roads, campsites, buildings, utilities, and other structures) should not be located in the River Protection Overlay, except when they meet the following two criteria: (a) where required for access to or across the river, for health and safety, or for the maintenance of historic properties; and (b) where it is impractical to locate them outside the River Protection Overlay.

   Existing facilities meeting these criteria may remain, and they may be replaced, repaired, or relocated within the River Protection Overlay, but only if the replacement, repair, or relocation does not directly and adversely affect the Outstandingly Remarkable Values.

   New facilities and development may be constructed in the River Protection Overlay only when meeting these criteria and when located where they do not materially impair the natural function of the river, impede linkages to tributary inflow and backwater areas, or disrupt contribution of woody debris to the river, and where they do not have a direct and adverse impact on the Outstandingly Remarkable Values.

2) Actions within the bed and banks of the river to construct, replace, repair, or relocate essential facilities (i.e., primary roads and bridges, wastewater collection and treatment, domestic water supply, electrical distribution, and similar facilities required to keep the park operating) and facilities that directly protect and enhance the Outstandingly Remarkable Values (e.g., raft launch facilities to preserve the spectrum of recreational experiences and to concentrate use in a hardened area) may be permitted, provided that:

   - Project design minimizes impacts to the free-flowing condition of the river, interference with linkages to tributary inflow and backwater areas, and disruption of contribution of woody debris to the river.
   - The project incorporates mitigation measures to avoid or reduce impacts.

3) Facilities and development covered by items 1 or 2, above, that occur within the bed or banks of the river and that affect the free-flowing condition of the river must also comply with Section 7 of the Wild and Scenic Rivers Act.

4) Other existing facilities that are not addressed by items 1 or 2 should be removed, and must be removed at the earliest practicable opportunity when major rehabilitation is needed or when a facility is no longer of use. Facilities proposed in the River Protection Overlay must

meet the stringent requirements of its prescriptions. However, existing facilities in the River Protection Overlay are allowed to remain even if they do not conform with prescriptions. The National Park Service may address an existing, nonconforming facility in the River Protection Overlay at any time, such as through a planning effort.

Existing Land Uses

Land use within and adjacent to the Merced River corridor through Yosemite National Park is primarily publicly managed parkland, with some areas of private ownership within and adjacent to the Merced River corridor. The gross area within the park's authorized boundary is 761,266 acres. This includes nonfederal ownership totaling 1,736 acres, of which approximately 10 acres are easements. There are 366 privately owned tracts within the park boundaries, totaling 233 acres, much of which is within the Merced River corridor in Wawona. Local governments manage 21 tracts within the park boundaries, totaling 1,502 acres.

The majority of land surrounding the park is publicly managed by the U.S. Forest Service, which administers four national forests that border the park: Stanislaus, Toiyabe, Inyo, and Sierra. These lands are managed for general forest, wilderness, and dispersed recreation use. The U.S. Forest Service and the Bureau of Land Management produced a management plan (USFS and BLM 1991b) for the portions of the Merced River designated as Wild and Scenic within their jurisdictions and are planning to update that plan in the future. The region surrounding the park includes four counties: Mariposa, Tuolumne, Madera, and Mono. Cooperative planning efforts between federal, state, and county agencies within the region have addressed critical natural, cultural, and recreational resource concerns and management policies. Yosemite management has worked with interagency groups to coordinate long-range planning activities with surrounding landowners and land management agencies.

The majority of land within Yosemite National Park is designated Wilderness. The main stem of the Merced River traverses wilderness from its headwaters to a point approximately one-half mile upstream of Nevada Fall, where the river enters Yosemite Valley. With the exception of the privately held lands and the National Park Service–administered lands in the Wawona area and westward to the border of the park, the entire length of the South Fork of the Merced River in Yosemite flows through wilderness. Land use within the Merced River corridor is described below.

Main Stem of the Merced River

Wilderness. Almost 95% of Yosemite is designated Wilderness, which includes a small amount of land currently designated as potential Wilderness additions. Structures located in the wilderness portions of the Merced River corridor are limited to the Merced Lake High Sierra Camp (7 buildings and 22 tent cabins), toilet facilities at the two backpackers campgrounds, and 10 bridges and other support facilities. These areas are used solely for wilderness recreation, and use levels are controlled by trailhead quotas managed by the park's wilderness management program.

Yosemite Valley. Yosemite Valley is the most heavily used recreation area in Yosemite National Park. The Valley contains major development areas, such as Yosemite Village, Yosemite Lodge, The Ahwahnee, Curry Village, Housekeeping Camp, and several campgrounds. In addition to the recreation areas and visitor facilities located in the Valley, many park and concessionaire administrative and maintenance facilities are located there. Only a few structures in the Valley are actually located within the Merced River corridor.

Merced River Gorge. The majority of the Merced River gorge is undisturbed outside of the road prism and is bordered on both sides by designated Wilderness. Facilities within the Merced River corridor in the gorge include a decommissioned powerhouse (east of the Cascades Creek confluence), the Cascades Picnic Area, and the Arch Rock Entrance Station, which includes several National Park Service structures and a small picnic area. An aboveground high-voltage electricity transmission line that supplies power to Yosemite Valley follows the El Portal Road to the decommissioned powerhouse, where it transitions to an underground transmission system.

El Portal. The El Portal Administrative Site contains 1,139 acres and is adjacent to the western boundary of Yosemite National Park. Park administrative facilities and the community of El Portal are located within the boundaries of the El Portal Administrative Site. El Portal was designated as an administrative area in 1958 following the passage of federal legislation (USC Section 16, Sec. 47-1) that authorized the acquisition of private lands and a land transfer with the U.S. Forest Service. Its purpose is to "to preserve the extraordinary natural qualities of Yosemite National Park" by allowing the National Park Service to locate employee housing, administrative offices, and maintenance facilities outside the park, thus avoiding the impacts of developing such facilities within the park. This legislation also directed that this area would not be subject to the laws and regulations governing Yosemite National Park.

Residential areas in the El Portal Administrative Site include Rancheria Flat, a National Park Service housing area with single-family residences, duplexes, and apartments; Trailer Village/Abbieville, a National Park Service and Concessioner employee housing area; The Motor Inn Cabins, a housing area for National Park Service employees; the El Portal Hotel, which houses Yosemite Institute employees and administrative facilities; and Old El Portal, with single-family homes for National Park Service and concessioner employees. Houses in Old El Portal are privately owned; however, the land is leased from the government through short-term special-use permits that are renewed annually. Due to a housing shortage for employees, many single-family homes house several employees.

Other National Park Service facilities at El Portal include a wastewater treatment plant and the El Portal administrative and maintenance facility, both at Railroad Flat. Additional National Park Service–owned facilities in El Portal include the Child Development Center, the Yosemite Association Administrative Offices, the National Park Service Fiscal and Human Resource Offices, a Fire Management crew station, the Carroll Clark Community Hall, the El Portal Market, and a transportation exhibit highlighting the history of rail operations in the area. The U.S. Forest Service owns the El Portal Wildland/Structural Fire Station and ambulance bay, and the U.S. Postal Service owns the El Portal Post Office. Mariposa County owns the El Portal Elementary/High Schools and Library, as well as the El Portal Community Pool. Privately owned facilities in El Portal include a gas station and bulk fuel storage facility, a telecommunications facility, and the private houses on government land described above.

The Sierra National Forest borders the Merced River to the south of the El Portal Administrative Site and on the south side of the river west of El Portal. The Stanislaus National Forest borders the Merced River along the north side of the river west of the El Portal Administrative Site. The Sierra National Forest manages the Merced Wild and Scenic River corridor on Forest Service lands west of El Portal to just west of the Sweetwater Creek confluence. The Bureau of Land Management manages the remainder of the main stem between the Sweetwater Creek confluence to 300 feet east of the Bear Creek confluence.

The National Park Service, U.S. Forest Service, and U.S. Bureau of Land Management all have a general policy to purchase private lands along the Merced River as properties become available. Currently, there are private inholdings within the Stanislaus National Forest located between the El Portal Administrative Site and the park boundary, along the Merced River. Private facilities on these lands provide visitor services, such as overnight accommodations, conference and meeting space, recreation facilities and restaurants. Since these facilities are located on private lands, these activities are not managed or controlled by the National Park Service.

South Fork

Wilderness. Land along the South Fork upstream from Wawona to the headwaters of the river (approximately 25 miles) is entirely federally managed and is used solely for wilderness recreation. Most of these lands within the Merced River corridor are administered by the National Park Service, with the exception of an approximately 3-mile section where the National Park Service controls lands on the north side of the river and the U.S. Forest Service (Sierra National Forest) controls lands to the south of the river. From a point approximately 2.5 miles downstream from the Wawona Campground (at the western edge of the park boundary) to the confluence with the main stem, a distance of approximately 17 miles, lands along the South Fork are administered by the U.S. Forest Service (Sierra National Forest), which has produced its own plan for the lands it administers within the Merced River corridor.

Wawona. Wawona is located in the southwestern corner of the park, about 27 miles south of Yosemite Valley and 4.5 miles north of the park's South Entrance. Development at Wawona includes several National Park Service and concessioner facilities. Of these facilities, Wawona Campground, horse camp, Wawona Hotel, the golf course, several maintenance buildings, the water and wastewater treatment plants, store, gas station, Covered Bridge, and the Pioneer Yosemite History Center (containing 15 structures on 3.3 acres) are within the Merced River corridor.

Several private and National Park Service–owned residences are in Section 35, the designation given by the U.S. Geological Survey on its maps of the 1-square-mile area of land that defines the township of Wawona. Section 35 consists of 636 acres, 206 acres of which are privately held, while the remaining 430 acres are federal lands. There is a store on the privately owned portion of Section 35. The school and post office sit outside Section 35 on National Park Service land. The library is within Section 35; however, it sits on National Park Service land within a National Park Service building. All government housing within Section 35 is on National Park Service land. The 430 acres of federal lands in Section 35 were acquired over the past 50 years on an opportunity purchase basis. The developed portion of Section 35 is bounded on three sides by designated Wilderness. A total of 302 private tracts in Section 35 are interspersed among National Park Service-owned land. Some private tracts are less than one-half acre in size, and there are several tracts that exceed 1 acre in size. A 28.8-acre camp is operated by the Seventh Day Adventist Church. Most of the tracts are developed for seasonal or permanent residential use, and less than 10% are undeveloped. Several of these private tracts border the South Fork of the Merced River and are within the Merced River corridor.

In 1985, the National Park Service retroceded partial concurrent jurisdiction over civil matters in Section 35 to the State of California on private lands. In 1987, the National Park Service initiated a memorandum of agreement with Mariposa County to implement the retrocession, giving Mariposa County the needed authority to establish land-use regulation in Section 35. In October

1987, the National Park Service and Mariposa County jointly approved the *Wawona Town Planning Area Specific Plan/FEIR* (Mariposa County Planning Department 1987).

Proposed Protection Methods

Proposed protection methods for the nonfederal areas within the park include long- and short-term strategies.

Section 10(e) of the Wild and Scenic Rivers Act allows federal agencies to enter cooperative agreements with states and local governments in the administration of a river segment. While no incorporated cities exist within the corridor and no local zoning guidelines have been issued by the Secretary of the Interior, it is the intent of the National Park Service to work with Mariposa County during the development of any future zoning ordinances to ensure that such zoning is consistent with the purposes of the Wild and Scenic Rivers Act. Under all alternatives, the National Park Service would continue to assist, advise, and cooperate with Mariposa County or its political subdivisions, private landowners, private organizations, and individuals to protect and manage private lands along the Merced River and to protect Outstandingly Remarkable Values where nonfederal lands are within the river corridor. Land-use regulation will provide the primary protection at Wawona, along with opportunity purchases and land exchanges.

Private property within the river corridor is not zoned under the Merced River Plan. The Secretary of the Interior is authorized to acquire lands and interests in lands within the authorized boundaries of the main stem and South Fork of the Merced River under Section 6(a) of the Wild and Scenic Rivers Act, and to use condemnation to acquire easements on lands within the corridor when necessary. The vast majority of lands within the river corridor are owned in fee title by the United States, and the National Park Service has no intention of acquiring additional lands in fee title by condemnation under authority of the Wild and Scenic Rivers Act. However, it is the intent of the National Park Service to work cooperatively with private landowners within the corridor whenever possible to ensure that Outstandingly Remarkable Values of the river segment are protected and enhanced. Yosemite National Park is identified as an inholding area, and there is no acquisition ceiling for the park. Priorities include acquisition of tracts in Wawona within the Merced Wild and Scenic River corridor and undeveloped land adjacent to open public areas.

Transportation

State highways leading into Yosemite National Park (Highways 41, 120, and 140) transition into an internal parkwide road system at the entrance stations. Although the State of California has a road right-of-way for Highway 140 through the El Portal Administrative Site, they have no rights-of-way through the park, so there are no state highways within the park boundaries; however, state highway numbers are used on park signs to help orient visitors. Additional transportation facilities within the park consist of a series of spur roads, access drives, pedestrian trails, bicycle paths, and parking areas leading from the main roads. The park has roughly 200 miles of roads, of which about 30 miles traverse the Yosemite Valley floor. On an average August day in 2004, about 5,870 vehicles entered the park, consisting primarily of park visitors and park employees (who mostly live along the Highway 140 corridor) (NPS 2004f). Vehicle entries generally are evenly spread among park entrance stations. During August 2004, the South Entrance Station (Wawona Road/Highway 41) accommodated the highest percentage of entries at 29%. The Tioga Pass Entrance (Tioga Road/Highway 120 East) received 21%, the Big Oak Flat Entrance (Big Oak Flat

Road/Highway 120 West) received 26%, the Arch Rock Entrance (El Portal Road/Highway 140) handled 23%, and the Hetch Hetchy Entrance handled 1% of entries.

Yosemite Roadway System and Traffic Volumes

Major park roadways within the study corridors are described below, with traffic volume data recorded at fixed counter locations within the park.

Daily and Hourly Variations in Traffic

Yosemite National Park experiences varying visitation according to the day of the week, as well as by season because of its location near major population centers in northern and central California. Visitor travel to and from the park results in daily traffic peaks in the morning and evening. Traffic volumes on the busiest days are significantly higher than the average volumes. Generally, the busiest days occur on weekends in the summer, with holiday weekends having the highest volumes of traffic. Peaking conditions are similar at locations throughout the park. Data for Yosemite Valley were assembled to illustrate the effects of peaking on traffic volumes (DEA 2005). Similar peaking patterns exist at the entrance stations and on other park roads. During the peak season of 2003 (Memorial Day weekend through Labor Day weekend), an average of 4,682 vehicles entered Yosemite Valley on Southside Drive daily. On the busiest day, 6,962 vehicles entered the Valley, or 49% more vehicles than entered on average.

Planning for management activities and facilities where peak conditions are significantly different from average typically applies the concept of design conditions. Design conditions address typically busy days during the peak season, but not the day with the highest visitation. For Yosemite Valley in 2003, the seventh highest day (Saturday, August 9) was selected to represent design conditions. On that day 5,843 vehicles entered Yosemite Valley on Southside Drive—about 25% more than the average.

Traffic volumes inbound to Yosemite Valley increase through the early portion of the day, reaching a peak from 10:00 a.m. to about noon. Average inbound traffic volumes on Southside Drive during this period in August are about 480 vehicles per hour. On the busiest day in 2003, the inbound hourly volume of traffic reached about 780 to 785 vehicles per hour. On these days, the peak travel period extends from 10:00 a.m. to about 2:00 p.m. On the seventh busiest day, peak traffic conditions extended from 11:00 a.m. to 2:00 p.m., with volumes of 620 to 640 vehicles per hour.

Average outbound traffic volumes on Northside Drive in Yosemite Valley reach a peak of about 540 vehicles per hour on average between 4:00 p.m. and 5:00 p.m. in August. Traffic volumes on the average day equal or exceed 500 vehicles per hour on Northside Drive from about 2:00 p.m. to 5:00 p.m. On the busiest day in 2003, the outbound traffic volume peaked at 873 vehicles per hour and exceeded 500 vehicles per hour from 1:00 p.m. to 7:00 p.m. On the seventh busiest day, outbound traffic peaked at 673 vehicles per hour from 4:00 p.m. to 5:00 p.m. and the volume exceeded 500 vehicles per hour from 2:00 p.m. to 6:00 p.m. (All data are from permanent count stations on roadways on Yosemite Valley [DEA 2005].)

Merced River Corridor

El Portal Road. The El Portal Road is about 7.5 miles long within the park. At the park boundary, this road connects to Highway 140. The El Portal Road enters the park near the El Portal Administrative Site, passes through the Arch Rock Entrance Station, and continues to the Valley Loop Road near Pohono Bridge. It is maintained for year-round access and has been historically

called the All-Year Highway. The road is characterized by steep, rocky canyon walls with small river flats and terraces and has a typical pavement width that varies from 19 feet to 22 feet. The wider sections of El Portal Road from the park boundary in El Portal to the intersection with Big Oak Flat Road were reconstructed according to plans approved through a 1997 Environmental Assessment. Plans to rehabilitate the easternmost section of the El Portal Road were halted by a lawsuit regarding the adequacy of the environmental assessment and potential impacts to the Merced River. Final plans for rehabilitation of this section of the El Portal Road have been suspended until the completion of the Revised Merced River Plan/SEIS and subsequent NEPA and NHPA compliance, environmental permitting, and design for this segment have been completed.

Average daily traffic volumes entering at the Arch Rock Entrance Station in August 2004 were about 1,370 vehicles (NPS 2004f). Studies conducted in 1999 showed that traffic volumes on El Portal Road consisted of about 6% heavy vehicles (buses, recreational vehicles, and trucks) (BRW, Inc. 1999). About 55% of bus volume entering Yosemite during the summer arrives via El Portal Road. During the off-peak winter months, El Portal Road carries up to 44% of the total traffic entering the park and about 85% of bus traffic entering the park.

Big Oak Flat Road. Big Oak Flat Road is about 18 miles long. It leads from the Big Oak Flat Entrance Station through Hodgdon Meadow and Crane Flat and intersects the El Portal Road 1 mile downstream from Pohono Bridge on the Valley floor (the Big Oak Flat Road also provides access to the Valley from the Tioga Pass Entrance). Outside the park, this road connects to Highway 120. Big Oak Flat Road may be used as a through route in conjunction with other major park roads and is maintained for year-round access. The topography changes from mountainous on the east end of the road to rolling at the west end. The width paved roadway ranges from 26 to 30 feet. Average daily traffic volumes entering at the Big Oak Flat Entrance Station in August 2004 were about 1,510 vehicles (NPS 2004f).

The Valley Loop Road. The Valley Loop Road is an approximately 12-mile-long combination one-way/two-way loop road that provides primary circulation within Yosemite Valley. It also connects the other major roads, facilitating through-park traffic, and is maintained for year-round use. The pavement width is about 21 feet and there are two travel lanes. Four bridges across the Merced River connect the roadway running parallel to the south Valley wall (Southside Drive) with the roadway on the north (Northside Drive). One-way operation is maintained along Southside Drive from Pohono Bridge at the west Valley to Stoneman Bridge near Curry Village. Two segments of one-way operation are maintained on Northside Drive. The first one-way section travels from Stoneman Bridge to Yosemite Village. The second one-way section travels from Yosemite Lodge to the Pohono Bridge. Two-way traffic is allowed between Yosemite Lodge and Yosemite Village on Northside Drive. In addition to Pohono and Stoneman Bridges, connections between Northside Drive and Southside Drive are provided at El Capitan Bridge and at Sentinel Bridge near the Yosemite Chapel. Average daily traffic volumes in August 2003 were about 4,750 vehicles on Southside Drive and 4,790 vehicles on Northside Drive (NPS 2003a).[20] Average daily volumes on peak weekends and peak holiday weekends have exceeded the August 2003 daily average in the past. In addition, monthly daily average traffic volumes may vary from these stated above.

[20] Daily volumes of traffic on Southside Drive and Northside Drive are collected by automatic traffic counters embedded in these roadways. The above-reported volumes reflect raw data from those automatic counters, and the approximate 40-vehicle difference between daily traffic inbound to, and outbound from, the Valley likely is caused by a combination of overcounting and undercounting errors.

South Fork Corridor

Wawona Road. Wawona Road is about 27 miles long within the park. At the South Entrance, this road connects to Highway 41. Wawona Road is the principal access to Wawona, Mariposa Grove, Badger Pass Ski Area, Glacier Point, and Yosemite Valley and is maintained for year-round access. Throughout its length, the 24-foot-wide road travels over mountainous terrain with steep grades and is surrounded by moderate to dense forest. It should be noted that the South Fork Bridge, an important link of this road, is condemned, and traffic has been detoured onto a temporary bridge. As such, this route is vulnerable to flooding and washouts and may not always be accessible. Average daily traffic volumes entering at the South Entrance Station in August 2004 were about 1,700 vehicles (NPS 2004f).

Traffic Conditions

Daily traffic volumes recorded at fixed counter locations within the park indicate a long-term historical trend of growth in traffic, but in recent years, traffic levels have remained fairly constant. Daily traffic volumes normally do not exceed the capacity of any of the major roadways. On the busiest summer days, travelers on most park roads during peak travel hours encounter only minor to moderate congestion. However, at key activity areas (popular attractions, parking areas, and major intersections) and at the park entrance stations, moderate to major congestion occurs. Disruptions to traffic flow are often attributed to excessive circulation by visitors and tour bus drivers seeking parking spaces.

The formal parking areas serving the most active visitor facilities are perpetually full. On summer weekends, parking spills out of the formal areas onto roadsides throughout the east Valley and at popular attraction areas in the west Valley. Traffic and pedestrian conflicts are common during periods of maximum visitation.

Merced River Corridor

Yosemite Valley. The roadway system in the Valley can be confusing to first-time visitors because of the one-way circulation, limited opportunities to cross the Merced River, and circuitous travel routes. Excess vehicle circulation is common (particularly in the area between Curry Village and Yosemite Village), as visitors seek the best routes to their destinations and search for limited parking spaces.[21] The Superintendent's Compendium for Yosemite National Park includes provisions for the park to restrict vehicular access into Yosemite Valley under certain conditions. Restricted access measures have occasionally been implemented to limit vehicle access during peak visitation days. When implemented, these measures divert traffic away from the Valley during peak periods when parking has reached capacity, and congested conditions are causing long backups at road intersections. Highly congested locations include the intersections along Northside Drive at Yosemite Village and at the entrance to the Yosemite Lodge parking area with a pedestrian crossing to Lower Yosemite Fall. Both of these intersections are on the two-way segment of the loop road system. Other congestion points in the Valley include the four-way intersection near Curry Village and the intersection of Village Drive with The Ahwahnee access road at the north end of Yosemite Village. Traffic congestion in the Valley can cause frustrating delays to visitors in private vehicles, leads to increased vehicle emissions, and disrupts the operation of the Valley shuttle bus system.

[21] Starting with the 1999 summer season, the Camp 6 area, located east of Sentinel Road and south of Northside Drive, was reconfigured and organized to provide a centralized parking area for day visitors that is efficient and easy to locate. Approximately 520 parking spaces are currently provided. Additional parking for day visitors is located near the Village Store, but the Village Store spaces are designated for short-term use. Previously, day-visitor parking was also available at Yosemite Falls, but these spaces were replaced by an expansion of Camp 6 in 2003.

Visitor traffic congestion historically has been exacerbated by the location of visitor parking facilities and by directional signs. For example, many visitors bound for Yosemite Lodge and day-visitor parking in the Camp 6 area near Yosemite Village are unnecessarily routed to the east end of the developed area and then to Yosemite Village via Northside Drive, traversing the most congested part of the road system.

El Portal Road. Prior to the current improvement project, this road operated at an unacceptable level of service, due to steep grade, minimal lane width, and inadequate lateral clearance. The typical level of service characterizations, however, may not be appropriate for roadways in the park because the function of such roads is not to provide fast transportation but to provide safe and efficient accommodation of park visitors and to serve essential management access needs.[22]

As stated above, restricted access measures are occasionally implemented on the busiest summer weekends when congestion in Yosemite Valley is most severe. Congestion is monitored using qualitative factors, such as observations of traffic conditions and the judgment of park personnel. When congestion reaches unacceptable levels, access to Yosemite Valley is restricted, and, on some occasions, visitors are turned away at the park entrance stations. However, because implementation of restricted access measures is labor-intensive, diverts park staff from other operations, and can result in moving congestion impacts into other less developed park areas, they have been implemented infrequently since 1994.

South Fork Corridor

As stated above, the number of vehicles on park roads has increased over the years, but traffic volumes generally do not exceed the capacity of the roads. Traffic conditions on Wawona Road are typically acceptable along the South Fork of the Merced River where Wawona Road crosses and then follows the river. Travelers encounter minor to moderate congestion on the busiest summer days.

Transit and Tour Bus Services

Bus transportation in Yosemite National Park includes regional public transportation, charter and tour bus operators, concessioner-operated tours, and shuttle bus services provided by the park concessioner. With the exception of shuttle bus services in Tuolumne Meadows and to the Mariposa Grove from Wawona, nearly all buses travel to and from or within the Valley.

According to visitor surveys conducted during 1999, about 49% of private-vehicle travelers and 55% of tour bus travelers use the Valley shuttle bus system. In 1998, average daily passengers on the Valley shuttle during the peak-season months was about 520 riders, with a maximum daily passenger load as high as about 1,000 riders (Yosemite Concession Services 1999).

Merced River Corridor

Regional Bus Transit. The Yosemite Area Regional Transportation System (YARTS) was formed by a Joint Powers Authority in 1999 that is made up of the member counties of Mariposa, Merced, and Mono. The Merced County Area Government (MCAG) provides administration, management, and marketing for YARTS. Buses and personnel are provided by VIA Bus Lines.

[22] Level of service characterization is a qualitative measure of how well a roadway is operating. Such characterizations typically are based on physical and traffic aspects of the roadway, including road width, terrain, mix of vehicle types (e.g., automobiles versus buses), and average travel speed.

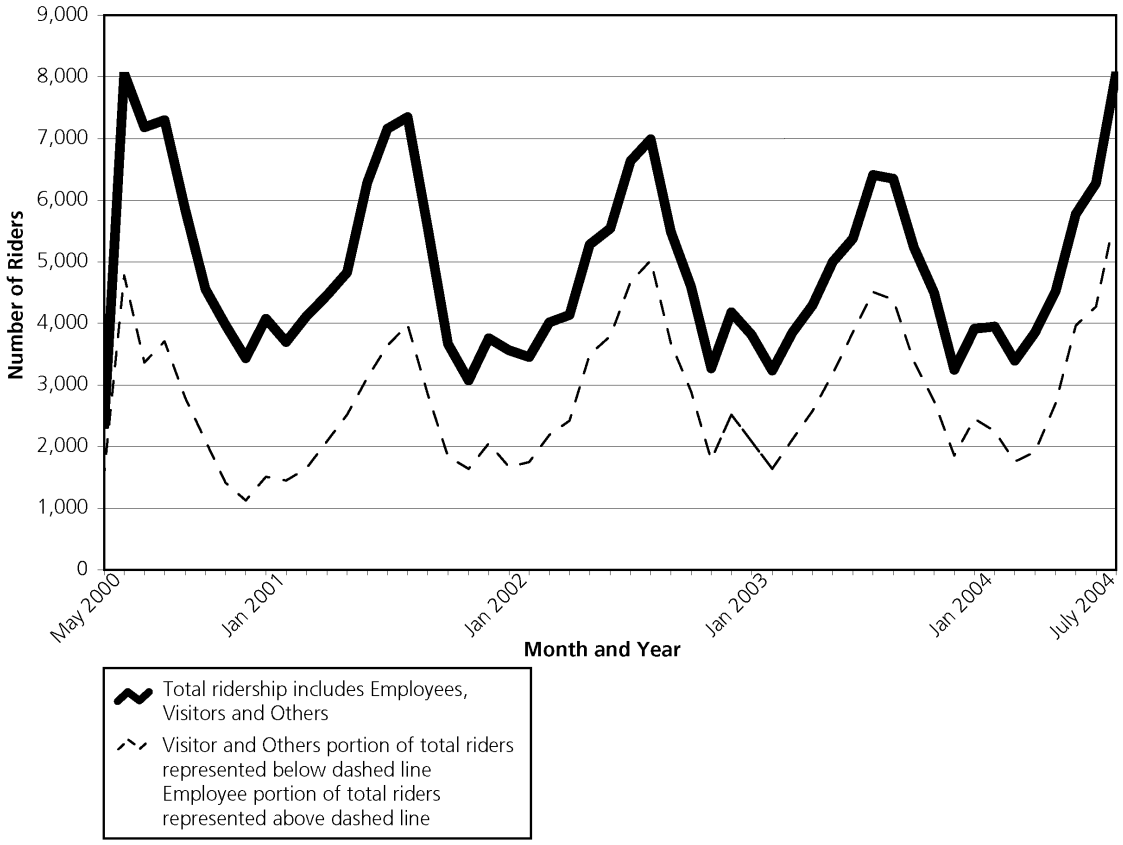
YARTS provides regional bus service with three daily runs from Merced to Yosemite Valley and two daily runs from Mariposa to Yosemite Valley. Less service is provided on weekends, and more service is provided in summer, including a daily round-trip from Mammoth and points in Mono County through the Tuolumne Meadows area and connection to Valley buses.

YARTS service began operations in 2000 in order to provide an alternative mode of transportation to and from Yosemite National Park. The service is designed to serve the following traveling patterns:

- Visitors staying in the neighboring gateway communities and visiting Yosemite National Park.
- Employees along the Highway 140 corridor who work in El Portal or Yosemite National Park.
- Students and employees who travel to Merced for school and/or work.
- Visitors who travel from Mono County to Yosemite National Park for recreation such as hiking during the summer months only.

Table IV-7 and figure IV-1 presents YARTS ridership data for employees, visitors, and others along the Highway 140 corridor from May 2000 through July 2004 (NPS 2005c). During this timeframe, the trend in overall ridership has been consistent, although distinct seasonal patterns have developed.

Figure IV-1
YARTS Ridership along Highway 140 May 2000 through July 2004



Note: See Table IV-7 for YARTS ridership data.
Source: NPS 2005

Table IV-7
Total YARTS Ridership along Highway 140, Merced to Yosemite Valley, May 2000 through July 2004

Year	Riders	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
2000	Visitors and Others	—	—	—	—	1,541	4,779	3,370	3,707	2,793	2,096	1,418	1,131	20,835
	Employees	—	—	—	—	739	3,236	3,774	3,552	3,017	2,423	2,516	2,265	21,522
	TOTAL	—	—	—	—	2,280	8,015	7,144	7,259	5,810	4,519	3,934	3,396	42,357
2001	Visitors and Others	1,514	1,452	1,647	2,088	2,517	3,120	3,641	3,980	2,848	1,842	1,640	2,056	28,345
	Employees	2,525	2,211	2,427	2,331	2,274	3,130	3,478	3,331	2,664	1,788	1,400	1,665	29,224
	TOTAL	4,039	3,663	4,074	4,419	4,791	6,250	7,119	7,311	5,512	3,630	3,040	3,721	57,569
2002	Visitors and Others	1,671	1,749	2,189	2,423	3,496	3,795	4,670	5,019	3,682	2,896	1,785	2,517	35,892
	Employees	1,857	1,665	1,788	1,679	1,748	1,707	1,926	1,929	1,764	1,663	1,448	1,626	20,800
	TOTAL	3,528	3,414	3,977	4,102	5,244	5,502	6,596	6,948	5,446	4,559	3,233	4,143	56,692
2003	Visitors and Others	2,088	1,642	2,118	2,584	3,184	3,856	4,511	4,388	3,383	2,738	1,853	2,451	34,796
	Employees	1,687	1,554	1,697	1,678	1,777	1,480	1,857	1,920	1,812	1,724	1,358	1,422	19,966
	TOTAL	3,775	3,196	3,815	4,262	4,961	5,336	6,368	6,308	5,195	4,462	3,211	3,873	54,762
2004	Visitors and Others	2,252	1,758	1,916	2,705	3,968	4,270	5,826	NA	NA	NA	NA	NA	22,695
	Employees	1,660	1,595	1,895	1,781	1,765	1,966	2,200	NA	NA	NA	NA	NA	12,862
	TOTAL	3,912	3,353	3,811	4,486	5,733	6,236	8,026	NA	NA	NA	NA	NA	35,557

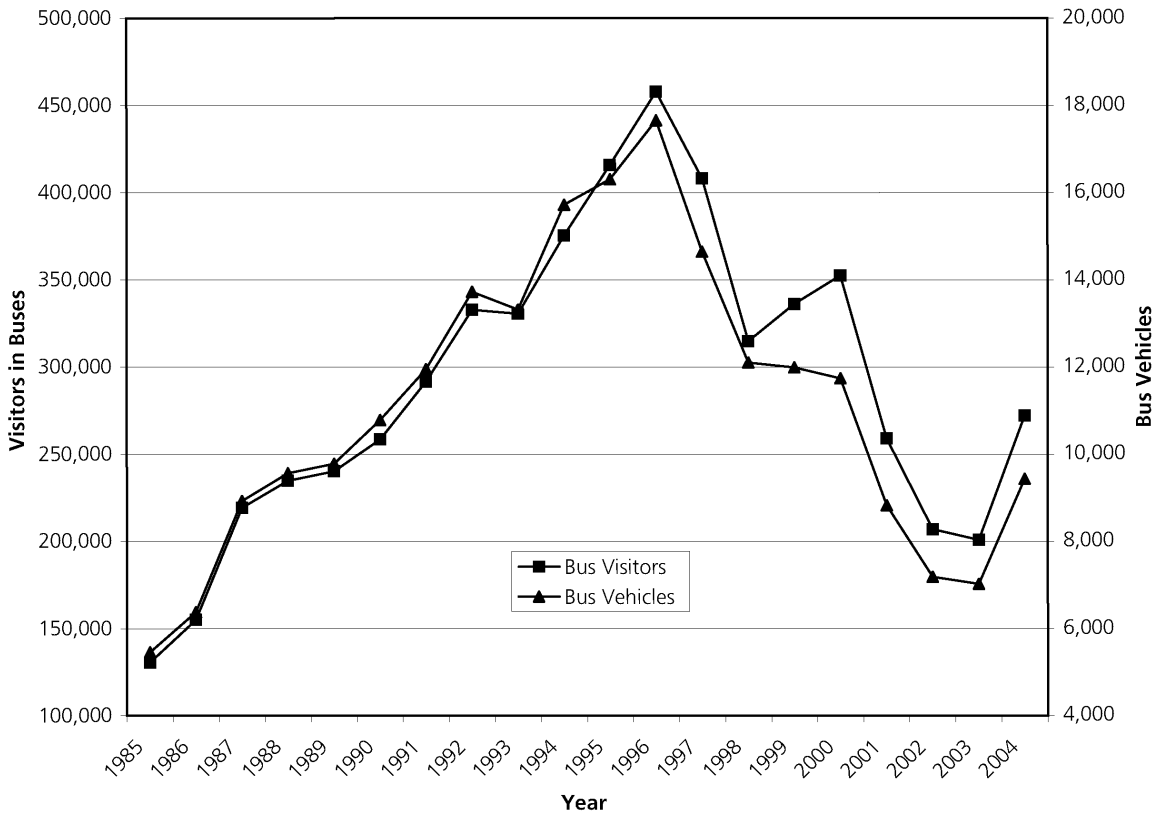
NOTES:
— denotes no data.
NA = data not available .
Numbers do not include Amtrak riders.
Employees rode free first year.
Number of runs reduced after first year.

SOURCE: NPS 2005c

During the peak months of June, July, and August, total ridership along the Highway 140 corridor ranged between 6,236 and 8,026. During the off-peak months of November, December, and January total ridership ranged between 3,040 and 4,039. YARTS ridership to the park along the Highway 140 corridor represents a very small percentage of total park visitation. For the years 2001 through 2003, total annual YARTS ridership ranged between 54,762 and 57,569, representing between 1.5% and 1.6% of total annual park visitation. Visitor ridership closely follows the seasonal visitation numbers for the park with the four summer months of June through September representing approximately 47% of total visitor ridership for the years 2002 through 2004. At this time, there is no justification to assume this trend would not continue in the future in the same manner.

Charter and Tour Buses. The National Park Service tracks the number of buses entering the park as well as the number of visitors that arrive by bus. Figure IV-2 shows the number of visitors arriving by bus along with the number of buses entering the park for the 20-year period between 1985 and 2004 (NPS 2004f).

Figure IV-2
Yosemite National Park Visitation by Bus*



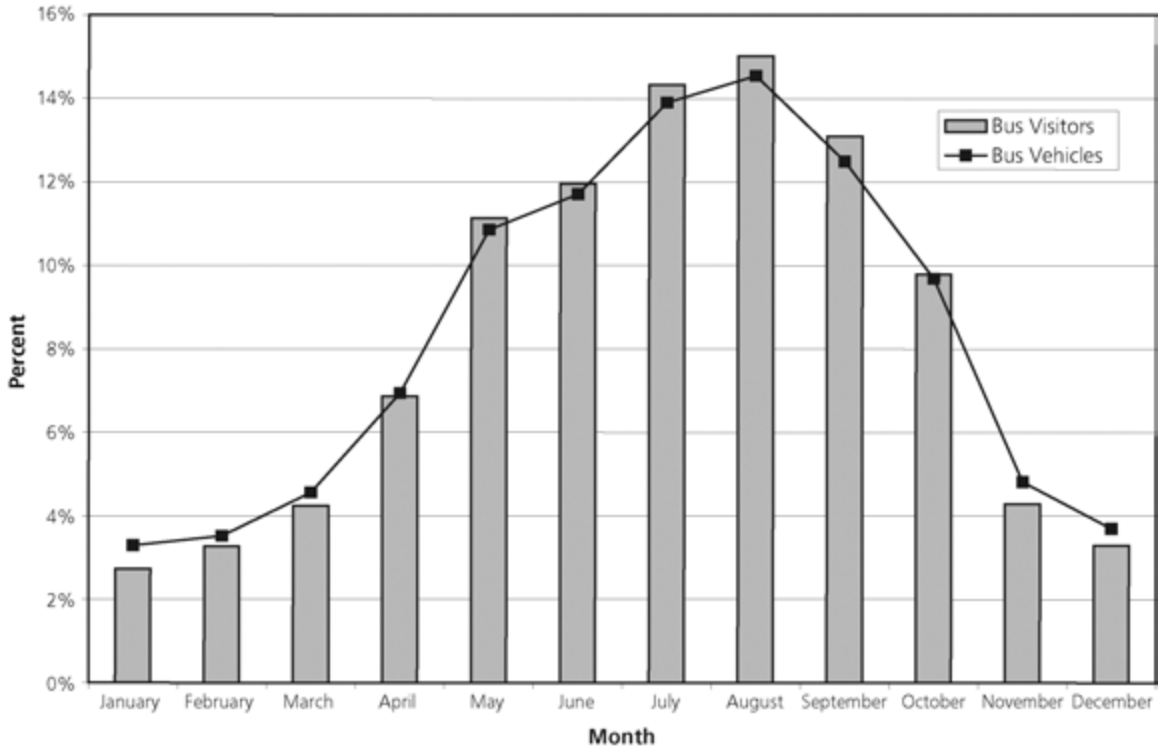
Source: NPS Public Use Statistics web site: www2.nature.nps/gov (NPS 2004f)
* Bus visitation includes commercial, transit, school and other buses/vans with greater than 15 passengers.

As shown on figure IV-2, visitors traveling to the park by bus steadily increased from 1985 (approximately 140,000 visitors and 5,500 buses) to 1996 (approximately 450,000 visitors and 18,000 buses). Since 1996 through 2003, both the number of visitors arriving by bus and the number of buses has generally declined. In 2003, approximately 200,000 visitors arrived on 7,000 buses. Those numbers rose in 2004 to approximately 270,000 visitors arriving on about 9500

buses. The pattern of visitors arriving by bus over this 20-year period generally follows the pattern for overall park visitation for this same period (see figure IV-4 in Park Visitation Trends in the Socioeconomics section of this chapter). The percentage of all visitors to the park arriving by bus ranged between a low of 4.7% in 1985 to a high of 10.9% in 1996, and has declined since. In 2003, the percentage of all visitors arriving by bus was 5.7% of total park visitation, and this percentage increased to 7.8% in 2004.

Figure IV-3 shows the percentage of annual buses as well bus visitation by month averaged over the period 1985 to 2004 (NPS 2004f). As shown in the figure, about 14% - 15% of the people who visit Yosemite on buses during an average year arrive in the peak months of July and August, with May, June and September each accounting for 11% to 13% of annual visits by bus. Visitation by bus in the off-peak months of November through February is less than 30% of the peak season visitation by bus. Visitation by bus in the shoulder season months of April and October ranges from 45% to 65% of the peak season visitation by bus. The monthly patterns of visitation to Yosemite by bus have remained relatively constant over the 20-year period for which bus visitation data is available. For example, visits by bus in both July and August 1996 represented 15% of the total visitation to Yosemite by bus in 1996.

Figure IV-3
Percent of Annual Buses and Bus Visitors by Month



Source: NPS Public Use Statistics web site: www2.nature.nps.gov (NPS 2004f)

During August 2004, an average of 41 commercial tour buses entered the park each day. The daily average number of commercial buses is currently lower than the Valley historically accommodated in past peak years such as the summer of 1996. Nearly all buses eventually make their way to Yosemite Valley; tours include day-use itineraries and overnight stays.

Commercial tour buses entering the park typically offer one-day tours (without an overnight stay), or offer tours with an overnight stay. Buses providing day tours with no overnight stay arrive at the park in mid- to late morning and depart the park in mid-to late afternoon, with stays in the park of between 4-6 hours. A typical one-day tour to Yosemite Valley includes short 15-30 minute stops at popular vistas such as Tunnel View and along Southside Drive at the Bridalveil Fall viewing area, then proceeding to Yosemite Lodge for a longer stop of 2-3 hours. At the Lodge, visitors have a variety of options that include walking to Lower Yosemite Fall, visiting the Yosemite Lodge gift shop and food court, and/or getting on the Valley shuttle bus for a trip around the Valley floor. While stopped at the Lodge, buses park in the 32 designated bus parking spaces adjacent to the this facility. The number of buses simultaneously arriving and departing at these locations (i.e., bunching) has been a problem in the park in the past. Currently, there are no regulations that control or prevent bunching.

Upon leaving the Valley, buses typically stop along Northside Drive at the El Capitan Meadow for 15-30 minutes to enjoy views of El Capitan and the adjacent El Capitan meadow. Some day tours may also include a stop at the Mariposa Grove of Giant Sequoias if they enter or depart the park through Wawona.

Buses that bring visitors to the park for overnight stays generally follow the same routine as described above for day trips, the exception being that once buses arrive at the Lodge, visitors depart and check into the Lodge for their overnight stay. The bus then departs with tour guests who were brought to the park 1-3 days earlier and have checked out of the Lodge for a return trip back to their point of origin or to another out-of-park destination.

A survey conducted in 1991 (Gramman 1992) indicated that visitors to the park by bus are more likely to be from foreign countries than visitors arriving in private vehicles (45% vs. 15%). Visitors by bus also tend to be older (31% over 55) than those arriving in private vehicles (10% over 55). Given this, and the fact that day visitors arriving by bus stop at popular areas in the Valley for short periods of time, day visitors arriving by bus tend to stay close to their tour group and stay on hardened areas in the vicinity of the Lodge and the trail to Lower Yosemite Fall, the Tunnel View parking area, and the hardened areas in the vicinity of Bridalveil Fall. The exception to this may be the El Capitan Meadow, where some visitors tend to stray into the meadow adjacent to the roadway to gain a better view of El Capitan. However, stops in this area are relatively short (about 15-30 minutes).

This contrasts with other visitors to the park, particularly in the Yosemite Valley area. Overnight visitors and other day use visitors arriving by car have a greater opportunity to move in and out of the corridor, and/or individual management zones. These visitors are more likely to enjoy the river by swimming or rafting, picnicking, biking, and taking day hikes to Mirror Lake, Happy Isles, and to the Little Yosemite Valley and Half Dome.

Valley Shuttle Bus System. The current shuttle bus system operates year-round in Yosemite Valley, offering service to the major developed areas at the east Valley. In addition, shuttle buses also operate between Yosemite Valley and Badger Pass during the winter season when the ski area is operating. During the summer, a fleet of 12 shuttle buses operates on the main shuttle route every 6 to 10 minutes. The main route follows an 8-mile loop with 23 stops. Service is provided from 7:00 a.m. to 10:00 p.m. in the summer. Fewer shuttle buses and a reduced schedule are operated for the remainder of the year. During the summer, a special bus route provides direct service

between the Yosemite Village day-visitor parking area and the Yosemite Valley Visitor Center in Yosemite Village. This route operates every 10 to 15 minutes from 8:00 a.m. to 9:00 p.m.

The majority of the shuttle bus route follows public park-access roads. Short sections of the route use restricted sections of roadway. Conflicts are often created for the shuttle buses by vehicle traffic, pedestrians, and bicyclists. Frequently, passenger loads exceed the normal capacity of the buses. Delays in service can often be caused by the loading and unloading of overcrowded buses.

Valley Floor Tours. Tours are available throughout the day for visitors seeking an informative and scenic experience in Yosemite Valley. Open-air trams (towed by a propane truck-tractor) with a capacity of 70 passengers are used in summer to carry visitors along the Valley Loop Road and to Tunnel View on the Wawona Road above the west Valley. The trams are usually at capacity from mid-morning to late afternoon.

Park Tours. A variety of tours is available for visitors choosing to explore Yosemite by means other than private vehicles. Services are provided by DNC Parks & Resorts. Several of these routes originate from the lodging facilities in Yosemite Valley.

Transit Ridership. Bus ridership on YARTS transit service is approximately 57,000 people per year, averaged over the three years of operation since 2000.

South Fork Corridor

In the spring through fall, a free shuttle bus service operates between Wawona and Mariposa Grove of Giant Sequoias. The Wawona Shuttle is a continuous loop on a 30-minute frequency that runs between the Wawona Pioneer and Grocery Store and the parking lot in the Mariposa Grove. There is no service between Yosemite Valley and Wawona.

As described above, a variety of park tours by DNC Parks & Resorts is available for visitors choosing to explore Yosemite by means other than private vehicles. In summer, daily trips from Yosemite Valley include a hikers' bus to Glacier Point and one to Tuolumne Meadows, and a grand tour that includes the Valley floor, the Mariposa Grove of Giant Sequoias, and Glacier Point.

Parking Facilities

Visitor parking areas are provided in all the primary developed areas throughout Yosemite Valley and Wawona. Scattered turnouts along the roads provide access to interpretive signs and viewpoints. Parking includes a combination of day-visitor and overnight lots, roadside turnouts, shared-use areas, and employee parking. Competition for limited parking is intense in the peak season.

Merced River Corridor

Yosemite Valley. Yosemite Valley is the area with the highest concentration of development and the most parking spaces in Yosemite National Park. Because of the extensive use of road shoulders for overflow parking during periods of high demand, and because many parking areas are not paved or marked, it is difficult to identify a specific parking supply. However, an inventory of parking used by visitors in areas of Yosemite Valley was conducted in February 1999 and was updated in July 2003 and October 2004.

The 2003 parking inventory identified 1,510 spaces for day-visitor vehicles, the majority of this is in the east Valley, primarily at Camp 6, the Village Store parking lot, Curry Orchard, and at various destinations along the Northside and Southside Drive loop roads (DEA 2005). An additional parking inventory conducted in fall 2004 identified 687 parking spaces in the west Valley (between the Lodge and Pohono Bridge on Northside Drive, and between Pohono Bridge and the El Capitan crossover). Many of the spaces are informal turnouts and other areas are best suited to short-term use associated with auto touring. Parking for overnight guest vehicles is available at lodging, campground, and wilderness access areas. No designated day-visitor parking is available in the Yosemite Lodge area, but day visitors often compete with overnight guests for the available spaces.

The demand for parking in the Valley is affected by the number of people living in, working in, and visiting the area. Parking demand varies during the day and from day to day as the number of day and overnight visitors and nonresident employees fluctuates. It is estimated that the highest number of overnight visitors and residents in Yosemite Valley occurs late Saturday nights during the summer.

On crowded summer days, most formal parking is fully occupied, with parking spilling onto the roadway shoulders throughout the east Valley. This uncontrolled parking leads to pedestrian, bicycle, and vehicle conflicts, damage to vegetation and soils along the road edge, and the formation of social trails. During these peak times, parking attendants direct day visitors to use the available spaces within the main Yosemite Village parking area as efficiently as possible, and they also direct vehicles to park as efficiently as possible in roadside spaces along Sentinel Drive and Northside Drive. Under this directed parking scenario, a maximum capacity of between 1,500 to 1,600 day-visitor vehicles can be achieved for the east Valley.

In the west Valley area, parking lots are available at Bridalveil Fall and Tunnel View, and numerous roadside spaces exist along Southside Drive, Northside Drive, and El Capitan crossover between Pohono Bridge and the east Valley. The majority of the roadside spaces in west Valley are used by visitors for short time periods as they stop for views and taking photographs.

Merced River Gorge. Current access to the Gorge is limited by available roadside parking along the shoulder of the El Portal Road, at two off road, paved parking lots, and at the paved parking lot next to the Arch Rock Entrance Station. A parking inventory conducted in October 2004 identified 244 vehicle parking spaces and two bus parking spaces available in the gorge area between Pohono Bridge and the park boundary.

El Portal. An inventory of parking used by visitors to the El Portal Administrative Site was conducted in October 2004. Approximately 360 day-visitor parking spaces were identified, mainly informal parking areas along the shoulders of Highway 140 and Foresta Road, that provide visitor access to the Merced River.

South Fork Corridor

Parking is provided in Wawona for visitors and employees associated with facilities such as the Wawona Hotel complex, the Wawona grocery story and gift shop, the Pioneer Yosemite History Center, a campground, and two picnic areas. Also, visitors riding the free shuttle bus to the Mariposa Grove are encouraged to park in Wawona. Parking demand varies during the day and from day to day as the number of visitors and employees fluctuates.

An inventory of parking used by visitors to the Wawona area was conducted in October 2004. Approximately 213 vehicle parking and 14 bus parking spaces were identified around the Wawona Hotel and Golf Course, the Wawona store, and Pioneer Yosemite History Center, those located adjacent to Forest Drive, and along Chilnualna Falls Road. When visitors are catching the free shuttle bus to Mariposa Grove from Wawona, they often park along the road shoulders of the Wawona Road and Forest Drive. This uncontrolled parking leads to pedestrian and vehicular conflicts.

Scenic Resources

The scenery of Yosemite National Park is one of its most significant resources and is largely responsible for the enormous popularity of the park. Since the first explorations and descriptions of Yosemite Valley by Euro-Americans in the mid-19th century, views of the pastoral Valley juxtaposed with towering geologic features and dramatic waterfalls have been recognized as outstanding resources of Yosemite Valley. Indeed, the beauty of the Yosemite landscape came to the attention of the nation largely through the early writings, paintings, and photographs produced by nationally recognized artists and visitors to the region, who in many ways influenced the U.S. Congressional legislation leading to the designation of Yosemite as a place worthy of preservation. The scenic resources of Yosemite have a high degree of cultural significance. Most of the quintessential views into and from the Valley are iconic and are reflected in the works of artists including Albert Bierstadt, Ansel Adams, Thomas Moran, and Myron Hunt. The entire park, including the wilderness and other areas outside Yosemite Valley, remains a favorite subject for professional and amateur artists, photographers, and writers, whose work continues to communicate to visitors and nonvisitors alike the unique scenic resource values of the park.

Scenic views from nearly all lands within the Merced River corridor are distinctive. Steep valley and canyon walls, clear air, spectacular rock formations, and panoramic views combine to offer a wealth of visual resources nearly unsurpassed in the United States. As people move through the varied topography and vegetation along sections of the valleys and canyons that characterize the Merced River, whether on foot, horseback, bicycle, or nonmotorized watercraft, they experience a sequence or pattern of visual resources that give a cumulative visual experience. This in itself is a unique experience above and beyond that of enjoying any one single viewpoint. This cumulative experience involves the interaction of multiple elements in relation to each other: the juxtaposition of individual features with the foreground and background, the interface of different surfaces, and the interplay of light reflecting off the different colors and textures of the elements making up the visual landscape. Protecting this pattern of visual resources is as important as protecting any one visual resource.

The visual landscape is the main reason that Yosemite National Park was established and is one of the primary resources that the National Park Service is charged with protecting. As such, the National Park Service has taken the approach in analyzing potential impacts on visual resources that these inherent resources are self-evidently valuable, and the crux of any analysis is concentrated on how visitors to the park experience these resources. Following this principle, the National Park Service established policies and regulations to protect visual resources, including efforts to characterize and catalog important scenic landscapes. In the past 20 years, the National Park Service has further developed these policies by identifying important scenic resources and establishing a framework for protecting them, including restrictions on development of humanmade structures within visually important areas. Today, although structures and infrastructure intrude into some scenic views from the main stem and South Fork of the Merced

River, or views of the river (such as the roads near the river in Yosemite Valley), the area is largely pristine and humanmade features do not dominate, even in the landscapes where they are visible.

Wilderness Visual Resources

Visual resources viewable from within the Upper Merced River corridor in the Yosemite Wilderness are less studied than those in Yosemite Valley and other developed areas but exhibit equivalent scenic resource value. Domes and other rock features dominate the scenery in Little Yosemite Valley, where the Merced River meanders through relatively flat land formed by ancient glaciers. Farther upstream past Bunnell Cascade, which is itself an important visual resource, the canyon narrows into the Lost Valley, then Echo Valley, and then opens again to meadows and lakes in the area of Merced and Washburn Lakes. Above Washburn Lake, the river includes lakes surrounded by peaks of the Clark and Cathedral Ranges, which both are important scenic resources within the Yosemite Wilderness and the Ansel Adams Wilderness (Inyo and Sierra National Forests) and contribute to the scenic resources of the Merced River. Visual intrusions in this area include the Merced Lake High Sierra Camp and the composting toilet at Little Yosemite Valley Backpackers Campground.

Similarly, the wilderness areas in the upper reaches of the South Fork of the Merced River largely remain as pristine and undisturbed as they were hundreds of years ago. Visitors to the South Fork experience views of large pothole pools within slickrock cascades, old growth forest, and meadowlands. The South Fork travels through V-shaped canyons; prominent features of the wilderness along the South Fork include Moraine Meadows and soda springs above Gravelly Ford.

Farther downstream, as the South Fork approaches Wawona, important visual resources include Wawona Dome. Scenic resources in the South Fork canyon below Wawona consist primarily of whitewater cascades tumbling down the deep and narrow, untrailed canyon.

With the exception of the few buildings around Merced Lake, trails, trail signs, and bridges, virtually no humanmade structures intrude into the views of the wilderness. Only a small fraction of the visitors to the park ever experience the scenic resources of the wilderness; the lack of people and modern cultural artifacts enhances the beauty of the area and the opportunity to enjoy these landscapes.

Yosemite Valley Visual Resources

Scenic resources have been studied and analyzed in Yosemite National Park since at least 1865, when a board of commissioners appointed by the governor of the State of California commissioned three artists to study and document the scenery of Yosemite. The Merced River is featured prominently in the work produced by that commission. Most recently, as part of the development of its *General Management Plan*, the National Park Service conducted a study in the late 1970s to determine existing viewing conditions within Yosemite Valley and to identify the landscape features most visitors look for and are able to distinguish. Based on this study, the 11 most important features within Yosemite Valley are Half Dome, Yosemite Falls, El Capitan, Bridalveil Fall, Three Brothers, Cathedral Rocks and Spires, Sentinel Rock, Glacier Point, North Dome, Washington Column, and Royal Arches. The study also evaluated all points from which these 11 features could be seen (assuming no vegetation or structures obstructed the view) to establish the scenic viewing potential of different locations on the Valley floor. Existing viewpoints were identified and rated for the quality of their views and their proximity to roads

and trails. All 11 of these features can be seen from various sections of the Merced River through Yosemite Valley. Other important scenic resources viewable from within the Merced River corridor in Yosemite Valley include Nevada, Illilouette, and Ribbon Falls; the cliffs at Yosemite Point/Lost Arrow Spire; and the scenic interface of river, rock, meadow, and forest throughout the Valley.

The historic viewpoint analysis identified areas within Yosemite Valley that were consistently selected by eminent historic photographers and painters as the best areas for photographing and painting scenic features. The Merced River is featured prominently in the foreground, intermediate ground, or background of many historical viewpoints of the Valley, both inside and outside the Merced River corridor. Once the existing and historic viewpoints were established, specific locations in the Valley were classified in the *General Management Plan* according to the following criteria:

- *A–Scenic* are areas included in scenic views commonly chosen by eminent early photographers and painters, or included in the most significant scenic views that exist today (includes all meadows and the entire length of the Merced River in the Valley).
- *B–Scenic* are areas included in scenic views less commonly chosen by historic photographers and painters, or that compose less significant modern views, based on park managements' observations.
- *C–Scenic* are areas of minor scenic quality and areas that can absorb visual intrusion without detracting from either primary or secondary views.

The study conducted for the *General Management Plan* resulted in the development of a Yosemite Valley Scenic Analysis map (refer to figure III-6 in the Merced River Plan/FEIS). This map is a compilation of the Yosemite Valley historic and existing viewpoint analyses in the *General Management Plan*.

The Yosemite Valley Scenic Analysis map allows better understanding of existing conditions within each of the scenic categories established in the *General Management Plan*. Areas in the Valley with visual impacts include 155 acres of the 1,800 acres classified as A–Scenic, 222 acres of the 1,116 acres classified as B–Scenic, and 28 acres of the 73 acres classified as C–Scenic. These impacts are primarily intrusions by humanmade features, though some historically important views have become blocked by non-native vegetation. Major existing visual intrusions are roads and traffic through Ahwahnee Meadow, Stoneman Meadow, and other meadows when viewing Half Dome (one of the 11 most important features) from the Valley floor, including from within the Merced River corridor. Other major intrusions into the scenic beauty of Yosemite Valley include National Park Service and concessioner maintenance and warehouse facilities, Camp 6, and Curry Village. Of the 155 acres of affected A–Scenic resources, 5 acres are located within the Merced River corridor in the west Valley. These include the Bridalveil Fall parking lot and Cathedral Beach and El Capitan Picnic Areas. Table IV-8 identifies the major visual intrusions within each scenic category.

Table IV-8
Summary of Major Intrusions Within Each Scenic Category

Scenic Category	Existing Major Intrusions	Number of Acres	Total Number of Acres of Scenic Category
A–Scenic	Yosemite Lodge, Camp 6, Lower Pines Campground, North Pines Campground[a]	155 acres	1,800 acres Valleywide
B–Scenic	Yosemite Village, Camp 4, Curry Village, Upper Pines, Valley Stable, Housekeeping Camp[a]	222 acres	1,116 acres Valleywide
C–Scenic	Southeastern portion of Upper Pines Campground[a]	28 acres	73 acres Valleywide

a This does not reflect all development within this scenic category

Merced River Gorge Visual Resources

Visual resources within the V-shaped Merced River gorge downstream from Yosemite Valley are somewhat limited because of the steep terrain and forest cover. Important views from the Merced River or its banks within the gorge include panoramic views of the steep walls and rock features that define the gorge, such as Pulpit Rock, the Rostrum, and Elephant Rock, as well as the Cascades and other spectacular rapids among giant boulders. Some humanmade structures intrude into the views from within the Merced River corridor in the gorge, such as the Cascades Power Plant, but these structures do not dominate the natural landscape from any viewpoint.

El Portal

As the gorge widens into the El Portal area, views are slightly expanded. As in the Valley and the Merced River gorge, the canyon walls are still steep in El Portal. Scenery directly viewed from within the Merced River corridor is primarily of the river and the canyon walls. Because the vegetation has changed from a Sierran mixed conifer to oak woodland in the lower part of the gorge and because the canyon walls illustrate the geologic transition from granite to metasedimentary bedrock, the El Portal segment provides scenery that is different from other parts of the Merced River corridor within Yosemite National Park. Distinct views of Chinquapin Fall to the east of El Portal are visible from several locations in the El Portal segment. Humanmade structures (including stores, housing, a gas station, a trailer village, and park administrative facilities) and Highway 140 are adjacent to the river, the foreground views from the river corridor throughout the El Portal segment are diminished.

Wawona Area Visual Resources

Scenery directly viewed from within the Merced River corridor in the Wawona area is primarily of the South Fork itself, with distant views of forests and granite features such as Wawona Dome. Near views include managed landscapes throughout the private development in Section 35 downriver to the Wawona Campground. Due to this scale, these elements may not dominate the landscape but are an element of the mix of landscapes themselves.

Common Conditions Affecting Visual Resources

A condition that may substantially impair the enjoyment of visual resources at times in all areas of the park is the decreased visibility caused by photochemical smog. Photochemical smog is created through a series of chemical reactions that occur whenever sufficient concentrations of nitrogen oxides and hydrocarbons are exposed to ultraviolet light. Exact information on the degree of decreased visibility caused by smog in Yosemite is not currently available. The degree of visibility loss generally is a function of the time of day, relative humidity, and meteorological conditions.

However, because nitrogen oxide and hydrocarbon concentrations in the park approach levels recorded in urban areas, it is assumed that some decrease in visibility in Yosemite is associated with vehicle exhaust emissions. Decreased visibility may also be experienced at times from smoke caused by natural and prescribed fires or campfires.

Another factor that may affect the experience of visual resources seen from the Merced River or its banks is the change in patterns of vegetation in the park caused by humans since early Euro-American settlers entered Yosemite Valley. Early historical photographs of the Valley depict the forested or riparian banks of the Merced River dominated by broad-leafed trees before Euro-American settlers began developing the Valley. Early photos of Yosemite Valley also show that the meadows were considerably larger because of the high water table and seasonal flooding prior to the blasting of a portion of the El Capitan moraine in 1879. Due in part to the lowering of the moraine and subsequent lowering of water tables, the banks of the Merced River are now dominated by pine trees and other conifers, which grow taller and in denser stands than broad-leafed trees, thus significantly blocking views that were previously open. In addition, because natural or cultural fire processes were discontinued during Euro-American settlement in the Valley, dense stands of conifers have cropped up in previously open meadows and block historically open scenic views. The National Park Service has considered restoring the vegetation along the Merced River and in the meadows to conditions similar to those of the mid-1800s and may undertake such an effort in the future.

Socioeconomics

According to visitor reports, approximately 3.4 million people visit Yosemite National Park annually (NPS 2004e). Yosemite visitors spend millions of dollars on entrance fees, campgrounds, hotel lodging, meals, transportation, and other goods and services both inside the park and in gateway communities outside the park. As a result, visitor spending is an important source of income and employment for the park, the primary park concessioner, and the gateway communities.

This socioeconomics section contains three subsections. The first section characterizes the regional economy, which includes Madera, Mariposa, Merced, Mono, and Tuolumne Counties. The affected region includes the four counties surrounding the park, plus Merced County. Economic and statistical profiles were developed for each county surrounding the park to assess the importance of tourism to the region. The profiles provide an economic baseline with detailed information on the size of each county's principal economic sectors in terms of output, income, employment, and other relevant economic indicators.

The economic effects of Yosemite National Park visitor spending on the counties surrounding the park are related to the underlying structure of each county's economy. Counties with a large proportion of tourism-related businesses are more affected by changes in tourism spending than counties where tourism-dependent businesses constitute a small component of the economy.

The second section profiles socioeconomic conditions in the three primary developed areas along the main stem and South Fork of the Merced River: Yosemite Valley, Wawona, and the El Portal Administrative Site. The section provides information on housing, employment, primary concessioner and National Park Service facilities, and community amenities.

The third section characterizes the Yosemite National Park visitor population. The profile includes visitor trip characteristics, visitor population characteristics, park visitation trends, regional lodging characteristics, and visitor expenditures. This section also provides visitor demographics information on minority and low-income populations.

The information provided on the regional economy is largely drawn from a socioeconomic report prepared by Dornbusch & Company, Inc. (1999) for the National Park Service. IMPLAN, an economic model that estimates the effects on a specific economy from changes in spending, was the primary data source used to compile the economic baseline. Micro IMPLAN Group (1996) provided county-specific data on income, output, and other economic variables as part of its input-output system. The IMPLAN data were indexed to 1998 dollars using the U.S. Department of Labor, Bureau of Labor Statistics, Consumer Price Index for All Urban Consumers (Bureau of Labor Statistics 2004). Other economic data were drawn from the U.S. Bureau of the Census (2004), the California Department of Finance (2004) and California Employment Development Department (2004), and the California State Board of Equalization (2004).

Regional Economy

The region evaluated in this section includes the five primary gateway counties to Yosemite National Park: Madera, Mariposa, Merced, Mono, and Tuolumne Counties. The four main access roads to the park pass through the five gateway counties; Highway 41 passes through Madera and Mariposa Counties, Highway 140 passes through Mariposa and Merced Counties, Highway 120 east passes through Mono County, and Highway 120 west passes through Tuolumne County. The discussion generally provides information on areas within 100 miles, or 2.5 hours driving time, from Yosemite Valley. Travel and lodging expenditures within the 100-mile radius of Yosemite Valley are likely to be Yosemite National Park–related, since the park is the dominant tourist destination in the region (Dornbusch & Company, Inc. 1999).

Yosemite National Park is primarily located in Mariposa and Tuolumne Counties, with a small southern portion in Madera County. The developed areas along the main stem and South Fork of the Merced River are located within the jurisdiction of Mariposa County, including Yosemite Valley and the El Portal Administrative Site, with the exception of a portion of Wawona, which is located in Madera County.

Stanislaus, San Joaquin, and Fresno Counties were excluded from the affected region because it is difficult to distinguish the portions of the tourist economies of these counties that are associated with Yosemite visitation versus other tourist destinations. Also, tourism is a relatively small component of these counties' overall economies.

Regional Comparison

Population. In 2003, the total population of the five-county affected region was approximately 441,393 (see table IV-9). Merced County is the most populous county, with roughly 231,574 residents and accounts for over 50% of the residents in the five-county region. Mono County is the least populous of the five counties, with about 12,988 residents, despite having the largest land area. Mariposa County has a total population of approximately 17,803 residents. Table IV-9 provides population figures for the five counties in the affected region.

Table IV-9
Population by County

County	Population (2003)
Madera	133,463
Mariposa	17,803
Merced	231,574
Mono	12,988
Tuolumne	56,755
Total	441,393

SOURCE: U.S. Bureau of the Census 2004.

The populations of all five counties in the affected region are predicted to grow steadily through 2050 (see table IV-10). The rate of population growth in the region is expected to peak between 2010 and 2020, with a growth of 24% in that decade. The per-decade rate of population growth is expected to decrease after 2020. Over the long-term, the region is expected to see an average population growth of 20% per decade. Merced, the largest county, is expected to see the greatest population growth over this period, averaging 24.4% growth per decade.

Table IV-10
County Population Projections, 2000-2050

County	2000	2010	2020	2030	2040	2050
Madera	124,372	150,278	183,966	219,832	259,353	302,859
Mariposa	17,185	18,608	20,607	22,435	23,979	25,456
Merced	210,876	277,715	360,831	437,880	528,788	625,313
Mono	12,939	14,705	16,248	17,471	18,178	18,862
Tuolumne	54,946	59,883	65,452	68,566	70,537	72,265
Total	420,318	521,189	647,104	766,184	900,835	1,044,755

SOURCE: California Department of Finance 2004.

Employment. The employment figures include all waged, salaried, and self-employed jobs in each county, and both full-time and part-time workers. In 1996, total employment was approximately 164,000 in the five-county area. Approximately 47.8% of the total employment in the affected region was in Merced County (Dornbusch & Company, Inc. 1999). Madera County had the second largest employment base in the region, accounting for approximately 29.3% of total employment. Mariposa County, which includes Yosemite Valley, El Portal, and Wawona, accounted for approximately 4.9% of total employment in the affected region. Table IV-11 provides total employment estimates for the counties by industry sector. The figures are used as the baseline for employment conditions.

Table IV-11
1996 Employment by Major Industry Sector

Industry Sector	Madera	Mariposa	Merced	Mono	Tuolumne	Total
Total	48,106	8,095	78,565	8,104	21,479	164,349
Agriculture	13,977	348	15,899	170	520	30,913
Mining	108	31	12	36	118	304
Construction	2,666	467	3,193	797	1,893	9,016
Manufacturing	3,836	354	10,832	111	1,422	16,554
Transportation, Public Utilities	2,848	299	5,199	218	1,248	9,812
Wholesale Trade	1,269	56	1,886	84	321	3,617
Retail Trade	2,614	287	4,913	653	2,183	10,650
Food Stores/Eating & Drinking	3,137	674	6,539	1,156	2,406	13,912
Finance, Insurance, Real Estate	1,833	352	3,879	625	1,372	8,062
Hotels & Lodging	615	2,386	310	1,862	532	5,706
Services	8,434	970	13,026	1,056	5,252	28,738
Government	6,769	1,871	12,877	1,336	4,212	27,065

SOURCES: Micro IMPLAN Group 1996, Input-Output System B IMPLAN, and Dornbusch & Company, Inc. 1999. Totals may not add up exactly due to rounding.

According to estimates from Census 2000, the total civilian labor force in the five-county region in 2000 was 172,927, of which 151,892 were employed. All five counties have unemployment rates above the national and state averages. The region's average rate of unemployment in 2000 was 12.2% compared to a 2000 unemployment rate of 7.0% for California overall (U.S. Bureau of the Census 2000).

Income. Total personal income includes employee compensation, proprietor income, other property income, and indirect business tax. In 1996, total personal income for the five-county area was approximately $6.9 billion (1998 dollars) (see table IV-12) (Dornbusch & Company, Inc. 1999). Merced County accounted for approximately 48.1% of total personal income in the five-county affected environment, and Madera County, with the second largest economy, accounted for approximately 28.6%. Mariposa County accounted for approximately 4.7% of total personal income in the affected region.

Table IV-12
1996 Income by Major Industry Sector (in Millions of 1998 Dollars)

Industry Sector	Madera	Mariposa	Merced	Mono	Tuolumne	Total
Total	$1,962.8	$319.3	$3,301.3	$355.5	$918.3	$6,857.2
Agriculture	$415.8	$16.6	$583.0	$7.9	$21.6	$1,044.9
Mining	$8.2	$2.2	$0.7	$3.1	$9.6	$23.9
Construction	$86.8	$13.5	$101.5	$25.9	$59.5	$287.2
Manufacturing	$269.9	$14.2	$552.4	$3.3	$98.7	$938.4
Transportation, Public Utilities	$173.8	$20.3	$350.5	$17.9	$83.2	$645.7
Wholesale Trade	$86.4	$3.1	$104.1	$5.1	$15.4	$214.2
Retail Trade	$66.7	$7.9	$124.8	$16.1	$56.7	$272.2
Food Stores/Eating & Drinking	$69.9	$13.7	$152.8	$26.2	$53.4	$315.9
Finance, Insurance, Real Estate	$257.6	$57.1	$466.2	$91.0	$167.2	$1,039.0
Hotels & Lodging	$16.9	$77.4	$6.7	$68.8	$11.8	$181.6
Services	$245.7	$24.0	$372.7	$25.8	$167.4	$835.5
Government	$265.1	$69.3	$485.9	$64.6	$173.9	$1,058.8

SOURCES: Micro IMPLAN Group 1996, Input-Output System B IMPLAN, as compiled by George Goldman, Department of Agricultural and Resource Economics, University of California at Berkeley; and Dornbusch & Company, Inc. 1999. Totals may not add up exactly due to rounding.

Output. Economic output is a measure of productivity. Measures of economic output vary depending on the industry sector. For the agricultural, wholesale trade, and retail trade sectors, output is measured by the value of products sold. In the manufacturing sector, output is a measure of the value added by the manufacturer or the value of shipments. In the service sector, output is measured as receipts in dollars (Dornbusch & Company, Inc. 1999).

The estimated total output of goods and services for the five-county affected region in 1996 was approximately $13.1 billion (1998 dollars) (see table IV-13). Merced County accounted for approximately 53.6% of total economic output in the affected region. Mariposa County, which had the smallest economy in the five-county affected region, accounted for approximately 4.0% of output. Based on output, manufacturing was the largest economic sector in the five counties combined.

Table IV-13
1996 Economic Output by County and Industry Sector (in Millions of 1998 Dollars)

Industry Sector	Madera	Mariposa	Merced	Mono	Tuolumne	Total
Total	$3,498.0	$528.6	$7,046.7	$554.4	$1,518.4	$13,146.1
Agriculture	$798.1	$22.3	$1,385.5	$14.8	$33.3	$2,254.0
Mining	$14.0	$5.5	$1.1	$5.2	$19.9	$45.7
Construction	$224.2	$37.1	$265.1	$66.8	$156.1	$749.2
Manufacturing	$730.5	$41.7	$2,292.2	$9.4	$259.6	$3,333.4
Transportation, Public Utilities	$321.1	$51.6	$718.5	$27.3	$150.0	$1,268.5
Wholesale Trade	$125.0	$4.5	$150.7	$7.4	$22.3	$310.0
Retail Trade	$82.5	$9.5	$155.4	$19.7	$69.7	$336.8
Food Stores/Eating & Drinking	$109.6	$21.8	$242.3	$44.4	$84.9	$502.9
Finance, Insurance, Real Estate	$365.4	$81.2	$680.0	$128.5	$237.4	$1,492.4
Hotels & Lodging	$31.1	$136.3	$13.3	$117.6	$23.1	$321.4
Services	$428.0	$46.6	$621.2	$48.5	$279.1	$1,423.4
Government	$268.6	$70.4	$521.6	$64.9	$183.0	$1,108.5

SOURCES: Micro IMPLAN Group (1996), Input-Output System B IMPLAN, and Dornbusch & Company, Inc. 1999. Totals may not add up exactly due to rounding.

Taxable Retail Sales. Taxable retail sales are good indicators of annual spending in the travel-service sectors, since they represent the taxes paid for transactions with consumers. The total taxable retail sales figures include the taxes paid by businesses on raw materials and services. In 1998, the total taxable retail sales for the five counties was nearly $3.0 billion (1998 dollars). Merced County accounted for approximately 49.9% of total taxable sales in the five-county affected region, followed by Madera County, which accounted for 26.5%. Taxable sales for the region increased by almost 13% from 1998 to 2002. Merced County now accounts for over half of taxable sales in the region (51.6%).

Mariposa County, which includes Yosemite Valley, El Portal, and Wawona, accounted for about 4.2% of total taxable sales in 1998 and only 3.6% of taxable sales in 2002. Table IV-14 shows total taxable retail sales by county.

Table IV-14
1998-2002 Total Taxable Retail Sales by County (in Millions of 1998 Dollars)

County	1998	1999	2000	2001	2002
Total	$2,920.0	2,645.8	3,113.1	3,261.0	$3,291.6
Madera	$777.8	704.7	810.8	833.9	$795.0
Mariposa	$121.7	110.3	124.5	120.5	$119.7
Merced	$1,454.8	1,318.2	1,557.7	1,647.3	$1,698.4
Mono	$158.0	143.2	174.0	185.3	$185.4
Tuolumne	$407.7	369.4	446.1	474.0	$493.1

SOURCES: California State Board of Equalization 2004, Bureau of Labor Statistics 2004.

County Profiles

Madera County. The central economic activity in Madera County is agriculture, which constitutes nearly one-third of the county's total employment and over 20% of the county's personal income and economic output (see tables IV-11, IV-12, and IV-13). The agricultural sector stimulates production in related sectors of the economy, including jobs in food processing, transportation, and wholesale trade (Dornbusch & Company, Inc. 1999).

According to the U.S. Department of Commerce (2004), personal income in Madera County increased from $1,794.8 million in 1996 to $2,320.2 million in 2001, an increase of 29%. Nonfarm employment in Madera County is expected to increase from 28,100 in 2001 to 33,200 jobs in 2008, an increase of 18.1% (California Employment Development Department 2004). The service industry accounts for the largest portion of non-farm employment and is expected to grow the most rapidly. Government employment, the second largest non-farm industry, is also expected to increase rapidly through 2008. Trade and manufacturing industries are also expected to grow, while transportation, public utilities, finance, insurance, and real estate are expected to be stable.

Mariposa County. Recreation and tourism are major industries in Mariposa County. The county's primary recreation area/tourist attraction is Yosemite National Park, much of which lies within the county, including the developed areas of Yosemite Valley, Wawona, and the El Portal Administrative Site. Major recreation areas in Mariposa County include Stanislaus National Forest and Sierra National Forest, including the U.S. Forest Service/Bureau of Land Management–managed recreation areas along the Merced River. Other recreation resources in

Mariposa County include Lake McSwain and Lake McClure, where camping is available (Dornbusch & Company, Inc. 1999).

Lodging, food and beverage, and other service industries are central to the county's economy and accounted for nearly 50% of employment and over one-third of personal income and economic output in 1996. Government is also a major economic sector in the county, accounting for 23.1% of employment, 21.7% of income, and 13.3% of total output. Many Yosemite National Park employees live in Mariposa County and commute to work in Yosemite National Park. The finance, insurance, and real estate sector accounted for 17.9% of income and 15.3% of economic output, although only about 4% of total employment (see tables IV-11, IV-12, and IV-13).

According to the U.S. Department of Commerce (2004), personal income in Mariposa County increased from $306.1 million in 1996 to $391.9 million in 2001, an increase of 28%. Nonfarm employment in Mariposa County is expected to grow from 5,320 in 2001 to 6,100 by 2008, an increase of 14.7% (California Employment Development Department 2004). The transportation and public utilities sector are expected to increase most rapidly, related to increased demand for transportation services to Yosemite National Park. Construction is also expected to increase substantially, as is services employment and manufacturing. Finance, insurance, and real estate employment are expected to remain stable.

Merced County. Merced County, located west of Yosemite National Park, has the largest economy in the affected region. Agriculture is the largest economic sector in Merced County and accounted for over 20% of employment, 17.7% of personal income, and 19.7% of economic output in 1996. The primary commodities include milk products, chicken, and cattle. The economy has a light industry component, much of which is geared toward agricultural products (Dornbusch & Company, Inc. 1999).

According to the U.S. Department of Commerce (2004), personal income in Merced County increased from $3,241.5 million in 1996 to $4,033.4 million in 2001, an increase of 24%. Nonfarm employment in Merced County is expected to grow from 52,200 in 2001 to 60,400 by 2008, an increase of almost 16% (California Employment Development Department 2004). Merced County will see growth in most industries, particularly construction, services, and trade. Again, finance, insurance, and real estate will remain stable.

Merced County's primary tourist attraction, particularly for the city of Merced, is Yosemite National Park, which is located over 50 miles from the county's eastern boundary (Dornbusch & Company, Inc. 1999).

Mono County. Mono County is the primary gateway county for visitors entering through the eastern park entrance. Park access via this entrance is limited in the winter, because the entrance is typically closed from November to late May due to snowfall.

Lodging, food, and beverage, and other services are central to Mono County's economy, which is also bolstered by extensive natural resources and recreational opportunities. In 1996, approximately 50% of employment and over one-third of personal income and economic output in Mono County were provided by hotels and lodging, food and beverage, and other service industries. Mammoth Lakes, which is located in southern Mono County, is the center of the county's winter tourism industry and is the fastest growing community in the county. Related

employment is erratic since it depends heavily on snowfall at Mammoth Lakes Ski Resort (Dornbusch & Company, Inc. 1999).

According to the Department of Commerce (2004), personal income in Mono County increased from $223.4 million in 1996 to $314.6 million in 2001, an increase of 41%. Nonfarm employment in Mono County is expected to grow from 6,570 in 2001 to 7,250 by 2008, an increase of 10.4% (California Employment Development Department 2004). Although construction and mining employment is expected to increase the most, service employment is also expected to grow substantially related to strong growth in lodging and recreation for tourists. Employment in government, trade, and the finance industries is also expected to increase. Manufacturing employment is expected to decrease by 2008.

Tuolumne County. Yosemite National Park is in the southeastern portion of Tuolumne County. The services sector was the largest employer in the county in 1996, accounting for 24.4% of employment and over 18% of personal income and economic output (see tables IV-11, IV-12, and IV-13).

According to the Department of Commerce (2004), personal income in Tuolumne County increased from $962.0 million in 1996 to $1,299.5 million in 2001, an increase of 35%. Nonfarm employment in Tuolumne County is projected to increase from 16,630 in 2001 to 18,750 by 2008, an increase of almost 13% (California Employment Development Department 2004). Most of the job growth is expected in the services, retail trade, construction, and manufacturing sectors, but all industry sectors are expected to increase.

Other recreational attractions in Tuolumne County include Columbia State Park, Stanislaus National Forest, Dodge Ridge Ski Area, and Leland Meadows.

Local Communities

There are three developed areas along the main stem and South Fork of the Merced River: Yosemite Valley, El Portal, and Wawona. The following discussion profiles the socioeconomic environments of these communities collectively and individually.

Employment

During the 2004 peak season, the National Park Service employed approximately 784 staff parkwide and an estimated 584 employees within the Merced River corridor (the 200 employees not counted as working in the river corridor are those employed in Tuolumne Meadows, White Wolf, Crane Flat, Hodgdon Meadows, Big Oak Flat, Mather, and Hetch Hetchy). During the 2004 peak season, the primary park concessioner employed approximately 1,875 staff within the Merced River corridor for a total of 2,459 National Park Service and primary concessioner employees (NPS 2004g).

Housing

National Park Service employees are generally housed in single-family homes, apartments, and dorms. Currently a total of 1,683 employee beds exist within the Merced River corridor and are distributed as follows: Yosemite Valley – 1,241 employee beds, Merced River gorge – 7 employee beds, El Portal – 290 employee beds, and Wawona – 145 employee beds.

Commuters

It is estimated that 606 National Park Service and concessioner staff currently commute into the river corridor daily. The number of commuters was estimated by determining the difference in the number of employees working in the corridor and the number of employees housed in the corridor. In addition, due to the distribution of employee work shifts across all 7 days of the week, it was estimated that approximately 71% of the total potential commuters enter the corridor on a given day.

Yosemite Wilderness

Facilities. Few visitor-serving accommodations are located in wilderness areas along the Merced River. The only facilities within the wilderness reaches of the Merced River corridor include restrooms at the Backpackers Campgrounds (Little Yosemite Valley and Merced Lake), a ranger station tent at Little Yosemite Valley, and the Merced Lake High Sierra Camp. The primary park concessioner operates Merced Lake High Sierra Camp, which is located in proximity to the Merced Lake Backpackers Campground. Merced Lake High Sierra Camp is one of five High Sierra Camps located in the Wilderness of Yosemite National Park. Guests are lodged in tent cabins, and meals are served. Merced Lake High Sierra Camp has a total of 19 visitor tent cabins and a capacity of approximately 60 overnight visitors.

Employment. Most workers in the Wilderness areas are employed by the National Park Service. These workers include law enforcement rangers, trail crews, back country utility workers, and resource managers. The primary park concessioner also provides employment in the wilderness.

Yosemite Valley

Yosemite Valley is the economic center of Yosemite National Park. Yosemite Valley is the park's most popular visitor destination, with over 80% of tourists visiting the Valley (Nelson\Nygaard Consulting Associates 1998).

Facilities. Yosemite Valley hosts the most concentrated array of visitor services and facilities in the park. Yosemite Village is the core area for most of the development and day use in Yosemite Valley and includes a visitor center, museum, concessioner Village Store complex and food service, and National Park Service and primary park concessioner administration offices.

Camping in Yosemite Valley is provided at six campgrounds. The three drive-in campgrounds, Upper Pines Campground, Lower Pines Campground, and North Pines Campground, operate on a reservation system though the National Park Reservation Service. Camp 4 is a first-come, first-served walk-in campground. Backpackers Campground, another walk-in campground, is reserved for pre- and post-trip nights for wilderness permit holders. Yellow Pine is a National Park Service volunteer walk-in campground. Although the campgrounds are not concession operated, campers use concession facilities located elsewhere, including showers, coin-operated laundries, stores, and restaurants.

The revenue-generating services in Yosemite Valley are predominantly operated by the primary park concessioner. Major concessioner facilities outside of Yosemite Village include the 245-room Yosemite Lodge, The Ahwahnee (with 123 rooms), the 266-unit Housekeeping Camp, the 628-unit Curry Village, and the Valley stable. The lodging facilities are accompanied by concession-operated food service and stores. The concessioner operates several equipment-rental establishments that provide bicycles, rafts, and cross-country skis.

Commute. Generally, individuals who reside in Yosemite Valley also work there. Commute time into Yosemite Valley from El Portal is approximately 30 minutes, and from Mariposa is about 60 minutes. Commute time between Yosemite Valley and Wawona is approximately 50 minutes. The commute from Yosemite Valley is approximately 70 minutes to Fish Camp, 75 minutes to Sugar Pine, and 80 minutes to Oakhurst (table IV-15). Heavy visitor traffic during the summer and snow during the winter can increase commute times.

Table IV-15
Employee Housing at Selected Locations in Yosemite National Park[a]

	Total Employee Housing[a, b] (Valley, Wawona, El Portal)
Yosemite Valley	1,241
El Portal	290[c]
Wawona	145
Gorge (Arch Rock)	7
TOTAL	1,683

a Housing data presented in this table indicate the number of beds dedicated to an employee. For example, a single-family house dedicated to one employee is considered to be one bed. Spouses or partners employed by other employers are not double counted, as beds are assigned to the primary employee whose job permits the housing allotment. Privately owned housing is counted as an individual unit (bed).
b Includes private housing in El Portal and Wawona, and other employers' housing (Yosemite Institute, Yosemite Association, U.S. Post Office, etc.).
c Some of these units are privately owned trailers in the El Portal Trailer Village that are occupied by primary park concessioner employees.
SOURCE: NPS 2004g

Community Amenities. Community amenities are facilities that support the basic functions of a human settlement, including schools, libraries, post offices, and stores. Yosemite Valley has the highest concentration of amenities in the park. Yosemite Valley has an elementary school that includes kindergarten through eighth grade. Junior high and high school students typically travel to Mariposa to attend school. Stores and restaurants are provided in Yosemite Lodge, Yosemite Village, The Ahwahnee, and Curry Village areas. These facilities are generally within walking distance of major housing areas and offer quick, relatively convenient services. Other Yosemite Valley amenities include a post office, a medical and dental clinic, laundry facilities, wellness center, hair care, uniform service, entertainment, and security personnel. The spectacular natural environment of Yosemite Valley provides outdoor recreational opportunities for Valley residents.

El Portal

The community of El Portal is located within the El Portal Administrative Site, located approximately 16 miles west of Yosemite Valley on Highway 140. The El Portal Administrative Site is a 1,139-acre area that was designated by the U.S. Congress as an administrative area for the National Park Service in 1958.

Facilities. El Portal houses many functions essential to the management and operation of Yosemite National Park, and serves as a primary housing area for park permanent, term, and seasonal employees. Primary administrative, maintenance, laboratory, storage, and warehouse facilities are located on the site. Concessioner and park partner administrative and operational facilities in El Portal include Yosemite Association and Yosemite Institute facilities, a small grocery store, a service station, a bulk fuel storage area, and a telecommunications facility.

Adjacent to both the El Portal Administrative Site and the Yosemite National Park boundary is a 44-acre parcel of private property that contains a 335-room hotel, with restaurant facilities, conference and meeting room facilities, and a grocery/gift store.

Employment. Most workers in El Portal are employed by the National Park Service. Other employers include two concessioners who operate the service station and grocery store in El Portal, the Yosemite Association, the Yosemite Institute, the Yosemite Fund, the Mariposa County School District, and the U.S. Postal Service.

Housing. El Portal is a small community of approximately 640 residents. Individuals living in El Portal generally work for the National Park Service, park partners, or one of the park concessioners. Many employees who reside in El Portal do not live in government- or company-owned housing. Many homes in Old El Portal are privately owned but are located on land owned by the federal government. Homeowners in Old El Portal lease these parcels through the park's special-use permit program. Currently, regulations are being developed to describe the administrative relationship between these private homeowners and the National Park Service.

Currently 290 employee beds are located in El Portal (table IV-15), including Rancheria Flat and a few government-owned residences in El Portal Village Center.

Commute. Many employees who live in El Portal commute from El Portal to Yosemite Valley. Commuting time between El Portal and Yosemite Valley is approximately 30 minutes. Heavy visitor traffic on El Portal Road during the summer, and snow during the winter, can increase commute time. Regional transit is provided to El Portal by YARTS.

Community Amenities. El Portal is a small community with few amenities. These include an elementary school with kindergarten through sixth grades, a small high school a county library, a child development center, a post office, a chapel, a Wildland/Structural Fire Station and ambulance bay, and the Carroll Clark Community Hall, Recreational amenities include a baseball/soccer field, two tennis courts, a basketball court, a seasonal swimming pool, and two playgrounds. Other amenities include a concessioner-run service station and general store, as well as a privately owned restaurant at the Yosemite View Lodge. The spectacular natural environment of El Portal provides additional outdoor recreational opportunities for local residents such as swimming, fishing, hiking, and mountain biking.

Wawona

Wawona is located in the southwestern portion of Yosemite National Park.

Facilities. The National Park Service operates the 99-site Wawona Campground, the two-campsite Wawona Horse Camp, and the Pioneer Yosemite History Center, which is a collection of historic buildings relocated to the Wawona area from various locations throughout the park. The National Park Service offers stagecoach rides across the historic Covered Bridge to the Pioneer Yosemite History Center.

The concession facilities in Wawona include the 104-room Wawona Hotel complex, which features a dining room, bar, golf course, pro shop, and snack bar. Other concession facilities include a grocery store, gift shop, service station, and stable (NPS 1992a).

Employment. Most workers in Wawona are employed by the National Park Service or the primary concessioner. Additional employers include the U.S. Postal Service and the Madera County School District.

Housing. Individuals residing in Wawona generally do not work for the National Park Service or the primary park concessioner. Most individuals are retired, have external incomes, and are seasonal residents.

Most of the residences in Wawona are located in Section 35, which includes about 350 homes. Approximately 300 residences are privately owned (some of these residences are included in the National Park Service land acquisition program) and many are used as seasonal homes or rentals.

Employee housing includes individual residences, group houses with dormitory-style beds, and tents. Approximately 145 employee beds are located in Wawona (see table IV-15).

Commute. Commuting time between Wawona and Yosemite Valley is approximately 50 minutes. Heavy visitor traffic on the south entrance road during the summer and snow during the winter can increase commute time. The commute from Wawona is about 15 minutes to Fish Camp, 20 minutes to Sugar Pine, and 30 minutes to Oakhurst under good conditions.

Community Amenities. Wawona is a small community with few amenities. These include an elementary school with kindergarten through sixth grades, a library, a post office, a community hall, two small grocery stores, and a concession-run restaurant and service station. Recreational amenities include a baseball field, a basketball court, a golf course, and a playground. Residents may also make use of the pool and tennis court at the Wawona Hotel. The spectacular natural environment of Wawona provides outdoor recreational opportunities for local residents.

Visitor Population

The visitor population information is based on Draft Working Paper #3-3: *Year Round Data Collection Summary Report*, prepared as a concept document for the YARTS Board by Nelson\Nygaard Consulting Associates (1998). The year-round data collection effort, which gathered demographics, travel patterns, and preferences of Yosemite visitors, concluded in September 1998. The information presented below was compiled by Dornbusch & Company, Inc. (1999) from the *Year Round Data Collection Summary Report* and National Park Service monthly public use reports.

Visitor Trip Characteristics

The trip characteristics of Yosemite National Park visitors were used to determine the socioeconomic impacts on the affected region that may result from changes in park visitation and/or visitor spending. The nature and extent of socioeconomic impacts are affected by the trip characteristics of Yosemite visitors. The following analysis discusses the principal aspects of visitor trip characteristics that influence the socioeconomic impacts of annual visitation to Yosemite (Dornbusch & Company, Inc. 1999).

Approximately 80% of all visitors to the park visit Yosemite Valley–the most popular destination in the park. Wawona is also a popular park destination; approximately 20% of visitors to the park visit Wawona (Nelson\Nygaard Consulting Associates 1998).

Visitor Population Characteristics

Three categories of visitors can be identified among park visitors: park overnighters, local overnighters, and day visitors. Park overnighters are park visitors who lodge or camp overnight within the park. Overnight visitation in the park is controlled by the National Park Service and limited by the availability of lodging and camping facilities. Local overnighters are park visitors who lodge or camp within the Yosemite region during their trip. These visitors typically spend several days visiting the park. Day visitors are park visitors who either do not lodge or camp overnight in the region, or who are local residents.

In the National Park Service's visitation counts and statistics, local overnighters and day visitors are recognized as day users, since both travel daily in and out of the park during their Yosemite trip. Some visitors fall into two categories. For example, park visitors may stay overnight both inside and outside the park during their visit. For the purposes of the impact analysis, distinct visitor population estimates were developed to account for these overlaps.

According to YARTS's survey results and the population definitions described above, park overnighters constitute about 20%, local overnighters about 40%, and day visitors about 40% of the park visitor population (Dornbusch & Company, Inc. 1999).

Park Visitation Trends

The National Park Service tracks monthly visitation to Yosemite National Park, and this information is available to the public at *www2.nature.nps.gov*. Table IV-16 presents monthly visitation numbers for the 25-year period from 1980 through 2004. During this period, the park's annual attendance averaged 3.39 million, however, as shown on figure IV-4 two distinct visitation trends during this timeframe have occurred.

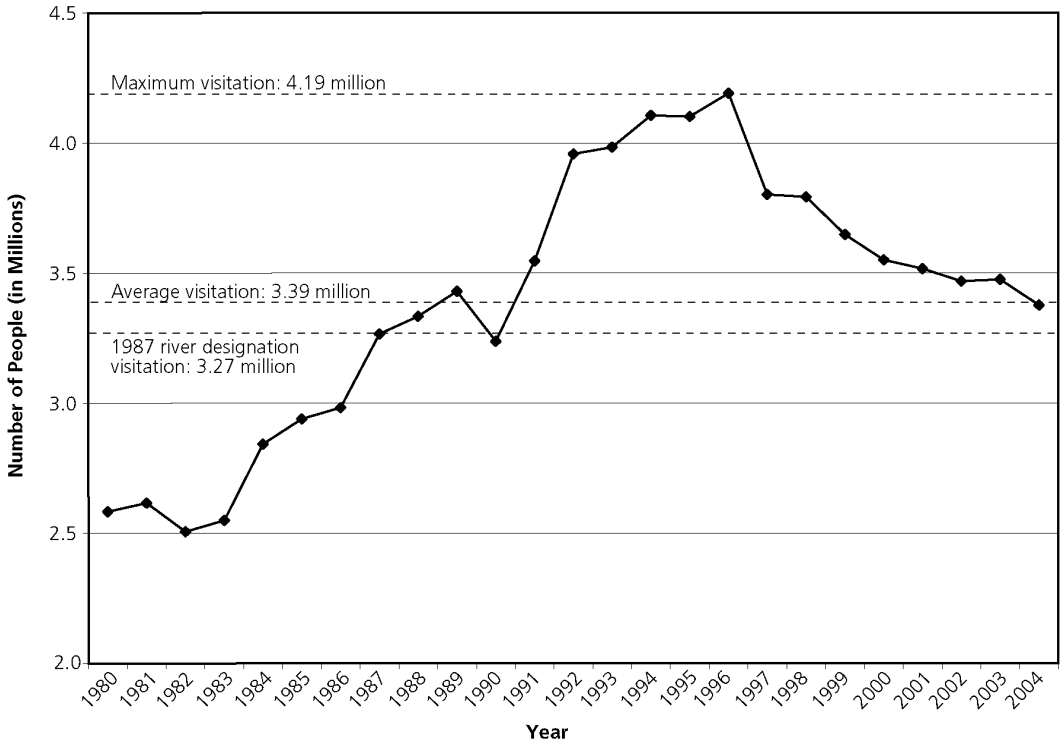
From 1980 through 1996, annual visitation generally increased from 2.58 million to a peak of 4.19 million, an increase of approximately 3.1% annually. During this period, overnight visitation within the park was relatively unchanged at approximately 2.1 million overnight stays per year. Therefore, the growth in visitation during this period can be primarily attributed to an increase in day users. Growth in day use from 1980 through 1996 rose approximately 9% per year.

After the January 1997 flood, total visitation to the park dropped from 4.19 million in 1996 to 3.80 million in 1997, a 9.3% decrease. This began a decreasing trend in annual visitation that continued through 2004, when annual visitation lowered to 3.38 million. Annual overnight stays after the 1997 flood have remained relatively unchanged at approximately 1.62 million. This decrease from pre-flood years can be attributed the loss of 397 campsites and 266 lodging units in Yosemite Valley as a result of the 1997 flood. Therefore, the decline in annual visitation to the park from 1997 through 2004 can be attributed to an average decline in day use of approximately 4.5% per year.

It is interesting to note that the annual park attendance in 1987 (when the Merced River was designated Wild and Scenic), was 3.27 million. In 2004, the annual attendance was 3.38 million, an increase of just 110,000, or approximately 3.4 % more than in 1987.

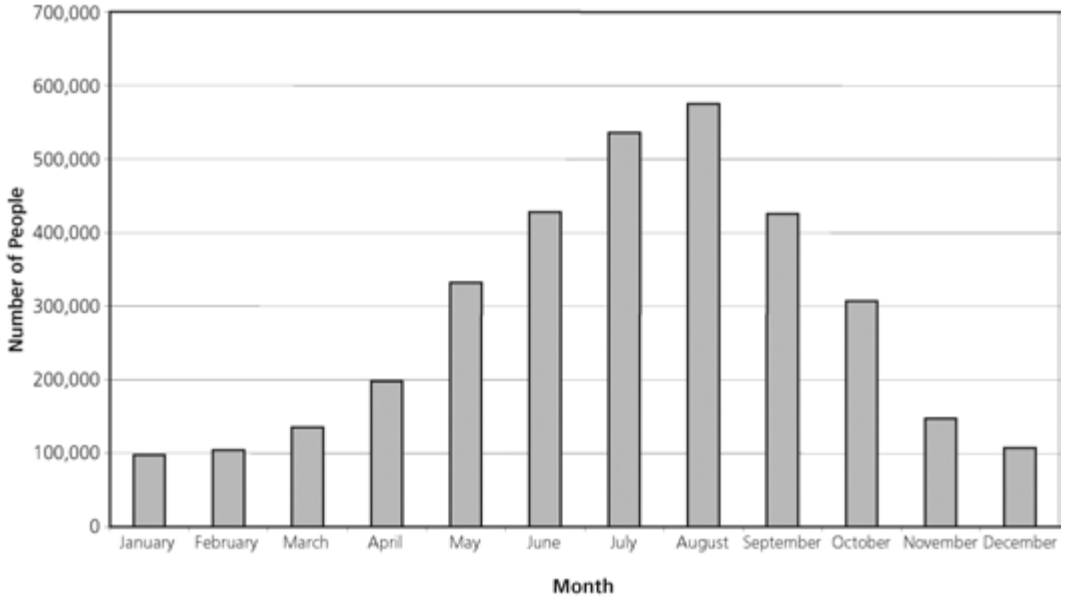
There is also a distinct seasonal distribution of visitors to the park. As shown on figure IV-5, during the same 25-year period from 1980 through 2004 visitation to the park averaged approximately 100,000 during the months of January and February, and then steadily climbed to an average of 570,000 in the month of August. After August, visitation steadily drops to approximately 110,000 in December.

Figure IV-4
Annual Park Visitation 1980 to 2004



See Table IV-16 for visitation data.
Source: Yosemite National Park Visitation Statistics from NPS Public Use Statistics web site (www2.nature.nps.gov)

Figure IV-5
Average Monthly Park Visitation



See Table IV-16 for visitation data.
Source: NPS Public Use Statistics web site: www2.nature.nps/gov (NPS 2004f)

Table IV-16
Monthly Parkwide Visitation 1980 through 2004

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Total
1980	69,483	78,784	103,920	125,702	221,019	321,000	431,693	487,419	299,942	246,776	122,538	74,878	2,583,154
1981	63,171	93,994	86,500	158,279	292,853	349,877	419,003	460,091	325,252	197,445	99,442	70,353	2,616,260
1982	63,338	70,940	73,442	76,263	263,768	376,713	440,824	448,569	314,889	214,410	88,631	74,454	2,506,241
1983	67,464	67,042	86,620	94,002	223,268	277,448	458,087	490,690	363,739	251,947	91,219	77,973	2,549,499
1984	79,215	87,145	106,225	153,721	287,408	377,477	430,166	513,105	384,295	225,951	105,765	92,469	2,842,942
1985	87,831	90,376	105,247	165,366	326,110	389,977	464,472	516,641	356,837	238,751	109,689	88,139	2,939,436
1986	96,687	77,201	119,107	157,895	302,641	375,285	455,473	541,506	352,942	254,656	156,839	92,526	2,982,758
1987	98,548	102,788	113,843	199,380	387,137	434,499	505,168	545,290	340,364	291,561	152,545	95,219	3,266,342
1988	98,563	113,907	159,359	197,609	375,059	418,842	494,513	520,373	398,934	303,151	149,765	103,853	3,333,928
1989	106,940	100,421	149,507	211,873	391,618	428,086	530,216	542,846	404,164	274,294	170,338	119,316	3,429,619
1990	103,694	105,288	150,608	246,878	377,857	439,984	498,787	380,609	377,212	285,665	168,418	102,834	3,237,834
1991	108,860	115,296	122,235	194,893	368,093	410,840	540,040	608,830	456,855	332,045	170,507	118,672	3,547,166
1992	131,820	125,612	155,425	261,559	441,132	504,193	588,083	607,441	486,824	368,711	169,695	117,147	3,957,642
1993	105,603	109,761	157,436	255,632	393,316	462,972	626,255	657,727	521,545	382,450	177,907	133,145	3,983,749
1994	136,085	131,835	192,911	256,724	398,909	513,182	607,305	690,087	529,514	348,319	152,123	148,761	4,105,755
1995	128,310	156,556	129,262	260,057	289,712	466,955	687,122	679,443	571,074	423,934	217,997	91,506	4,101,928
1996	107,781	139,893	187,291	262,972	360,793	545,917	644,949	703,707	535,468	378,036	178,344	145,406	4,190,557
1997	12,520	66,667	141,924	207,890	331,123	476,930	616,404	721,711	534,051	385,095	174,754	132,328	3,801,397
1998	118,353	113,122	163,143	240,317	318,963	359,580	626,095	697,082	498,062	398,718	147,540	111,779	3,792,754
1999	105,681	107,269	143,509	177,722	351,619	468,003	582,087	651,244	451,291	344,686	158,024	107,249	3,648,384
2000	97,985	108,347	143,057	226,438	331,465	474,099	572,126	569,982	405,343	337,950	151,514	131,759	3,550,065
2001	107,032	106,617	148,716	201,847	330,805	452,950	551,648	615,549	467,690	276,024	144,732	113,584	3,517,194
2002	113,069	118,009	147,201	193,912	307,253	450,298	529,011	585,787	437,698	309,775	155,554	120,608	3,468,175
2003	121,489	115,714	142,824	180,981	291,181	459,764	548,378	611,500	417,414	327,503	141,526	117,043	3,475,317
2004	104,098	108,296	149,543	232,515	332,403	463,077	546,905	525,887	407,037	279,791	126,304	100,477	3,376,333
Monthly Average	**97,345**	**104,435**	**135,154**	**197,617**	**331,820**	**427,918**	**535,792**	**574,925**	**425,537**	**307,106**	**147,268**	**107,259**	**3,392,177**

SOURCE: Yosemite National Park Visitation Statistics from NPS Public Use Statistics web site (www2.nature,nps.gov)

Length of Stay

Length of stay is an important factor in determining the magnitude of visitor impacts on the park, the concessioner, and the surrounding counties. The average length of stay for park visitors is based on a 1990-1991 Yosemite visitor survey (Gramann 1992). An average length of stay of 4.2 hours was used for day visitors (Dornbusch & Company, Inc. 1999).

Regional Lodging Characteristics

Approximately half of Yosemite day visitors lodge or camp overnight in the five-county affected region. These visitors are categorized as *local overnighters* in the impact analysis. Other visitors lodge overnight outside the affected regions (either at their homes or other accommodations) and are identified as *day visitors*.

Table IV-17 shows the locations where local overnighters visiting Yosemite during the summer reported staying overnight in the region. According to the survey results, the greatest percentage of local overnight visitors stay in Madera County, followed by Mono County and Mariposa County (Dornbusch & Company, Inc. 1999).

Table IV-17
Local Overnight Visitors' Lodging Locations (Summer)[a]

County	Proportion Staying Overnight[b]
Madera	32.6%
Mariposa	25.6%
Merced	1.8%
Mono	28.4%
Tuolumne	10.5%

a Summer overnight lodging patterns are most relevant, as future impacts to Yosemite visitation will predominantly occur during the summer months when visitation peaks.
b Percentages have been adjusted to account for respondents who reported lodging at other locations outside the affected region.
SOURCE: Dornbusch & Company, Inc. 1999.

The most recent information on the overnight accommodation capacities of the surrounding counties is provided by YARTS. As part of YARTS's recent planning efforts, Nelson\Nygaard Consulting Associates identified and inventoried the lodging and campground facilities in the region along main highways and in proximity to the park. Although the inventory was performed during the winter and closed facilities were not surveyed, Nelson\Nygaard Consulting Associates (1998) concluded that the inventory represents a reasonable estimate of the region's lodging and camping capacity. Table IV-18 presents the results of the analysis, adjusted to show overnight accommodation capacities by county (Dornbusch & Company, Inc. 1999).

Table IV-18
Existing Lodging and Camping Capacity in the Yosemite Region (excluding National Park Service facilities)[a]

County	Lodging Capacity (units)[b]	Camping Capacity (sites)	Total Overnight Capacity
Madera	694	292	986
Mariposa	1,182	246	1,428
Merced[c]	350+	--	350+
Mono[d]	467	348+	815+
Tuolumne[e]	118	502	620
Total	2,811+	1,388+	4,199+

a Capacity estimates are for accommodations that are either adjoining Yosemite or on primary park access routes (and excluding Yosemite Valley lodging and camping sites).
b A typical lodging unit can provide overnight accommodations for up to 4 adults.
c Capacity estimate only represents locations identified during YARTS stakeholder interviews and sites adjacent to Highway 140 and 16th Street.
d Lodging and camping at Mammoth Lakes was not included in this capacity estimate.
e Estimate does not include lodging and camping facilities in Tuolumne's Gold Country region.
SOURCE: Dornbusch & Company, Inc. 1999.

Visitor Expenditures

Average Visitor Expenditures. Visitor spending information was developed from the 1998 YARTS Draft Working Paper #3-3 (Nelson\Nygaard Consulting Associates 1998). The spending estimates presented in table IV-19 were determined by taking weighted averages of the spending ranges reported by respondents to the YARTS visitor survey (Dornbusch & Company, Inc. 1999).

Table IV-19
Average Daily Spending by Yosemite Visitors in the Affected Region (per capita in 1998 dollars)

	Day Visitors	Local Overnighters	Park Overnighters
Lodging	n/a	$31.20	$28.95
Food	$12.69	$20.63	$19.50
Retail	$6.02	$7.68	$7.65
Transportation	$6.83	$7.17	$5.20
Total	$25.54	$66.68	$61.30

SOURCE: Dornbusch & Company, Inc. 1999.

Total Visitor Expenditures. Total Yosemite visitor spending was calculated to estimate the magnitude of the economic impact that Yosemite visitation has on the surrounding counties and the primary park concessioner. The daily visitor spending estimates are the primary source for determining the annual total Yosemite visitor expenditures. Lower average daily spending figures would result in smaller aggregate economic impacts from visitor spending. Total visitor spending in each visitor category has been estimated by multiplying the average daily visitor spending figures and the corresponding annual visitation (in visitor days).

Table IV-20 provides estimates of total Yosemite visitor spending within the Yosemite region. Using estimated daily per capita spending figures for each visitor category (see table IV-19) and 1998 visitation figures obtained from National Park Service monthly public use reports, the total Yosemite visitor spending in 1998 is estimated to be approximately $240 million (1998 dollars). This figure represents only Yosemite visitor spending in the park and the surrounding region. Yosemite visitors staying overnight outside the affected region are recognized as day visitors. As a result, their spending on lodging and other services outside the affected region is not included (Dornbusch & Company, Inc. 1999).

Table IV-20
Total Spending by Yosemite Visitor Population Categories in 1998 (in 1998 dollars)

	Estimated Annual Visits (millions)	Average Length of Stay in Region (days/Yosemite Visit)	Average Total Daily Spending ($ per capita)	Total Spending in Region ($ millions)
Park Overnighters	0.59	2.7	$61.30	$97.3
Local Overnighters	1.53	1[a]	$66.68	$102.3
Day Visitors	1.53	1	$25.54	$39.2
Total	3.66			$238.8

a Local overnighters typically make multiple visits to the park during their Yosemite trip. However, each day trip into the park corresponds to one day of spending in the region.
SOURCE: Dornbusch & Company, Inc. 1999.

Visitor Demographics (Minority and Low-Income Populations)

Demographic information on the Yosemite visitor population from past Yosemite visitor surveys is limited. The 1990-1991 Gramann (1992) survey of Yosemite visitors provides the most recent and complete information on the ethnic background of Yosemite visitors; its findings are presented in table IV-21. As the table shows, non-Anglo visitors to the park are underrepresented compared to the California population. Gramann suggested that the lack of ethnic diversity in Yosemite visitation is common to most rural national parks and was probably the result of a "combination of economic constraints among ethnic minorities, differences in cultural preferences, and fears of discrimination among some ethnic groups."

Table IV-21
Ethnicity of Yosemite Visitors and California and Yosemite Region Residents

Ethnic Background	Yosemite Auto Travelers	Yosemite Bus Travelers	California Residents	Yosemite Region[a] Residents
Anglo	86.6%	80.6%	57.4%	62.7%
Hispanic	3.6%	4.5%	11.6%	11.0%
Asian	3.3%	5.8%	9.6%	5.0%
American Indian	1.4%	2.4%	0.8%	1.5%
African-American	0.4%	3.8%	7.4%	3.8%
Other	4.7%	2.9%	13.1%	16.1%

a Yosemite region includes Madera, Mariposa, Merced, Mono, and Tuolumne Counties.
SOURCE: Dornbusch & Company, Inc. 1999.

Although no more recent information is available, anecdotal information from park staff indicates that minority visitor levels have increased in recent years. The park plans to conduct a new visitor survey in 2005 to update information on visitor demographics.

The Gramann survey also reveals that the demographic mix of people living in the five counties surrounding Yosemite National Park is similar to that of the state as a whole, though African-American and Asian-American populations are somewhat lower in the five counties than the state as a whole, and American Indian populations in the five counties are significantly higher than in the state as a whole. These figures suggest that visitors to the park from the five local counties do not reflect the ethnic diversity of the local population, probably for the same reasons as mentioned above (Gramann 1992).

As shown in table IV-22, households with an annual income greater than $100,000 constitute the highest percentage of visitors to Yosemite National Park (26%, using the income categories in the table). Households with an annual income of less than $20,000 constitute the smallest percentage of visitors (5%). By contrast, households with an annual income below $20,000 constitute the highest percentage of the population in the state as a whole (37%, using the income categories in the table). These figures suggest that people from low-income households are largely underrepresented in the population of visitors to Yosemite National Park. This is true on both a statewide and regional basis. Factors that may account for this underrepresentation include the cost of travel to the park, the cost of entering the park, and the cost of staying at the park, as well as the possible cultural reasons mentioned above.

Table IV-22
Annual Household Income of Yosemite Visitors, California and Yosemite Region Residents

<table>
<tr><th>Annual Household Income Category</th><th>Yosemite Visitors</th><th>California Residents</th><th>Yosemite Region[a] Residents</th></tr>
<tr><td>Less than $20,000</td><td>5%</td><td>37%</td><td>26%</td></tr>
<tr><td>$20,000 to $39,000</td><td>14%</td><td>34%</td><td>29%</td></tr>
<tr><td>$40,000 to $49,000</td><td rowspan="2">21%</td><td>10%</td><td>12%</td></tr>
<tr><td>$50,000 to $59,000</td><td rowspan="2">13%</td><td rowspan="2">18%</td></tr>
<tr><td>$60,000 to $69,000</td><td rowspan="2">19%</td></tr>
<tr><td>$70,000 to $79,000</td><td rowspan="3">6%</td><td rowspan="3">15%</td></tr>
<tr><td>$80,000 to $99,000</td><td>14%</td></tr>
<tr><td>More than $100,000</td><td>26%</td></tr>
<tr><td>Total</td><td>100%</td><td>100%</td><td>100%</td></tr>
</table>

a Yosemite region includes Madera, Mariposa, Merced, Mono, and Tuolumne Counties.
SOURCES: Dornbusch & Company, Inc. 1999.

Park Operations and Facilities

Park Operations

Many programs and facilities administered by Yosemite National Park are located within the Merced River corridor. Facilities such as campgrounds and trails are located along the main stem in wilderness, and facilities such as office buildings, residences, and utility infrastructure are located in Yosemite Valley, the El Portal Administrative Site, and along the South Fork in Wawona. Park operations fall into eight basic divisions: Superintendent's Office, Resources Management and Science, Facility Management, Visitor Protection, Administrative Management, Business and Revenue Management, Project Management, and Interpretation and Education.

Resources Management and Science

Resources Management and Science staff protect the natural, cultural, and physical resources of the park. They are responsible for resource data collection and monitoring, prescribing natural and cultural resource impacts mitigation for construction projects, ecological restoration of sensitive areas, and vegetation and wildlife management. Facilities necessary to support Resources Management and Science activities and programs include office and storage space, laboratory facilities, vehicle parking, and employee housing.

Facilities Management

Facilities Management staff conduct preventive and corrective maintenance on park infrastructure and is responsible for forestry maintenance in conjunction with fire management. The Facilities Management Division includes the following:

- The Utilities Branch operates and maintains all water and wastewater utility systems, operates two wastewater treatment plants within the corridor, maintains potable water production and the high voltage electric system parkwide, and performs energy audits on park energy consumption. Operations are based in El Portal, Yosemite Valley, Wawona, Tuolumne Meadows, and the backcountry.
- The Roads and Trails Branch is responsible for maintaining all park roads, frontcountry and backcountry trails, performing hazard tree removal, operating the Yosemite Valley and Tuolumne Meadows Stables, and operating the Sign Shop and the Machine Shop. Operations are based in El Portal, Mather, Yosemite Valley, Wawona, and Tuolumne Meadows.
- The Design and Engineering Branch provides engineers, landscape architects, and surveyors and manages project funding requests.
- The Buildings and Grounds Branch maintains and corrects deficiencies in administrative facilities, employee housing units, and campground facilities. This branch also performs parkwide custodial operations and historic structure preservation. Operations are based in El Portal, Mather, Yosemite Valley, Wawona, and Tuolumne Meadows.

Facilities necessary to support Facility Management staff include equipment materials and tools storage, workshop and storage space, warehouse materials storage, office space, archival map storage space, vehicle parking, and employee housing.

Visitor Protection

Visitor Protection staff perform various visitor management and resource protection duties, including frontcountry and backcountry wilderness law enforcement operations, provision of emergency medical services, search and rescue, structural and wildland fire protection, transportation and circulation management, and parkwide dispatching services. Protection

rangers assist with monitoring natural and cultural resources, perform restoration activities, and provide assistance to park visitors. Facilities necessary to support Visitor Protection activities include wilderness centers and permit kiosks, ranger stations, parking for emergency vehicles and fire engines, incarceration facilities, helicopter landing pads, office and storage space, and employee housing for required occupants. The Little Yosemite Valley Ranger Station is within the Merced River corridor, and protection rangers regularly travel through this area to carry out their responsibilities.

Interpretation and Education

Interpretation and Education staff are responsible for providing natural, cultural, and physical resource information and interpretive programs throughout the year, consisting of evening programs, ranger-led talks, and open-air tram tours. In addition, staff is responsible for managing the Yosemite Valley and Tuolumne Meadows Visitor Centers, Pioneer Yosemite History Center, the Indian Village of Ahwahnee, the Yosemite Museum, the Wawona Information Station, and the Nature Center at Happy Isles. The Division of Interpretation and Education includes Public Outreach and Involvement, Media Relations, the Public Information Office, Curatorial Services, Publications, and the education branch staff. Facilities necessary to support the Interpretation and Education Division include visitor centers, museums, auditoriums, amphitheaters, office and storage space, vehicle parking, and employee housing.

Business and Revenue Management

Business and Revenue Management staff are responsible for the operation and staffing of all park campgrounds and entrance stations. Additionally, the division manages all contracted concessioner operations, such as lodging, retail and eating establishments; High Sierra Camp operations; equestrian, rafting and bicycle rental operations; Badger Pass; the Wawona Golf Course; galleries; and the Yosemite Medical Clinic. The division manages the Incidental Business Permit program, consisting of the regulation of tour buses, backcountry stock use, commercial tour and recreational guiding services, television and film productions, and weddings. Facilities necessary to support Business and Revenue Management operations include administrative office and storage space, entrance stations, vehicle parking, and employee housing.

Administrative Management

Administrative Management staff are responsible for managing the park's finances and budget, information technology systems, human resources, employee housing, and procurement and contracting. Facilities necessary to support Administrative Management include office and storage space, warehouse facilities, and computer operations systems.

Project Management

Project Management staff are responsible for major land use planning efforts and facility improvement projects for the park. The division is responsible for estimating design and construction costs, obtaining and managing park project funding, and implementing projects. The Office of Environmental Planning and Compliance branch of Project Management Division completes appropriate NEPA and National Historic Preservation Act compliance for all park projects. Planning Facilities necessary to support Project Management include office and storage space and vehicle parking.

Park Infrastructure and Facilities

Wilderness Trails

There are almost 800 miles of marked and maintained trails throughout the Yosemite Wilderness, with 10 bridges crossing the Merced River and its tributaries. These bridges are on the main stem or within one-quarter mile of the main stem in the Wilderness. Also on the main stem is a designated backpacker campground and ranger camp at Little Yosemite Valley, a designated campground at Moraine Dome, and a designated backpacker campground and High Sierra Camp at Merced Lake. Administrative facilities at Little Yosemite Valley include a composting toilet, campsites with food storage boxes, and a ranger camp. Administrative structures associated with the Merced Lake Backpackers Campground and High Sierra Camp include solar-powered water and sewer utilities, food storage boxes associated with campsites, and the buildings of the High Sierra Camp (as described in the Visitor Experience section under *Visitor Services*). A ranger cabin is located one mile east of Merced Lake. There are directional signs at all trail junctions. There are directional, informational, and regulatory signs in the designated campsites and Merced Lake High Sierra Camp. There are no administrative facilities beyond marked and maintained trails within one-quarter mile of the South Fork.

Roads

The National Park Service maintains approximately 200 miles of roads within the park. Major park routes include El Portal Road, Tioga Road, Big Oak Flat Road, Glacier Point Road, Valley Loop Road, and Wawona Road. Minor routes within the park are primarily those designated for administrative use and those providing circulation in campgrounds and residential areas.

The majority of park roads are at or past a normal service life and are generally in poor physical condition (NPS 1989b). Most park roads were designed and constructed in the 1920s and 1930s and have had only minor improvements in subsequent years. Therefore, many roads are below National Park Service standards for current and future projected use. Increases in average daily traffic levels and in the use of heavier vehicles have accelerated the deterioration of park roads, increasing the need for road improvements. The National Park Service is in the planning process for several road rehabilitation projects and rehabilitation projects are scheduled to begin on Northside and Southside Drive in 2007.

The National Park Service is responsible for maintaining roadways in Yosemite Valley and the Merced River gorge, and the majority of roadways in El Portal and Wawona. Road maintenance in the El Portal Administrative Site is divided between the National Park Service, the California Department of Transportation, and Mariposa County. Road maintenance in the Wawona area is divided between the National Park Service and Mariposa County.

Bridges and Tunnels

The Yosemite road system contains 4 tunnels and 30 bridges, each of which has unique maintenance issues and requirements. In addition to the road bridges, numerous footbridges exist within the Merced River corridor. There are three tunnels on Big Oak Flat Road and one tunnel in Wawona. The two shorter tunnels on Big Oak Flat Road are in good condition, but the longest Big Oak Flat Road tunnel and the Wawona tunnel need drainage and lining repairs. Bridges within the park are generally in good condition, with a few exceptions. Structural problems with the Yosemite Creek Campground Bridge and the South Fork Bridge in Wawona have forced the scheduled replacement of these two bridges. The Yosemite Creek Campground Bridge is closed to traffic; therefore, one section of the Yosemite Creek Campground has been closed for the past

couple of years. Replacement of this bridge is scheduled for 2005. The condition of the South Fork Bridge in Wawona has resulted in traffic being routed over a temporary bridge. Replacement of the temporary three-span bridge with a single-span bridge is expected to begin in spring 2005.

Bridges in Yosemite Valley include Clark's, Sugar Pine, Ahwahnee, Stoneman, Sentinel, El Capitan, Pohono, and several unnamed bridges over tributaries that feed into the Merced River. There are footbridges at Housekeeping Camp, as well as Superintendent's Bridge, Swinging Bridge, and several unnamed bridges over Merced River tributaries. Eight bridges in Yosemite Valley and the historic Covered Bridge in Wawona are all listed on the National Register of Historic Places. Bridges in the El Portal Administrative Site include Foresta Road bridge (just east of Moss Creek) and the Highway 140 bridge (just east of Abbieville) that cross the Merced River. One bridge in the Merced River gorge crosses Cascades Creek just east of the Cascades Picnic Area.

Campgrounds and Lodging

Several campgrounds and lodging units are located within the main stem of the Merced River corridor, some of which were damaged in the January 1997 flood and are now closed, including Upper River and Lower River Campgrounds. The 266 lodging units at Housekeeping Camp in Yosemite Valley are located along the Merced River. The Ahwahnee, a portion of Curry Village, and sections of Yosemite Lodge are located within one-quarter mile of the Merced River. In Yosemite Valley, the North Pines (86 sites), Upper Pines (240 sites), and Lower Pines (78 sites) Campgrounds, Backpackers Campground (30 sites), and Camp 4 (37 units) remain open, for a total of 475 camping sites. All of these sites are within one-quarter mile of the Merced River in Yosemite Valley. Yellow Pine Campground (4 sites) is also located in the Valley, but is used for park volunteers. In Wawona, the Wawona Campground (99 sites) and the Wawona Hotel are within one-quarter mile of the South Fork Merced River. No lodging or campground facilities are within the Merced River corridor on lands managed by the National Park Service in the El Portal Administrative Site.

Utilities

There is an extensive system of water, wastewater, electric, and communications utility systems in Yosemite Valley. Most utility systems in the park are operating within design capacity, with a few exceptions.

The water supply systems in El Portal and Wawona are marginal, as is the capacity of the Wawona Wastewater Treatment Plant. Any excess utility system capacity is due primarily to the closure of some lodging units and campgrounds following the January 1997 flood. Wastewater flows in Yosemite Valley decreased considerably after the flood because several campgrounds and lodging units were damaged or destroyed and subsequently closed. Leakage and resulting infiltration have been major problems in the past. The Facilities Management Division is making substantial improvements to the sewage collection system in Yosemite Valley, but leakage and infiltration still occur on occasion.

Wastewater in Yosemite Valley is pumped to the west end of Yosemite Valley, where it flows down to the El Portal Wastewater Treatment Plant at Railroad Flat, which has a 1 million gallons per day (gpd) capacity. A wastewater line runs between El Portal and Yosemite Valley beneath El Portal Road on the north side of the Merced River. Five wastewater treatment facilities are within

the park: El Portal, Hodgdon Meadow, Tuolumne Meadows, Wawona, and White Wolf. Of these, only the El Portal and Wawona facilities are located within one-quarter mile of the Merced River.

The National Park Service purchases power from Pacific Gas & Electric Company (PG&E). Electricity is carried into Yosemite Valley via a 70,000-volt transmission line that runs overhead through El Portal and the Merced River gorge to the substation at the old Cascades Powerhouse. The powerhouse is no longer active as a hydroelectric generator but is still used as a substation. From the powerhouse, power is stepped down to 12,000 volts. Conductors extend beneath El Portal Road to a substation in Yosemite Village. The Wawona Tunnel and Big Oak Flat Tunnel are served by overhead lines from the powerhouse. The primary electric distribution system is in generally good condition after upgrades over the last 12 years, although areas in Yosemite Valley still require rehabilitation. End users in Wawona, El Portal, Foresta, and Hodgdon Meadow are served directly by PG&E, whose facilities are within the park in several places.

SBC supplies telephone service into the park and El Portal primarily through microwave transmission. However, overhead phone lines are strung along the north side of the El Portal Road from the microwave transceiver at Turtleback Dome to serve Arch Rock. Overhead and underground lines serve various other locations throughout the park and El Portal.

There are 20 public water systems in the park; the Tuolumne Meadows and Wawona areas are the only large surface water systems in the park. The Wawona water system takes untreated water directly out of the South Fork of the Merced. This system is currently constrained in most years through much of the late summer and early fall because of low flows in the river. The National Park Service mandates stepped water-conservation measures whenever flows reach critical levels. Conservation measures start with banning irrigation use for the golf course and the lawns of homes and other buildings. The National Park Service is considering other options to increase the reliability of the water system at Wawona, including bringing water into Wawona via a 7-mile pipeline from the Mariposa Grove area and/or deep wells. Water is also taken out of the Merced River at Vernal Fall and Merced Lake for visitor use, though at much smaller quantities than at Wawona.

Three wells, a 2.5-million-gallon water storage tank, and several distribution lines supply Yosemite Valley's users with water. The system has the capacity to produce about 2,800 gallons per minute (gpm). Components of the water system are being replaced and upgraded due to damage sustained in the January 1997 flood. These improvements will restore reliability to the system, provide monitoring of system conditions, and allow for remote control of pumping.

El Portal's water supply system consists of six wells adjacent to the Merced River and three tanks with a total storage capacity of 900,000 gallons, for a total production capacity of approximately 220 gpm. The water system in El Portal is marginally sufficient for the current levels of use but does not have adequate capacity to compensate for any component failure or any increased development.

The National Park Service's water distribution system in Wawona is supplied by surface water drawn from the South Fork at a rate of 480 gpm. The potable water is held in four tanks with a total design capacity of 1,250,000 gallons.

Energy

Regulations, Policies, and Planning Objectives

National Park Service management policies require that all facilities be managed, operated, and maintained to minimize energy consumption and development of nonrenewable fuels. The policies also require that new energy-efficient technologies be used where appropriate and cost-effective. The Energy Policy Act of 1992 directs the use of energy-efficient building designs and equipment and the utilization of alternative motor fuels where practicable.

One of the management objectives for park operations, as outlined in previous planning efforts and Executive Order 13123, is to install facilities and utility systems that conserve energy. Design techniques and application of new technology to reduce energy and water consumption should be incorporated in the design of new facilities. Recent energy conservation and fuel substitution projects that are directed at facilities and vehicles in the park include development of a training program in conjunction with Southern California Edison for heating, ventilating, and air conditioning (HVAC) technicians to increase the energy efficiency of HVAC systems; fluorescent lighting retrofits from T-12 lamps to more energy-efficient T-8 lamps; installation of energy-efficient motors and air handling systems at the El Portal Wastewater Treatment Plant. Yosemite National Park through partnerships has developed two grid-connected, solar panel array projects in El Portal: a 20-panel solar energy system for the El Portal Wastewater Treatment Plant and a 374-panel solar energy system for the El Portal Maintenance Complex and Administrative Facility. The annual energy savings related to these solar energy projects is estimated to be 2%.

Energy Consumption

Energy sources consumed by stationary sources within Yosemite Valley include electricity, fuel oil, propane, and wood. National Park Service and Delaware North Company mobile sources (e.g., motor vehicles) consume gasoline and diesel fuel, while the majority of visitor vehicles operate on gasoline. Table IV-23 summarizes the estimated energy consumed in Yosemite Valley in 2003.

Table IV-23
2003 Yosemite Valley Energy Consumption

Consumer	Energy or Fuel Type					
	Electricity[a] (kWh)	Propane (gal)	Fuel Oil (gal)	Gasoline (gal)	Diesel Fuel (gal)	Wood (tons)
National Park Service	3,593,844	106,186	23,606	99,775	40,792	N/A
Delaware North Companies	12,964,526	428,721	753,635	N/A	N/A	227[b]
Visitors	N/A	N/A	N/A	1,378,869	145,510	100[c]
Total	16,558,370	534,907	777,241	1,478,644	186,302	327

a Entire park (kWh = kilowatt-hour)
b Fireplace fuel
c Campfire fuel
SOURCE: Yosemite National Park and Delaware North Companies Parks and Resorts at Yosemite (NPS 2004s, t, u, y)

It should be noted that overall energy consumption in the Valley may vary from year to year, but an overall downward trend can be observed from past years, primarily in vehicular emissions and electrical consumption, as a result of more efficient equipment, engines and vehicle fleet turn-over.

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