Chapter 3
Physical and Biological Resources

3.1 Introduction

This chapter presents an overview of the physical and biological setting of the Plan study area. It describes the baseline physical and biological conditions upon which the impact analyses (Chapter 4 *Impact Assessment and Level of Take*) and conservation strategy (Chapter 5 *Conservation Strategy*) are based. The chapter also describes how existing data were used and new data were collected to create the baseline inventory. The physical setting of the study area is described in the context of the following subject areas.

- Location.
- Topography.
- Geology and soils.
- Climate and hydrology.
- Data sources and methods.

The biological setting of the study area is described in terms of the following subject areas.

- Land cover types.
- Associated wildlife and plants.
- Ecosystem function.
- Natural disturbances.
- Threats to each natural community.

The ecology and distribution of covered species are described along with species-habitat models that define the suitable or potential habitat for most covered species (**Appendix D**).

This chapter also explains how the land cover types, habitats, disturbances, ecosystem services, and current management of the lands are inter-related to provide a context for the management of the Reserve System described in Chapter 5.

3.2 Physical Setting

This section describes the physical setting of the study area including location, topography, geology and soils, hydrology, climate and watersheds.

3.2.1 Location

The Plan study area (519,506 acres) is located in Santa Clara County in the central California Coast Range[1]. The primary valley in the study area is the Santa Clara Valley, which stretches from San Francisco Bay to San Benito County. The Santa Clara Valley is bounded on the east by the Diablo Range, on the west by the Santa Cruz Mountains, and on the north by the San Francisco Bay shoreline. The study area excludes tidally influenced portions of the Baylands (**Figure 1-2**). For a description of the political, ecologic, and hydrologic factors used to define the study area, see Chapter 1 *Introduction*.

3.2.2 Topography

Overview

The Santa Clara Valley is the southerly, on-land portion of a regional topographic depression that includes San Francisco Bay as well as the Petaluma, Sonoma, and Napa Valleys to the north (Norris and Webb 1990). Roughly hourglass in shape, the Santa Clara Valley is approximately 11 miles wide at the southern end of San Francisco Bay, narrowing to a minimum of about 2.5 miles north of Morgan Hill.[2] The Santa Clara Valley extends south to the county line, where it widens to approximately seven miles and merges with the Bolsa and Hollister Valleys in San Benito County. The valley floor is nearly flat along the Bay, with gentle undulations and local, low hills to the south. Valley floor elevations increase from sea level in the north to approximately 350 feet above mean sea level (msl) at the valley's narrowest point north of Morgan Hill (**Figure 3-1**). This low "saddle" in the valley represents the watershed divide between the Coyote Valley Watershed in which streams flow north to San Francisco Bay, and the watersheds to the south in which streams flow south to the Pajaro River and ultimately to Monterey Bay (see *Watersheds* below for watershed descriptions).

On the west side of the valley, the Santa Cruz Mountains rise to a maximum elevation of almost 4,000 feet msl. Typical of the Coast Ranges, the range trends

[1] State Parks lands (Henry W. Coe State Park and Pacheco State Park) fall within the study area; however they are excluded from the permit area. As such, all of the land cover-based analyses in the Plan are based on the study area less State Parks lands unless otherwise noted. The size of the study area less State Parks lands is 460,205 acres.
[2] The narrowest portion of Santa Clara Valley is also referred to as Coyote Valley, and Coyote Valley is sometimes considered a separate geomorphic entity from the Santa Clara Valley. This Plan considers Coyote Valley a part of the greater Santa Clara Valley.

northwesterly and is characterized by steep, rugged slopes and abrupt, deeply incised drainages. The steepest interior portions of the range are bounded along the valley floor by more gently sloping foothills largely representing dissected alluvial fan geomorphology.

On the east side of the valley, the Diablo Range forms a similarly rugged barrier, flanked by more gently sloping but strongly dissected alluvial foothills. Like the Santa Cruz Mountains, the Diablo Range is a long, northwest-trending uplift characterized by extremely rugged topography and heights in excess of 1,000 feet. The highest peak in the range is Mt. Hamilton (4,213 feet msl), in Santa Clara County but immediately east of the study area. Other important peaks in the study area include, from north to south, Monument Peak (2,594 feet msl) at the County line, Mt. Madonna (1,897 feet msl), and Pacheco Peak (2,770 feet msl). Elevations in the study area are generally greatest within the Diablo Range, particularly in the southeast portion of the study area. The highest point in the study area is 3,777 feet msl within Henry W. Coe State Park (**Figure 3-1**). The highest point in the Santa Cruz Mountains within the study area is 3,644 feet msl (**Figure 3-1**).

Slope and Aspect

The rugged topography of the study area creates highly variable slopes and aspects. Slope may provide some insight to the type of land cover that could be present. Moreover, it is often incorporated into zoning restrictions as a function of a parcel's buildability. **Figure 3-2** shows the range and location of slope in the study area. Aspect is expressed as an azimuth (compass bearing) representing the direction normal to the plane that approximates the slope. South and southwest-facing slopes tend to receive the greatest amount and intensity of solar radiation in the study area, which can greatly influence vegetation and species occurrence. North and northeast-facing slopes are often the coolest aspects, all else being equal. Note the predominance of generally northeast- and southwest-facing slopes, consistent with the overall northwesterly trend of the ranges (**Figure 3-2**).

3.2.3 Geology

The geology and fault zones of the study area have an important influence on the distribution of landforms and soil types, which in turn influence vegetation and plant species distribution and abundance. In some cases, geology and soils also greatly influence wildlife species distribution. For example, many invertebrates are closely associated with particular plant species or vegetation types that are restricted to particular soil types and geologic substrates. On a regional scale, geologic activity has also greatly influenced the pattern of stream formation and the structure and function of local watersheds[3].

[3] Faults can also be an important source of groundwater for stream flow, particularly in droughts. In severe droughts (e.g., 1976–1977), stream reaches in or near faults were often the only local perennial stream habitat, serving as

Faulting

Topography in the study area largely reflects active tectonics associated with the fault system of the San Andreas plate boundary.

The Santa Cruz Mountains are being uplifted along a system of faults related to the San Andreas plate-boundary system (Kennedy and Hitchcock 2004). The San Andreas fault zone itself, the primary fault within the system, lies northwest along the east flank of the uplift (e.g., Wagner et al. 1991; Hart and Bryant 1997).

The western front of the Diablo Range is defined by the Hayward and Calaveras faults, both of which are active faults of the San Andreas system (Anderson et al. 1982; Wagner et al. 1991; Hart and Bryant 1997). The eastern rangefront bounding the San Joaquin Valley (i.e., the eastern edge of the Diablo Range) is also defined by faulting.

Geologic Units

Santa Cruz Mountains

The Santa Cruz Mountains uplift exposes a wide range of bedrock units in a complexly deformed series of fault slivers. These include a variety of units assigned to the Jura-Cretaceous Franciscan Complex: sandstone, greenstone, serpentinized ultramafic rocks, and small bodies of limestone. Volcanic rocks of Eocene and Miocene age and volcanic strata also of Miocene age are exposed locally. The low foothills along the eastern rangefront consist of Pleistocene alluvium recording uplift of the range (e.g., Wagner et al. 1991).

Ultramafic rocks are characterized by the occurrence of some form of ferromagnesian silicate mineral and are common throughout the world as local outcrops or large, regional formations. In the Coast Range of California, most ultramafic rocks are of the serpentinite variety. The prevailing view of the origin of Franciscan-associated sepentinites is that they are altered masses derived from the upper mantle and transferred tectonically to the earth's surface (Norris and Webb 1990). Therefore, serpentinite is often associated with southeast-to-northwest trending fault zones, as is the case in the study area. Serpentinite, and the serpentine soils derived from them, are distributed widely in California in the Coast Range from Santa Barbara County to the Oregon border and in the western Sierra Nevada foothills from Tulare to Plumas Counties (Kruckeberg 1984). Serpentine soils are particularly relevant to the ecology of the study area because they support unique species assemblages (see *Serpentine Soils* discussion below).

critical refuges for fish. Examples included: Upper Silver Creek (Silver Creek Fault), Arroyo Aguague (Calaveras Fault) as a source of flow for Upper Penitencia Creek, Coyote Creek between Coyote and Anderson reservoir (Calaveras Fault) and also downstream of Gilroy Hot Srpings (Madrone Fault), San Felipe Creek (Calaveras Fault), Bodfish Creek (Sargent Fault), and Tar Creek (Sargent Fault) (J. Smith pers. comm.).

Diablo Range

The central portion of the Diablo Range consists of mélange—locally including serpentinitic bodies—and metasandstone of the Jura-Cretaceous Franciscan Complex. Outcrops of mafic and ultramafic units (i.e., serpentinite) belonging to the Jurassic Coast Range Ophiolite are also locally present, and are particularly well developed along the active Ortigalita fault in the vicinity of Del Puerto Canyon (Wagner et al. 1991; Evarts et al. 1999).

The western Diablo rangefront is flanked by complexly faulted exposures of sedimentary strata of Cretaceous through Miocene age. These include deep marine strata assigned to the Great Valley Group, shallow marine strata of the Miocene San Pablo Group, and terrestrial strata of the Miocene Contra Costa Group (Wagner et al. 1991). Quaternary alluvial strata accumulated on essentially modern topography buttress against the rangefront, and both active (Holocene) alluvium and older Quaternary terrace deposits are present in the larger stream valleys (Wagner et al. 1991).

Valley Floor

The Santa Clara Valley is filled by as much as 1,950 feet of primarily continental (alluvial) sediment largely accumulated within the last 780,000 years. These deposits are essentially flat-lying (Wentworth et al. 2005).

3.2.4 Soils

Because of the geologic, climatic, and topographic diversity of the Santa Clara Valley and neighboring uplands, the study area's soils are also very diverse, and a large number of individual soil units have been mapped in the study area. These have been organized into 20 soil associations consisting of soil units of the same texture and composition. Following is a general overview of soil characteristics in the Santa Clara Valley and adjacent areas, by geographic position (U.S. Soil Conservation Service 1968, except as noted). **Figure 3-3** shows generalized soil type distribution in the study area.

- **Lowland areas influenced by tidal waters.** These typically fine-textured, saline, clay-rich soils are restricted to the north-central portion of the study area, along the Bay margin and as far south as parts of the Mountain View-Sunnyvale area. Plant associations supported by these soils may be limited by soil salinity and/or moisture content.
- **Level, low-lying valley areas.** Soils of the Santa Clara Valley flatlands are typically very deep, fine- to medium-textured, and poorly to somewhat poorly drained under natural conditions. Plant associations on these soils may be limited by soil texture and/or moisture content.
- **Major valley drainageways and lower alluvial fan surfaces.** Most soils formed on the flat alluvial plains along major valley drainages and on gently

to moderately sloping surfaces on the lower portions of alluvial fans are medium-textured, although some are gravelly. They range from moderately well drained to somewhat excessively drained under natural conditions. These soils are considered very good for cultivation.

- **Older alluvial fans and terraces in valley-margin and foothills.** Soils of the study area's older alluvial fans and terraces are texturally diverse. They are typically moderately drained to well drained but are underlain by subsoils that contain abundant clay and thus drain slowly. Plant associations on these soils may be limited by low fertility and/or low moisture content.
- **Upland soils.** Soils of the study area's mountainous uplands are typically shallow and well drained and have developed on site from local bedrock.

Serpentine Soils

Of particular importance from a conservation perspective are the study area's serpentine soils, which are derived from the serpentinite ultramafic rocks of the region. Serpentine soils are typically very shallow, nutrient-poor (i.e., low levels of nitrogen, potassium, phosphorous, and molybdenum essential for normal plant growth), high in magnesium, and may contain elevated levels of the heavy metals chromium and nickel that are toxic to many plant species (Kruckeberg 1954, 1984). Water availability in serpentine soils may also be limited (Davis et al. 1997). As a result, serpentine soils support limited and highly specialized floras and vegetation associations that often include a high number of endemic (i.e., largely or entirely restricted to serpentine soils) and special-status species (Kruckeberg 1984; Safford et al. 2005).

The occurrence of serpentine soils in Santa Clara County is best predicted by a combination of soil and geology maps. As shown in **Figure 3-4**, the study area supports an estimated 13,180 acres of serpentine soils, 9,194 acres of serpentine bedrock, and 12,636 acres where serpentine soil and bedrock overlap (Brabb and Dibblee 1974; Dibblee 1973, 1977)[4]. As inferred from serpentine soil and geology maps, we estimate a total of 35,010 acres of serpentine soils in the study area. By far the largest occurrence of serpentine in the study area is along the low ridge immediately east of U.S. 101 known as the "Kirby Hills" or "Coyote Ridge" between the Silver Creek Hills and Anderson Reservoir (this document uses the name Coyote Ridge for this feature). Other important outcrops of serpentine soils in the study area occur in or on the following areas:

- the Santa Teresa Hills,
- Communications Hill,
- Tulare Hill,
- the foothills of the Santa Cruz Mountains near Chesbro and Calero Reservoirs,

[4] For the purposes of this Plan, serpentine soils are assumed to occur where serpentine soils and serpentine bedrock are mapped. Each map layer alone is insufficient to fully represent field conditions.

- the foothills adjacent to and west of Anderson Reservoir, and
- the foothills adjacent to and west of Coyote Creek upstream of Anderson Reservoir and Coyote Reservoir.

Serpentine plants occur in small patches outside mapped serpentine soils and geology, possibly due to serpentine alluvial material washing downstream (J. Hillman pers. comm.).

3.2.5 Climate and Hydrology

Climate

Santa Clara County has a Mediterranean climate, characterized by extended periods of precipitation during the winter months and virtually no precipitation from spring through autumn. The wet season generally extends from November through April, while rainfall from May through October tends to be minimal. Annual average rainfall varies significantly due to topography and related orographic and rain shadow effects. Increased elevation on coastal oriented slopes (typically west/southwest facing) results in increased precipitation while descending the lee-side interior facing (typically east/northeast facing) results in decreased precipitation. A rainfall transect across the county illustrates this condition. For example, portions of Santa Clara County in the Santa Cruz Mountains receive 40 to 60 inches per year. Moving east, down the lee side of the Santa Cruz range into the rain shadow of the central Santa Clara Valley, precipitation falls an average of 13 to 14 inches in the vicinity of downtown San José (Santa Clara Basin Watershed Management Initiative 2003); see **Figure 3-5**). Similarly, moving further east and ascending the west facing slopes of the Diablo Range, precipitation increases with elevation to 20–30 inches per year. Further east into the interior valleys and ridgelines of the Diablo Range, precipitation amounts similarly fluctuate with elevation and aspect. In addition to orographic/rain shadow effects, site-specific conditions of elevation and aspect will influence local microclimates and water balance conditions. For example, canyon areas of north facing hillslopes and streams that experience less sunlight and less day-length will have less evaportranspiration, greater ambient soil moisture, and generally more moderate and cooler temperatures due to higher moisture content and greater shade.

The wind patterns in the Santa Clara Valley are influenced greatly by the terrain, resulting in a prevailing flow roughly parallel to the Valley's northwest-southeast axis. A north-northwesterly sea breeze often extends up the Valley during the afternoon and early evening and a light south-southeasterly drainage flow often occurs during the late evening and early morning. In summer a convergence zone is sometimes observed in the southern end of the Santa Clara Valley between Gilroy and Morgan Hill, when air flowing from the Monterey Bay through the Pajaro Gap gets channeled northward into the south end of the Santa Clara Valley and meets with the prevailing north-northwesterlies. Wind speeds are greatest in the spring and summer, and least in the fall and winter. Nighttime and early morning hours have light winds and are frequently calm year round, while summer afternoon and evenings can be breezy. Strong winds are rare, coming only with occasional winter storms.

The average annual rainfall in San José for the period of record of July 1, 1948 to December 31, 2005 was 14.66 inches (Western Regional Climate Center 2006). Average rainfall figures can be somewhat misleading because, in addition to seasonal variation, droughts in California are not uncommon. For example, annual rainfall in San José between 1948 and 2005 ranged from 6.12 inches in 1953 to 32.57 inches in 1983 (Western Regional Climate Center 2006). Snow may occur in the mountains where the headwaters for the watersheds are located but melts quickly and does not provide flow from snowmelt in the late spring to early summer as occurs in the Sierra Nevada Mountains.

The Mediterranean climate also produces fairly mild air temperatures in the valley floor that rarely drop far below freezing. North of San José, the average summer temperatures are rarely higher than 90°F. South of San José both summer and winter extremes are somewhat greater (Santa Clara Basin Watershed Management Initiative 2003).

Watershed Hydrology

The major watersheds within the northern portion of the Plan study area are those of the Coyote Creek and Guadalupe River. Portions of the upper Pajaro River Watershed occur in southern Santa Clara County and the study area (see **Figure 3-6**)[5]. Other major drainages that pass through Santa Clara Valley include the Los Gatos Creek, San Tomas Aquino Creek, Saratoga Creek, Calabazas Creek, Stevens Creek and Permanente Creek, all of which originate in the Santa Cruz Mountains. The lower portion of the Guadalupe River watershed is within the study area (**Figure 3-6**). Very small portions of the Calabazas Creek and San Tomas watersheds within San José are also part of the study area (**Figure 3-6**).

While rainfall is the primary source of surface flows in the County, high groundwater tables contribute to the flows of some local streams. Springs are a clear expression of groundwater intercepting the surface. In some areas, springs are an important contributor to perennial flows in local streams. There are 92 springs in the study area mapped by USGS; of these, seven occur on serpentine soils (**Figure 3-6**) and provide important habitat for Mt. Hamilton thistle, which is found primarily in serpentine seeps.

[5] The Pajaro Watershed in the study area includes the following watershed basins: Pacheco (in part), South Santa Clara Valley (in part), Llagas, Uvas, Pescadero (in part).

Coyote Creek Watershed

The Coyote Creek Watershed is the largest watershed in Santa Clara County (206,000 acres, or approximately 40% of the study area) and is entirely contained within the County and the study area except for the outflow to the Bay. The headwaters originate on the east side of Santa Clara County in the Diablo Range. The watershed is bounded by Coyote Creek to the west and the Diablo Range to the east. Coyote Creek is the longest creek in the County at approximately 63 miles. It originates in the Diablo Range at approximately 3,000 feet and flows southward then northward towards South San Francisco Bay (Santa Clara Valley Water District 2002a). Between its headwaters and Anderson Dam, Coyote Creek and its tributaries flow through mostly steep canyons or narrow valleys. Downstream of Anderson Dam, Coyote Creek flows through the flat Santa Clara Valley on a historically wide alluvial plain.

Coyote Creek originates in the Diablo Range and enters Coyote Valley at its topographic divide with the Llagas Basin to the south. Coyote Creek flows northwesterly through Coyote Valley and Santa Clara Valley before entering San Francisco Bay at Alviso. The major tributaries entering Coyote Creek include Fisher Creek, Upper Silver Creek, Lower Silver Creek, and Upper Penitencia Creek (Santa Clara Valley Water District 2002a). Flow in Coyote Creek below Anderson Dam is perennial, and in the summer is sustained with seepage and releases from Anderson Dam, groundwater, and urban runoff (Santa Clara Valley Water District 2002a). The creek also tends to be dry in dry years on the valley floor between Hellyer Park and Capitol Expressway (J. Smith pers. comm. 2009; J. Abel pers. comm. 2010). Coyote Creek above Anderson and Coyote Reservoirs is intermittent in several reaches. Many of the creeks draining into Coyote Creek are perennial, but the smaller tributaries on the eastern side of the watershed are dry during the summer and fall (Santa Clara Valley Water District 2002a).

Upper Penitencia Creek is kept artificially perennial through releases from the South Bay Aqueduct and the City of San José’s Cherry Flat Reservoir. Arroyo Aguague, a tributary to Upper Penitencia Creek in Alum Rock Park, provides surface flow to the creek even if there are no releases from Cherry Flat Reservoir (J. Smith pers. comm. 2009). Much like the Coyote Creek flow pattern, the perennial flow observed is the result of interim operations applied since the onset of the FAHCE proceedings. Under traditional operations, stream flow terminates at the Maybury diversion. Under interim operations a bypass flow is applied to maintain a hydraulic connection with the lower end of the stream and Coyote Creek. Despite augmented flow, recent summer droughts has resulted dry backs has occurred at Cherry Flat and Arroyo Aguague, upstream of the flow augment put-in point.

Coyote Valley is an extension of the Santa Clara ground-water basin and is commonly referred to as the Coyote Valley ground-water subbasin. The Coyote Narrows divides the Coyote Valley ground-water subbasin from the Santa Clara Valley ground-water basin. Characteristics of the basin and subbasin differ. Groundwater generally moves in a northwesterly direction or down the valley. The groundwater level in Coyote Valley is typically shallow or within 50 feet below the surface. Groundwater recharge is predominately from percolation of flow in Coyote Creek in the first 5 to 10 miles downstream of Anderson Dam. Coyote Creek is quite responsive to winter rains and subsequent stormwater runoff. Further downstream, subsurface flow is forced to the surface as the valley becomes confined at Coyote Narrows and returns to the shallow subsurface as it enters the Santa Clara groundwater basin. At the divide between the Coyote and Llagas watersheds there is some movement of groundwater from the Coyote watershed to the Llagas watershed.

In the Coyote Watershed, the SCVWD operates two reservoirs—Anderson and Coyote—that regulate flow into Coyote Creek. Anderson Reservoir is the largest reservoir in Santa Clara County, with a capacity of 90,373 acre-feet. The Coyote Reservoir has a capacity of 23,244 acre-feet. The small (<500 acre-feet) Cherry Flat Reservoir, operated by the City of San José, partially regulates the flows of Upper Penitencia Creek. Flows in other creeks are largely dependent on groundwater, springs, raw water turnouts, or piped urban runoff.

Percolation ponds have been maintained by the SCVWD throughout the watershed to actively promote aquifer recharge in order to minimize future subsidence and saltwater intrusion. These ponds of water are held over naturally occurring sandy gravel beds (Santa Clara Basin Watershed Management Initiative 2003). The four main groundwater recharge areas in the Coyote Watershed are the Penitencia, Overfelt, Ford Road, and Coyote ponds. The Penitencia percolation ponds receive water from Upper Penitencia Creek and the South Bay Aqueduct (which, in turn, receive water from the Sacramento–San Joaquin Delta). The Overfelt ponds are also near the lower reaches of Upper Penitencia creek. The Ford Road and Coyote ponds receive water from Coyote Creek, Anderson Reservoir, and the Central Valley Project supplied by the San Felipe Division of the Bureau of Reclamation. Between Anderson Reservoir and the Coyote Narrows, flows into Coyote Creek are an in-stream source of recharge to the Coyote Creek groundwater basin (Santa Clara Valley Water District 2002a). Flows from Upper Penitencia Creek also provide in-stream recharge in the basin.

Guadalupe River Watershed

The Guadalupe River Watershed headwaters originate on the west side of Santa Clara County in the Santa Cruz Mountains and encompass approximately 109,000 acres, 59,000 acres of which (54%) are in the study area. The Guadalupe River discharges to the southern terminus of San Francisco Bay via the Alviso Slough near the community of Alviso (Santa Clara Basin Watershed Management Initiative 2003). The lowermost reach by San Francisco Bay and the uppermost watershed are excluded from the study area.

Tributaries to the Guadalupe River include Los Gatos, Ross, and Canoas Creeks. Los Gatos Creek is the largest tributary to the Guadalupe River and joins the river near downtown San José (Santa Clara Basin Watershed Management Initiative 2003). Reservoirs in the Guadalupe River watershed include Almaden, Guadalupe, and Calero Reservoirs. All three reservoirs are relatively small;

Calero Reservoir has a capacity of 9,934 acre-feet, while Guadalupe and Almaden have capacities of 3,415 and 1,586 acre-feet, respectively. Runoff is captured in the reservoirs in the winter months and stored for use in the summer dry months. Water released from the reservoirs and the SCVWD's Almaden Valley pipeline maintains perennial stream habitat downstream on Guadalupe Creek to the Los Capitancillos percolation ponds and Guadalupe River. Lexington and Vasona Reservoirs regulate flows in Los Gatos Creek. Vasona Reservoir is the smallest maintained by SCVWD, at 400 acre-feet. Lexington Reservoir is not included in the Plan study area. Releases are made from Lexington Reservoir during summer for groundwater recharge, and flows are percolated into the groundwater upstream of the confluence with the Guadalupe River (Jones & Stokes 2002).

Nine percolation pond facilities are located in the Guadalupe Watershed. Each of the facilities has multiple ponds. Six of the nine percolation pond facilities are charged from Los Gatos Creek, with the rest charged from the Guadalupe River or Guadalupe Creek (Santa Clara Valley Water District 2002b).

Pajaro River Watershed

The Pajaro River is the largest coastal stream between San Francisco Bay and the Salinas Watershed in Monterey County (RMC 2005). Approximately 11.7 miles of the upper Pajaro River fall within the Plan study area in southern Santa Clara County. The Pajaro River eventually enters the Pacific Ocean at Monterey Bay. Pacheco, Uvas, Llagas, and Pescadero Creeks are the primary tributaries to the Pajaro River in the study area and cover an approximately 230,000 acre region. The creeks in this watershed are the only ones in Santa Clara County that flow southward for their entire length (Santa Clara Valley Water District 2002c). All of the Llagas Watershed (65,365 acre) and all of the Uvas Watershed (55,916 acres) are within the study area. Most of the Pacheco Watershed (100,742 acre) and a small portion of the Santa Cruz Mountains Watershed (i.e., the watershed of Pescadero Creek) are also included in the study area (7,269 acres).

Channels in the Llagas Creek watershed have been modified substantially to convey flood flows. Some channels are natural, while others in the urban areas of Morgan Hill, San Martin, and Gilroy are highly modified and largely unvegetated (U.S. Department of Agriculture 1982). Between U.S. 101 to Santa Theresa Blvd, portions of Uvas Creek have also been modified with levees and armoring to convey flood flows (J. Abel pers. comm. 2010). In addition, extensive quarry operations from to 1940s to 1960s in the Christmas Hill Park area have affected channel morphology of Uvas Creek (J. Abel pers. comm. 2010). Pacheco Creek remain largely unmodified by flood control projects.

There are three reservoirs in the Pajaro Watershed within the study area: Uvas and Chesbro, owned by SCVWD, and the Pacheco Reservoir, owned by the private Pacheco Pass Water District. Uvas Reservoir impounds water along Uvas Creek and has a capacity of 9,835 acre-feet. Chesbro Reservoir occurs along Llagas Creek and has a capacity of 7,945 acre-feet. SCVWD maintains percolation ponds below Chesbro Dam along Llagas Creek (U.S. Department of Agriculture 1982).

Soap Lake is a natural floodplain basin, approximately 9,000 acres in size, on the Pajaro River, divided between Santa Clara and San Benito Counties at the southern edge of the Santa Clara Valley and the northern edge of the Bolsa Valley. During significant rain events, Soap Lake is a floodplain that acts as a retention basin, capturing flows from Pacheco Creek and Tequisquita Slough. The lake discharges primarily to Miller Canal, which discharges to the Pajaro River near the mouth of Llagas Creek; at high flows a portion of the discharge flows to the old upper Pajaro River, which was bypassed by Miller Canal. During moderate floods, Soap Lake may extend just beyond San Felipe Lake in San Benito County. During 100-year events, Soap Lake may expand to several thousand acres, encompassing the lower reaches of Llagas Creek and Uvas Creek (RMC 2005). A recent study has determined that Soap Lake is vital to reduce flooding risk in the lower Pajaro River in Monterey County and within the cities of Castroville and Watsonville (RMC 2005).

Hydrologic Modifications

Due to urbanization and water-supply projects throughout the County, the natural hydrology of many streams and watersheds has been altered. Modification of natural flow patterns is the result of water storage and release from reservoirs and percolation ponds, increased runoff, channel modification, groundwater withdrawal, land subsidence, hydraulic structure placement, vegetation clearing, and urban development. The resulting stream hydrograph reduces peak winter flows and provides additional water during drier summer months. This alteration of the hydrograph is clearly evident in Coyote Creek. **Figure 3-7** shows mean monthly streamflow in Coyote Creek before and after the construction of Anderson Dam. In the winter, Anderson Reservoir captures rainfall and releases winter flows that are reduced and less variable from the historic condition. During the dry season, reservoirs also release water in order to maintain flows during the summer months, increasing flows compared to historic conditions. The net result has been a "flattening" of the hydrograph and reduction in the historic seasonal variations in flows. Increased summer flows and restrictions on channel meandering has also increased the density of riparian vegetation (Grossinger et al. 2006), altering ecosystem function.

Runoff from streams and surrounding areas becomes less attenuated (i.e., flashier) as the density of urban development increases. Replacement of natural vegetation with impermeable urban surfaces such as asphalt, concrete, and roofs; and highly efficient drainage systems increases the volume of runoff and the peak flow rate for frequent events (Santa Clara Valley Water District 2001). The decreased infiltration and increased runoff associated with urbanization can cause the size of peak floods to increase (County of Santa Clara Planning Department 1969).

Flooding due to increased runoff has changed historical stream morphology and flow patterns in the watersheds. While some of the stream channels in the upland areas are still natural, most of the tributaries within the valley floor area of the watershed have been significantly modified to optimize flood conveyance. Many types of channels have been constructed for controlling high flows, including earthen levees, trapezoidal concrete channels, floodwalls and culverts (Jones & Stokes 2000). Design and operation of flood-conveyance elements were historically focused on conveying 100-year storm flows and to accommodate new development adjacent to these stream corridors (Santa Clara Valley Water District 2002a).

Channelization projects designed to increase hydraulic capacity often expanded channel dimensions and straightened channel meanders. The construction of channels to unnatural dimensions leads to increased sediment deposition as the stream attempts to re-create smaller, equilibrium dimensions. For example, the lower reaches of Coyote Creek and the Guadalupe River have been channelized and the streams are now contained between several miles of earthen levees.

Intensive withdrawal of groundwater from the alluvial aquifers in the San José area between the early 1900s and mid-1960s caused a decline in groundwater levels and resulted in substantial land subsidence. For example, 12.7 feet of subsidence was measured in San José from 1916 to 1969 (Poland 1969; Poland and Ireland 1988). Subsidence was one important factor that led to increased flooding in the northern Santa Clara Valley in the twentieth century. Since 1967, recovery of the water table has been substantial because of increases in imported water by SCVWD, the use of percolation ponds and river systems to recharge the aquifer (in part with this imported water), and favorable local-water supply resulting in decreased withdrawal and increased recharge.

Percolation ponds provide holding areas where water slowly recharges groundwater to primarily offset pumping that exceeds the natural recharge. Percolation ponds also compensate for the reduced rates of infiltration from urban development and other impermeable land uses. The SCVWD releases locally conserved and imported water to 71 off-stream percolation ponds that range in size from less than 1 acre to more than 20 acres. Through local streams and percolation ponds, the SCVWD recharges the groundwater basin with about 157,000 acre-feet of water each year (Santa Clara Valley Water District 2002b). Groundwater recharge keeps some streams flowing year round, when under natural conditions, the streams would be dry during the summer into the early fall. Very little published information exists to present a current groundwater budget detailing inflows and outflows for the Santa Clara Valley basin (California Department of Water Resources 2004).

3.3 Ecosystems, Natural Communities, and Land Cover

3.3.1 Definitions

The following definitions are provided to clarify terms used in the NCCP Act. These terms are also found in the glossary (**Appendix A**).

Ecosystem Functions and Services

In order for this Plan to be approved, the NCCP Act requires CDFG to make findings that this Plan conserves, restores, and manages representative natural and seminatural landscapes to maintain the ecological integrity of large habitat blocks, ecosystem function, and biological diversity (California Fish and Game Code Section 2820(a)(4)(A)). For the purposes of this Plan, *ecosystem function* is defined as processes operating at the ecosystem level, such as the cycling of matter, energy, and nutrients that maintain the characteristics and biodiversity of an area (Mooney et al. 1995). Ecosystem functions include such biological and physical processes as hydrological regulation, dispersal, predation, herbivory, pollination, decomposition, nutrient cycling, soil disturbance, and energy fluctuations.

The general ecological concept of ecosystem function as it applies to conservation has evolved in the last two decades to focus on the subset called ecosystem services[6], and a shift in management strategy from protection of reserves to sustainability and stewardship of the human-occupied landscape (Daily and Matson 2008; Cowling et al. 2008). Ecosystem services include maintenance of habitat for endangered species as well as production of clean water and air, aesthetics for tourism, forage for livestock, and climate stabilization. They have human economic value that can generate payments as incentives to maintain those services. This newer concept recognizes the vital roles of people, including planners, managers, and consumers, in a vision of conservation for California rangelands (Daily 2011).

Biological Diversity

The NCCP Act calls for the protection of species diversity on a landscape or ecosystem level through the creation and long-term management of habitat reserves or other measures that provide equivalent conservation of covered species appropriate for land, aquatic, and marine habitats within the area (California Fish and Game Code Section 2820(a)(3)). The NCCP Act also calls

[6] Jack et al (2008) defines ecosystem services as the benefits that people derive from ecosystems, including commodities and regulating, supporting, and cultural services.

for maintaining biological diversity through conservation, restoration, and management of natural and seminatural landscapes.

Biological diversity or *biodiversity* is defined in this Plan as the variety of organisms considered at all levels, from genetic variants of a single species through arrays of species to arrays of genera, families, and higher taxonomic levels (Lincoln et al. 1998).

Ecological Integrity

The NCCP Act calls for sustaining the effective movement and interchange of organisms between habitat areas in a manner that maintains the ecological integrity of the habitat areas within the study area (California Fish and Game Code Section 2820(a)(4)(E)). The NCCP Act also calls for maintaining the ecological integrity of large habitat blocks through conservation, restoration, and management of natural and seminatural landscapes.

Ecosystems have *ecological integrity* when their native components are intact, including abiotic components, biodiversity, and ecosystem processes. This Plan seeks to support the goal of ecological integrity by protecting large blocks of habitat such that the various components of functioning ecosystems are maintained in an interconnected area.

Environmental Gradients

The NCCP Act calls for incorporating a range of environmental gradients such as slope, elevation, aspect, and coastal or inland characteristics to provide for shifting species distributions due to changed circumstances (California Fish and Game Code Section 2820(a)(4)(D)).

This Plan defines *environmental gradient* as a shift in physical and ecological parameters across a landscape, such as changes in topography, climate, geology, land cover types, and natural communities.

Natural Communities

Natural communities are a collection of species that co-occur in the same habitat or area and interact through trophic and spatial relationships. Communities are typically characterized by reference to one or more dominant species (Lincoln et al. 1998). The NCCP Act calls for the protection of natural communities on a landscape or ecosystem level through the creation and long-term management of habitat reserves or other measures that provide equivalent conservation of covered species appropriate for land, aquatic, and marine habitats within the area (California Fish and Game Code Section 2820(a)(3)). In the Santa Clara Valley Habitat Plan study area, seven natural communities and two additional land cover types (irrigated agriculture and developed) are defined that will be discussed further in the chapter.

The term *rangeland* is used in this Plan to refer to the collection of multiple natural communities on which the indigenous vegetation is predominantly grasses, grass-like plants, forbs or shrubs that are grazed or have the potential to be grazed, and which is used as a natural ecosystem for the production of grazing livestock and wildlife. Rangelands include natural grasslands, savannas, shrublands, many deserts, steppes, tundras, alpine communities and marshes (Allen et al. 2011). Rangelands usually occur in areas not suitable for cultivation, irrigation, residential development, industrial development, or timber production. The rangelands within the study area occur primarily in grassland land-cover types but also include oak woodlands, riparian forest, and seasonal wetlands. Rangelands in the study area are considered “working rangelands” because numerous economic activities (including livestock grazing) take place there.

3.3.2 Methods

Data Collection

Sources used to map and describe the physical setting of the study area are listed below.

- U.S. Geological Survey data on topography and hydrology.
- Geologic maps of the area (Wagner et al. 1991; Helley et al. 1994).
- Geologic map, Santa Clara County, California. California Division of Mines and Geology, scale 1:62,500 (Brabb and Dibblee 1974).
- Preliminary map of Santa Clara Valley serpentines [soils] (unpublished), scale 1:50,000 (Dibblee 1973, 1977).
- Preliminary geologic map of the Mt. Madonna quadrangle, Santa Clara and Santa Cruz Counties, California. U.S. Geological Survey Open-File Report [OF-73-59], scale 1:24,000 (Dibblee 1973).
- Soil survey information (U.S. Soil Conservation Service 1968).
- Other published information (Hickman 1993; Alt and Hyndman 2000; Santa Clara Valley Water District 2006).
- Springs and rainfall data from USGS (California Spatial Information Library 1997).
- Watershed data from California Interagency Watershed Map (CalWater version 2.2.1) (California Interagency Watershed Mapping Committee 1999).

Topography, hydrology, and soil data were downloaded from agency websites and imported into ArcInfo, where files were clipped and converted into the projection for the study area.

Land Cover Mapping

One of the primary data sources for this Plan is a detailed geographic information systems (GIS)-based map of land cover types within the study area. A *land cover type* is defined as the dominant character of the land surface discernible from aerial photographs, as determined by vegetation, water, or human uses. Land cover types are the most widely used units in analyzing ecosystem function, habitat diversity, natural communities, wetlands and streams, and covered species habitat. Data sources, mapping standards, and the classification and interpretation of land cover types are discussed below.

Data Sources

The following are the primary sources of information for the land cover mapping in the study area.

- True-color aerial photographs (resolution of 2 feet[7]) flown in December 2003 (acquired from AirPhoto USA).
- True-color aerial photographs for non-urban portion of the study area (resolution of 9 inches) flown in March 2001 (provided by Santa Clara Water District).
- Serpentine soils and serpentine geology digitized from the map sources listed above.

The ancillary data sources listed below were used to obtain information not available in the primary sources and to check the mapped information for accuracy.

- True-color aerial photographs (resolution 1.5 foot) flown in December 2005 (acquired from AirPhoto USA)[8].
- National Wetlands Inventory Maps (scale 1:65,000) from the U.S. Fish and Wildlife Service for a portion of the study area based on color-infrared photographs taken in 1982–1987.
- Streams (Produced by SCVWD in 2006–2007; see discussion below).
- Local roads (Santa Clara County data set).
- Coyote Valley Specific Plan vegetation data developed from site visits (City of San José 2004).
- Soil survey mapping (U.S. Soil Conservation Service 1968).
- Historical locations of valley oak; GIS layer digitized from the 1:62,500 Wieslander Vegetation Type Map, a dataset of photos, species inventories, and plot maps compiled in the 1920s and 1930s (California Department of Forestry and Fire Protection 1992).

[7] Each cell represents an area on the ground of approximately 2 feet by 2 feet, or 4 square feet.
[8] December 2005 air photos were not made available until March 2006. These photos could not be used as the primary air photo source because the land-cover mapping process started in November 2005.

- Vegetation maps of open space preserves adjacent to the western portion of the study area developed from air photo interpretation (Midpeninsula Regional Open Space District 2006).
- Vegetation map of the Coyote Creek Parkway County Park developed from remote sensing (County of Santa Clara Parks and Recreation Department 2004a).
- Land cover map for the San Francisco Public Utilities Commission's Alameda Watershed lands in Santa Clara and Alameda Counties (adjacent to the northern edge of the study area) developed from air photo interpretation (Jones & Stokes 2005).
- Current land cover maps for large projects in the study area:
  - The Castro Valley Ranch EIR, an approximately 8,500-acre site in the southwest corner of the study area, developed from site visits (H.T. Harvey & Associates 2006).
  - Mapping of freshwater and seasonal wetlands in Coyote Valley (City of San José 2007).
  - Land cover mapping of the proposed Lucky-Day Wildlife Conservation and Wetland Mitigation Bank (WRA Environmental Consultants 2008), north of Gilroy.
  - Land cover and habitat mapping for Young Ranch on Coyote Ridge (WRA Environmental Consultants 2012).
- Historical tideline data from Coyote Creek Historic Ecology Report (Grossinger et al. 2006) and historical land cover data from the study area (Grossinger et al. 2006; San Francisco Estuary Institute 2008).

In addition to using existing data sets, ICF biologists conducted field visits in accessible portions of the study area to develop and verify land cover mapping. An initial field visit was conducted on December 15, 2005 to develop the land cover classification and to perform preliminary verification of aerial photograph signatures. Other field visits were conducted on April 20–21, May 3–5, May 11–12, and May 24–25, 2006 to verify land cover types and consistency of mapping, and to collect additional data for land cover type descriptions. Initial mapping was verified by visual inspection from locations accessible by public roads and roads on state-owned and private lands for which access permission had been obtained. Areas were selected for field verification on the basis of the land cover types present and accessibility.

Access was difficult in many parts of the study area due to extensive private lands and few public roads. Access in the western portion of the study area was sufficient to verify the different land cover types that occurred there. Access in the central eastern portion of the study area was more limited, but also allowed most land cover types to be visited. Access to the extreme northeast, east, and area south of SR 152 was not possible due to extensive private holdings and lack of approvals for access. There were no unique land cover types in these areas so we believe that this lack of access did not compromise the land cover mapping.

Once field visits were conducted, land cover mapping was revised on the basis of field findings.

Land Cover Type Classification

A classification system for land cover types was developed for the study area based primarily on the widely used classification system of the CDFG (California Department of Fish and Game 2003a, 2007), which in turn is based on the vegetation classification system developed for the Manual of California Vegetation (Sawyer and Keeler-Wolf 1995). Additional input was obtained from the sources listed below.

- Holland (1986) and Mayer and Laudenslayer (1988, 1999).
- Current regional and local mapping projects such as Coyote Ridge (California Native Plant Society 2003), Sierra Azul Open Space Preserve (Midpeninsula Regional Open Space District 2006), and the land cover map for the San Francisco Public Utilities Commission's Alameda Watershed lands in Santa Clara and Alameda Counties, adjacent to the study area (Jones & Stokes 2005).
- Field visits by ICF senior biologists.

The proposed system (**Table 3-1**) has been adapted to incorporate classification systems used by the Local Partners with input from vegetation and wildlife specialists familiar with the study area. The land cover classification was developed with the criteria listed below.

- Each land cover type must be distinguishable on the digital aerial photography based on a unique and consistent signature, or with the use of ancillary data such as soil types or geologic substrate.
- Each land cover type should be useful to the Plan in terms of defining the location and extent of an important vegetation type, habitat for covered species, or a distinct type of development.
- The land cover type classification should be compatible with existing local, regional, and national land cover classification schemes when possible.

A list of land cover types is given in **Table 3-1**. A comparison ("cross-walk") between land cover types and common vegetation classification systems is presented in **Table 3-2**.

Mapping Procedures

ArcGIS 9.0 software was used to create a GIS dataset of land cover types. The land cover classification also defined the minimum mapping unit that was used for each land cover type. *Minimum mapping units* are the smallest area mapped for each type. Minimum mapping units range from 0.25 acre for wetland and riparian land cover types to 10 acres for most other land cover types. This range of minimum mapping units is sufficient for regional conservation planning and balances the need for high resolution (lower minimum mapping unit) with schedule and budget limitations (higher minimum mapping unit). Minimum mapping units are also limited by the resolution of the imagery and the distinctiveness of the land cover signature relative to adjacent land cover.

A 10-acre minimum mapping unit was used for all land cover types, except for the land cover types noted below.

- Serpentine bunchgrass grassland and mixed serpentine chaparral, which were mapped at a 1-acre minimum mapping unit.
- All riparian, wetland, and aquatic types, which were mapped at a 0.25-acre minimum mapping unit.
- Serpentine seeps and rock outcrops, which had no minimum mapping unit (but due to air photo resolution had a likely minimum mapping unit of 0.1–0.25 acres).

The mapping process involved digitizing polygons on screen (a process known as "*head-up digitizing*") from the primary aerial photographs described above, followed by field verification and a formal accuracy assessment.

Polygons were digitized for areas with distinct image signatures that met minimum mapping unit requirements. Digitizing was completed on-screen by botanists familiar with the study area, and well trained and experienced with this mapping procedure from other HCPs and NCCPs in northern California. Digitizing was conducted while viewing the aerial imagery at mapping scales of 1:4,800 to 1:6,000. The botanists were provided with grids of 0.25 acre and 10 acres to assist in maintaining the minimum mapping units during digitization. Once digitized, polygons were assigned to land cover types on the basis of the criteria in the land cover type definitions (described below under each land cover type).

During the mapping process, polygons with uncertain land cover types were flagged for future field verification. Once the mapping was complete, the botanists verified these ambiguous polygons in the field where access was available.

Serpentine bunchgrass grassland and serpentine chaparral were mapped based on the intersection of annual grassland and chaparral, respectively, with the serpentine soils and geology layers (**Figure 3-4**), and verified in the field where possible. Some areas along Coyote Ridge that were mapped as having serpentine soils or geology were excluded from the serpentine bunchgrass grassland or serpentine chaparral land cover layers because of a lack of field evidence of these plant communities (S. Weiss pers. comm.). Serpentine bunchgrass grassland mapping was refined based on site specific mapping when available (e.g., WRA Environmental Consultants 2009). Boundaries of aquatic features (ponds, reservoirs) were digitized based on the March 2001 photograph when water levels were higher than in the December 2003 image. Recent urban and agricultural development was updated based on the December 2005 aerial photography.

Ancillary information was used to supplement the land cover information acquired by aerial photograph interpretation. National Wetlands Inventory maps were used to check and augment the wetlands mapping, especially for isolated ponds and seasonal wetlands. Data from SCVWD were used as the stream layer for the area. In 2006–2007, SCVWD staff digitized all stream reaches in the study area using USGS Digitial Elevation Models (DEM) overlaying color orthophotos. Mapped signatures for specific land cover types were also compared with vegetation maps of the Sierra Azul Open Space Preserve (Midpeninsula Regional Open Space District 2006) to verify the accuracy of the current mapping effort.

Accuracy Assessment

A formal accuracy assessment could not be conducted for all land cover types due to the inaccessibility of large areas of the study area. However, a field accuracy assessment was performed for all land cover types on the Santa Clara Valley floor to quantify the reliability of the mapping. For land cover types with fewer than 30 polygons, all accessible polygons were field verified. For land cover types with more than 30 polygons, a random sample of 30–40 polygons was selected and verified if accessible. A total of 306 polygons were field verified during this accuracy assessment. Field verification was conducted by two staff, including one botanist. Field verification was performed by visual observation of land cover units from publicly-accessible roads using binoculars and views from vantage points where possible.

A polygon was classified in one of three ways. The first classification was “no change”, meaning the polygon was mapped correctly. The second classification was “error”, indicating a misinterpretation from the aerial imagery. The third classification was “change,” indicating a land use change that occurred after the aerial photographs were taken. The resulting map accuracy for the Valley floor was 73% when calculated by number of polygons. The map accuracy for the Valley floor was 89% when calculated by polygon area (31,258 acres were checked)[9]. All errors identified were corrected in the final land cover map.

Table 3-3a indicates the results of the accuracy assessment of the land cover mapping in the Valley floor by polygon. **Table 3-3b** provides the same results by acreage of land cover type.

Land cover types outside the Valley floor were spot checked throughout the rest of study area in a series of field visits from public roads. Based on the accuracy assessment and these site visits, a qualitative estimate of overall confidence in the mapping of all land cover types is presented in **Table 3-4**. Factors that were considered in this subjective estimate included:

[9] The error rate for urban and agricultural land-cover types may not be a good indication of the error rate for natural land-cover types due to the substantial differences in polygon size, complexity, and patterns of air photo signatures.

- the quantitative results of the accuracy assessment,
- the ability of field crews to visit a representative sample of polygons and verify land cover signatures and mapping units, and
- the distinctiveness of the air photo signature during the season of the photo flight.

Fish Habitat Assemblage Data

A map was developed of native and nonnative fish assemblages and aquatic habitat types throughout the major stream systems in the study area to characterize these important stream communities. Data was first developed to support SCVWD's Stream Maintenance Program. Dr. Jerry Smith of San José State University updated the map in July 2006 for the Science Advisors report of the Habitat Plan to reflect barrier removal and sampling results that occurred in the intervening years since the original map was created (Spencer et al. 2006). The map was then further revised and updated in 2007 by Dr. Smith and Jae Abel, a senior fisheries biologist at SCVWD. Jae Abel then adapted the map so that it corresponded to the new GIS stream data layer developed for the study area by SCVWD in early 2007. Ten categories were defined of fish assemblages and aquatic habitat types. These habitat categories and the fish assemblage map are described in **Appendix L**. The data presented in the appendix are to support the descriptions of natural communities in the study area. These data will not be updated as part of Plan implementation.

3.3.3 Covered Species

Ecology and Distribution

Detailed *species accounts* of each of the 19 covered species (**Table 1-2**) are provided in **Appendix D**. These accounts summarize ecological information, distribution, status, threats, population trends, and conservation and management activities in the study area. The accounts represent the best available scientific data for each species on which to base this Plan. The species accounts are not intended to summarize all biological information known about a species. Rather, each account summarizes scientific information that is relevant to this Plan. Each account is designed for easy reference; all literature cited within the account is provided within it. The biological data in these accounts form the basis for the impact analysis (Chapter 4) and conservation strategy (Chapter 5) in this Plan.

Land cover types are the basic unit of evaluation for habitat modeling, analyzing potential impacts, and developing conservation strategies for covered species. Most covered species are associated with one or more land cover types (**Table 3-5** for wildlife, **Table 3-6** for plants). These land cover type associations, plus other habitat features, were used to develop habitat distribution models for 15 of the 18 covered species that provide additional information on species impacts and conservation needs.

Habitat Distribution Models

Habitat distribution models were developed for select covered species to predict where within the study area covered species occur or could occur based on known habitat requirements. These models have been used to assist in quantifying impacts of covered activities on covered species and to assist in developing the conservation strategy[10]. Alternative reserve and restoration designs were evaluated against each covered species model, when available, to help ensure that regulatory standards and biological goals for these species will be met and that conservation for each species is maximized. Habitat distribution models for 15 of the covered species are described in detail in the respective species account (**Appendix D**). Methods used for all models are described below.

Because of model limitations (see *Model Limitations* discussion below), models could not be developed for three of the 18 covered species. For some species, the number of known occurrences within the study area was so low that habitat potential could not be modeled with confidence (e.g., Tiburon Indian paintbrush). Some plant species have very specialized habitat requirements that could not be modeled given the available data (e.g., coyote ceanothus, Santa Clara Valley dudleya). For species without models, development of the conservation strategy ultimately took a more conservative approach than for species with models. For example, field surveys were required more often in suitable habitat for species without models than for species with models. Information in the species accounts was adequate to develop the impact analysis and conservation measures for the species without habitat models.

The habitat map for Bay checkerspot butterfly, a covered species, was developed based on extensive field surveys. This map is described in more detail in the species account and should be considered as a habitat map rather than a predicted habitat distribution.

Model Structure and Development Methodology

The 15 habitat models described in the species accounts were designed to estimate the extent and location of key habitat characteristics of each species and to be repeatable and scientifically defensible, while remaining as simple as possible. The models are spatially-explicit, GIS-based "expert opinion models" based on identification of land cover types that provide important habitat for these species (**Table 3-5**). Land cover types were identified as suitable habitat based on the known or presumed habitat requirements and use patterns of each species. When supported by appropriate data, the models also incorporate physical parameters including

[10] Habitat distribution models have been developed on a regional scale using regional data. The models are intended for use in regional planning and do not necessarily provide accurate site-specific species information. For project planning, model results must always be field-verified.

- elevation limits using an absolute limit when data supported a clear limit, or one or more of seven elevation categories (0–500, 500–1000, 1001–1500, 1501–2000, 2001–2500, 2501–3000, 3001–3500 feet msl) when data were insufficient to determine an absolute limit,
- soil type based on eight broad categories (clay, loam, silt, sand, coarse sand, rock, other, unknown [U.S. Soil Conservation Service 1968]),
- presence or absence of serpentine soils and/or serpentine geology (Dibblee 1973, 1977; Brabb and Dibblee 1974)
- slope steepness based on three categories (flat 0–10%, moderate 11–25%, steep >25%), and
- ecoregion subsection (U.S. Forest Service 1997; see **Figure 3-8**).

Further, in some cases, perimeter zones that were used to designate habitat are defined by a certain distance from a land cover type. For example, the California red-legged frog model uses upland habitat for aestivation (summer hibernation) and dispersal, but the probability of use decreases with increasing distance from suitable breeding sites (e.g., ponds, streams).

Primary and secondary habitats for wildlife were designated according to type of habitat use. Land cover types used for breeding were designated as primary habitat. Secondary habitat includes other important habitats used for foraging, aestivation, migration, movement, or dispersal. This secondary habitat is no less important for the species than primary habitat but merely characterizes different habitat function for the species.

Determinations of suitable land cover types and additional physical parameters were based on available data from peer-reviewed scientific literature, survey reports, and environmental documents. Local survey data were used whenever possible to define model parameters. When data were inconclusive or contradictory, conservative values were assumed in estimating suitable habitat. See below for a discussion of the model limitations.

Covered Species Locations

Documented occurrences of covered species within the study area were used to validate and refine the models. Sources of occurrence data are listed below.

- California Natural Diversity Database (2008 and 2012 data).
- Plant occurrence records from 2004 SCVWD surveys of their facilities (J. Hillman pers. comm.).
- A 1999 survey of foothill yellow-legged frog in Santa Clara County (H.T. Harvey & Associates 1999).
- Least Bell's vireo survey data from SCVWD (Santa Clara Valley Water District 2002d, 2003, 2004).

- Rare plant and special-status wildlife survey data from field work conducted in 2005-2006 east of San José on an approximately 8,000-acre property owned by United Technologies Corporation (UTC) (T. Marker pers. comm.).
- Recent plant occurrence records from the California Native Plant Society (K. Bryant pers. comm., 2006–2007 data).
- Bay checkerspot butterfly survey data from field work conducted between 2009 and 2011 on the 2,150-acre Young Ranch site (WRA Environmental Consultants 2012).

Occurrences that fell outside a model's predicted habitat distribution were evaluated to determine whether they indicated flaws in the model or were anomalous or erroneous points. Erroneous points were deleted; anomalous points were retained but were not used to verify model results. The aerial photographs were examined to assess the significance of extreme outliers.

The majority of the records come from the CNDDB (California Natural Diversity Database 2008, 2012). Occurrences that have been documented since 1980 were assumed to be extant unless they were on sites that have obviously been converted to other land uses. These recent occurrences were used to verify habitat models. These occurrences are displayed as either *precise locations* or *general locations*, described in more detail in *Occurrence Data Precision* below. Any occurrence before 1980 is considered a *historical location*[11] and is not shown on the habitat model, with a few exceptions. Historical occurrences were considered if the land use at the location has clearly not changed since the sighting (e.g., a state park). Historical occurrences presumed extant were also used to supplement models with few recent occurrence records.

CNDDB Data Limitations

CNDDB records represent the best available statewide data but are limited in their use for conservation planning. CNDDB records rely on field biologists to voluntarily submit information on the results of surveys and monitoring. As a result, the database is biased geographically toward areas where surveys have been conducted or survey efforts are greater (many areas have not been surveyed at all and this is not reflected in the database). The database may also be biased toward species that receive more survey effort. For example, there have been more surveys for California red-legged frog than other special-status wildlife because it is a listed species. Conspicuous diurnal species such as raptors likely receive greater survey effort than nocturnal species such as bats. Plants typically receive less survey effort than wildlife.

[11] The year 1980 was selected as a somewhat arbitrary cutoff date. We assume that before this year occurrence records are more likely to be inaccurate or no longer present than occurrence records after this year. 1980 is also the cutoff date used by The Nature Conservancy in their internal ecoregional planning process in California.

Occurrence Data Precision

Data that are reported to the CNDDB are done so with varied precision. Some occurrences are very well documented with explicit locations (e.g., GPS coordinates) while others are reported with more general location information. CNDDB staff qualitatively categorize each occurrence record into one of two categories: *specific* and *non-specific* (California Natural Diversity Database 2008).

A *specific* occurrence has sufficient information to be located on a standard USGS 7.5-minute quadrangle map. This information may be based on political or natural features but has been very well described by the observer. These occurrences are mapped by CNDDB as points with an 80-meter radius or as specific polygons when information allows. For the purposes of this Plan these occurrences are mapped as points and are labeled as *precise location* on the habitat distribution models.

A *non-specific* occurrence is a species occurrence that has been documented by the observer in very general terms. Sometimes the precise location is unclear or lacks critical information that does not allow it to be mapped accurately. These occurrences are mapped by CNDDB as circular features with a radius of 0.1, 0.2, 0.4, 0.6, 0.8, or 1.0 mile. These occurrences can also be mapped with non-specific polygons, such as the boundary of a park where an occurrence is known to occur. For the purposes of this Plan these occurrences are mapped as points and are labeled as *general location* on the habitat distribution models.

Model Uses and Limitations

The habitat distribution models are intended to be used only for planning purposes at the scale of the study area. The precision of the habitat distribution models is limited by several factors, including the 10-acre/0.25-acre minimum mapping units used to map each land cover type. Areas of suitable habitat smaller than the mapping thresholds were not mapped and could therefore not be incorporated into the models. This constraint limited the degree of resolution of some habitat features potentially important to some species. Therefore, these models should only be used at the regional scale (i.e., scale of the study area) rather than for site-specific planning. In addition, these models are not intended to be used for project-level CEQA analysis, including determinations on the level of CEQA compliance required (e.g., whether a Categorical Exemption is warranted).

The habitat distribution models were limited to distinguishing habitat uses based on key life history requirements such as breeding, foraging, or dispersal that are tied to land cover types. The data do not allow for further distinctions of habitat quality on a regional scale. To account for these limitations, conservative estimates of habitat parameters were used. This approach tends to overestimate the actual extent of suitable or required habitat for this species, but is consistent with current conservation planning practices when data are limited (Noss et al. 1997).

For the most part, the models are used in this plan to denote suitable habitat. Suitable habitat was assumed to be occupied for the purposes of the take analysis and conservation strategy. This approach is justified because of the limitations in occurrence data described above and the infeasibility of determining presence or absence on such a large scale. To conclusively determine absence, the Wildlife Agencies typically require extensive protocol-level surveys in the field, sometimes spanning several years.

Alternative Approaches to Habitat Modeling

In developing the habitat distribution models, we considered other potential approaches. For example, the Science Advisors recommended that statistical modeling techniques be considered for determining species habitat relationships within the study area. Because the study area does not include any data on locations where species are absent, statistical modeling would have to be done with “presence-only models” (Hirzel et al. 2002; Hirzel and Arlettaz 2003; Guisan and Thuiller 2005; Elith et al. 2006; Guisan et al. 2006; Pearce and Boyce 2006). Presence-only models use species presence data to draw inferences about a species’ habitat preference. These models characterize the locations where the species were sighted, calculate habitat scores from those locations, and then compare them to habitat distributions within the entire area of interest. To eliminate the need for absence data, these models either assume that locations without sightings are “pseudo-absences” or that there is something different between sighting locations and all the other locations in the area of interest. After reviewing the data requirements and limitations of these models, we determined that it is not feasible to use them in this HCP/NCCP for the reasons outlined below.

The primary reason we were unable to use these techniques is a lack of available data for the covered species, particularly for species whose habitat requirements in the study area are poorly known and where this technique would be most helpful. For example, the specific habitat needs of San Joaquin kit fox are poorly known in the study area but there are only two observations of this species in the County. Presence-only models typically require at least 50 observations to produce robust results. The only covered species with 50 or more observations in the study area are the California red-legged frog, California tiger salamander, Western burrowing owl, and Western pond turtle. These species have relatively well-understood habitat/occurrence relationships, where an expert opinion model tends to work well. The remaining covered species have approximately 30 or fewer observations in the study, making them inappropriate for presence-only models. We investigated the use of museum records to supplement our occurrence data, but most of the online catalogs did not have recent records for our target species or collectors did not record enough information on habitat associations on the collection records to be useful for a presence-only model. Additional field data collection was also not feasible because of the large scale of the study area and schedule and budget limitations.

We also chose not to use presence only techniques because they are sensitive to the selection of the proper spatial extent and model cell size. The spatial extent of the model should represent the area sampled (Hirzel et al. 2002; Pearce and Boyce 2006). Because CNDDB and our other biological occurrence data do not provide information of the area surveyed it would be difficult to define the spatial limits of the model. Without this information the model results would be biased and may give more of an indication of sampling effort rather than actual habitat value (Pearce and Boyce 2006)[12]. For example, if most of the surveys were conducted along roadsides than the spatial extent of the model should only include habitats near roadsides. As a result, the available biological occurrences do not provide enough information to adequately assess what would be an appropriate spatial extent of the model.

These techniques are also sensitive to the type and number of pseudo-absence sites chosen for the analysis (Pearce and Boyce 2006; A. Gelfand pers. comm.). Because presence-only models sample the presence and pseudo-absence locations in different manners the proportion of presence within the sample does not represent the true prevalence of the species. Therefore, presence-only models with differing number of pseudo-absence sites can come up with dramatically different answers (A. Gelfand pers. comm.).

Finally, presence-only models do not propose a model to be estimated and therefore there is no likelihood function that can be used for statistical inference. Instead, presence-only models primarily fit surfaces or use mathematical values to describe a species relationship among a set of candidate sites. Without a defined likelihood function it is not possible to calculate confidence limits, probabilities of significance, or other values that allows the researcher understand the validity of the resulting model (Gelfand et al. 2006).

Instead of using the presence only modeling techniques we have chosen to use expert opinion models provided by species experts. There are several advantages to using these models in the HCP/NCCP planning process. The first benefit is that experts are identifying habitat as inherently good, not good relative to other sites in the area. This means that good sites have a relatively high probability of species occurrence. Second, research has shown that expert opinion models may overestimate suitable habitat (Johnson and Gillingham 2004). It is desirable to overestimate habitat for this plan because it allows for conservative estimates of impact (i.e., err on the side of overestimating impacts) and conservation of suitable areas. Finally, another important advantage of expert opinion models is that the variables and methods used to construct the models are easily understood and are reproducible by knowledgeable GIS practitioners. Application of presence-only statistical models requires specialized software and uses highly specialized statistical techniques.

[12] A recent application of this type of model using BIOMAPPER for the East San Diego County HCP/NCCP had over 1,700 data points for peninsular bighorn sheep. The model was highly labor-intensive and was very sensitive to subjective assignments of break points for the correlation classifications. In the end, the model produced results that were only somewhat useful for the HCP/NCCP (S. Fleury pers. comm.).

3.3.4 Biological Diversity of Study Area

Species richness, a measure of the number of species in a defined region, is the most readily available measure of diversity and is generally accepted as an index of biological wealth of a region. The number of species that are endemic or unique to a geographic region can provide a measure of biological distinctiveness that is recognized as another measure of biological wealth. When NatureServe examined the diversity and endemism of species for all 50 states in the U.S., California ranked first in both categories (Stein 2002). A unique combination of climate, geography, and topography make California one of the most biologically diverse areas in the world. California is home to several of the nation's biological "hotspots" and has been identified as one of 25 "hotspots" of biodiversity worldwide (Stein et al. 2000).

With a geography that is bordered by the Pacific Ocean, includes San Francisco Bay, and expands eastward into the Sacramento and San Joaquin Valleys, the San Francisco Bay Area is one of only six global hotspots of species rarity in the United States (California Department of Fish and Game 2003b). The nine counties that comprise the Bay Area account for just over 18,000 square kilometers (km^2), or nearly 5% of the state. Within that 5%, 64 of the 194 natural communities mapped by the California Gap Analysis occur (Wild 2002). This accounts for 33% of the natural communities in California.

More than a dozen major rivers flow into the Central Valley from the Sierra, Cascade, Klamath, and Coast Ranges and converge at the San Francisco Bay Delta; a vast network of wetlands that ultimately empties into Suisun Bay (California Department of Fish and Game 2003b). From the south several more rivers and creeks flow directly into San Francisco Bay, and the Bay itself is lined with tidal wetlands and marshes. These aquatic resources alone support over 200 species of birds, mammals, reptiles, and amphibians (California Department of Fish and Game 2003b). This interface with the San Francisco Bay, coupled with an assortment of upland habitat types with exceptional soil diversity and topography, makes the Bay Area a critical element in the biodiversity of California and of the world.

Situated on the south side of the Bay Area, Santa Clara County represents the extremes of the region. Due to the variation in topography and soil diversity within the County there are a wide array of natural community types and subsequently very diverse flora and fauna. The Santa Clara Basin Watershed Management Initiative (2003) reports that there are 93 identified special-status species in the Santa Clara Basin; 24 of which are either federal or state listed as threatened or endangered. The analysis conducted for this Plan identified 147 special-status species that occur or have the potential to occur in the Plan study area. Biological diversity is realized for all species groups and they are discussed in more detail below.

Mammals

Like many southwestern states California has a high diversity of mammals due to its large size and unique environments. In fact, California has the most diverse mammal population of any state and has the most endemic mammal species, with 17 (Stein 2002; California Department of Fish and Game 2003b). The south San Francisco Bay region ranks as medium to high in mammalian species rarity and richness within the state (California Department of Fish and Game 2003b). This is largely driven by the salt marshes in the Bay/Delta region and the riparian habitats that drain to them. Of the 195 known mammalian species within the state (Stein 2002) over 20% can be found within Santa Clara County. Between 40 and 47 of those species can be found in Santa Clara Valley and between 48 and 55 can be found in the surrounding Santa Cruz Mountains and Diablo Range (California Department of Fish and Game 2003b). This represents a range between 20% and 28% of the known mammalian species of the state, respectively, for the major geographic features of the Plan study area.

Birds

California supports one of the most diverse bird populations in the United States. In 2008 the list of birds that spend some part of the year in California was 636 species (California Bird Records Committee 2008).These species range from those who are endemic to California to those that are migratory species that spend part of the year in the state. The south San Francisco Bay region ranks as medium to high in bird species rarity and richness within the state (California Department of Fish and Game 2003b). This is largely driven by the salt marshes in the Bay/Delta region, which are particularly important to many migratory species and the riparian habitats and diverse upland habitats that make up the interior Bay Area. Of the 636 known bird species that either breed in or migrate through the state more than 45% can be found within Santa Clara County. An example of the bird diversity of the study area is provided by the list of 389 species that appear on the Checklist for Birds of Santa Clara County (South Bay Birders Unlimited 2007), 177 of which have been documented breeding in the county (Bousman 2005). Henry W. Coe State Park, the largest open space unit in the study area, supports 162 species of birds that have been confirmed in the park (Pine Ridge Association 2006a).

Reptiles

California ranks fifth overall in reptile diversity by state in the United States with 86 known species (Stein 2002). The south San Francisco Bay region ranks as low to medium in reptilian species rarity within the state and medium to high in species richness (California Department of Fish and Game 2003b). The distribution of reptilian species within the study area is varied. The Santa Clara Valley supports under 10% of the known reptilian species within the state, while the Santa Cruz Mountains and the Diablo Range support up to 30% (California Department of Fish and Game 2003b). An example of the reptile diversity of the study area is provided by the list of 27 reptile species found in Henry W. Coe State Park (Pine Ridge Association 2006b).

Amphibians

California ranks ninth overall in amphibian diversity in the United States with 57 known species (Stein 2002). The south San Francisco Bay region ranks low in amphibian species rarity within the state but medium to high in species richness (California Department of Fish and Game 2003b). The distribution of amphibian species within the study area is varied. The Santa Clara Valley supports less than 10% of the known amphibian species within the state, while the Diablo Range supports 15% and the Santa Cruz Mountains support up to 30% (California Department of Fish and Game 2003b). An example of the amphibian diversity of the study area is provided by the list of 11 amphibian species found in Henry W. Coe State Park (Pine Ridge Association 2006b).

Freshwater Fish

California ranks 34th overall in freshwater fish diversity by state in the United States with 62 known species (Stein 2002). The south San Francisco Bay region ranks low in fish species rarity within the state but medium to high in species richness (California Department of Fish and Game 2003b). The rivers and creeks that drain the Santa Cruz Mountains and the Diablo Range are home to 11 native and 19 nonnative species of fish (Santa Clara Basin Watershed Management Initiative 2003). This represents around 17% of the known freshwater fish species of the state. The most species rich is Coyote Creek with 10 native species followed by the Guadalupe River with seven (Santa Clara Basin Watershed Management Initiative 2003). In the south county, 11 native fish species are found within the Pajaro River watershed, although one of those species, the speckled dace, only occurs in the upper San Benito River, outside of the study area (J. Smith pers. comm. 2007). The abundance and distribution of native species have been reduced significantly over time through human impacts. The interface with the bay provides habitat for several species of anadromous fish including steelhead/rainbow trout, which has been observed in both Coyote Creek and the Guadalupe River (Santa Clara Basin Watershed Management Initiative 2003).

Invertebrates

There are many thousands of invertebrate species in California, with an estimated 28,000 species of insects alone (California Department of Fish and Game 2003b). The south San Francisco Bay region and most of the study area ranks as medium in invertebrate species rarity within the state (California Department of Fish and Game 2003b). Most of that rarity is driven by unique grassland and scrub habitats that support rare species of plants. These rare plant species in turn support the complex life stages of many insects, especially butterflies and moths.

The biological diversity of invertebrates in Santa Clara County and the study area is largely unknown.

Vascular Plants

California has the highest overall plant diversity in the United States with almost 8,000 known species (Hickman 1993; Stein 2002). Santa Clara County's moderate size and diverse physical and climatic characteristics create the conditions for a moderate to high level of botanical diversity. Unique habitats like serpentine grasslands in the study area support many special-status species, some of which are covered in this Plan. Of 8,363 plant taxa in California in the CalFlora database, Santa Clara County supports 1,778 native plant taxa and 507 nonnative plant taxa, or 27% of the plant taxa in the state in CalFlora (CalFlora Database 2006)[13].

The exact number of vascular plants in the study area is unknown. However, floristic surveys of large areas of open space in the study area provide an indication of floristic diversity. For example, the Pine Ridge Association maintains a list of 675 vascular plants found in Henry W. Coe State Park (Pine Ridge Association 2006c).

3.3.5 Natural Communities and Land Cover Types

The NCCP Act requires that natural communities within the study area that could be affected by Plan implementation be identified in an NCCP. Natural communities are defined by the vegetative communities within them. Accordingly, the vegetative communities, or land cover types, within each natural community are described below and shown in **Figure 3-9**.

This Plan includes seven natural communities.

- Grassland.
- Chaparral and coastal scrub.
- Oak woodland.
- Riparian forest and scrub.
- Conifer woodland.
- Wetland.
- Open water.

[13] These values somewhat overestimate the actual number of plant taxa in California and Santa Clara County because species are counted separately from each variety or subspecies in the CalFlora database. For example, *Polygonum amphibium* is counted as a unique entry from *Polygonum amphibium* var. *emersum*.

In addition, two broad categories of non-natural land cover types are defined and described below.

- Irrigated agriculture.
- Developed.

The description of each natural community provides information on historic land cover, associated wildlife, ecosystem function, and threats. Each of the 37 land cover types used in this Plan is discussed in one of the natural communities, as shown in the hierarchy in **Table 3-1**. When data are available, vegetation associations are also described for each land cover type. Vegetation associations are distinct units of plant communities defined by the dominant species of plants that are consistently found on the landscape.

Quantitative data on vegetation and plant diversity is often lacking for regional conservation plans. However, a unique data set is available for the Santa Clara Valley HCP/NCCP. In the spring and summer of 2001 and 2002, botanists and volunteers from the CNPS and the CDFG conducted extensive quantitative sampling of vegetation along the approximately 7,000 acre Coyote Ridge (Evens and San 2004). The purpose of this study was to define and document the range of vegetation associations and plant diversity in the mostly serpentine communities of the ridge. Data from 200 locations were analyzed and grouped into discrete associations using standard cluster analysis and ordination techniques.

A total of 47 vegetation associations were defined and described in detail that support 329 unique species. Four of these associations were newly recognized and 32 of them were identified as provisional because they were based on less than 10 samples. Vegetations associations defined by this important study are summarized in this chapter under the relevant natural community as a way to describe the variety of vegetation associations within each land cover type. It is expected that many of these 47 vegetation associations occur elsewhere in the study area. However, it should be recognized that the relatively small sample area (only 1% of the study area) provides limited information on the vegetation diversity of the study area.

The results of the land cover mapping are summarized in **Table 3-7** and described below for each land cover type. See **Figure 3-10** for the land cover map using all land cover types.

Grassland

Grassland consists of herbaceous vegetation dominated by grasses and forbs. Grassland in the study area is classified into six land cover types.

- California annual grassland.
- Non-serpentine native grassland (not mapped).
- Serpentine bunchgrass grassland.

- Serpentine rock outcrop / barrens.
- Serpentine seep.
- Rock outcrop (non-serpentine).

CDFG considers serpentine bunchgrass grassland a sensitive biotic community (California Department of Fish and Game 2003b). The land cover types serpentine seep, serpentine rock outcrop / barrens, and rock outcrop (non-serpentine) are typically associated with grasslands so are also discussed in this natural community.

Historical Extent and Composition

Historical records do not provide definitive data on the distribution of native perennial grasslands, but research indicates human use of fire may have had a profound impact on the historic distribution and extent of grasslands. Prior to European settlement, native perennial grasslands in Santa Clara County were likely subject to regular burning by native American people. Keeley (2002) surmises that because dense scrub or chaparral had little value to native Americans, they used periodic burning to clear shrubs and provide habitat for fire-tolerant native grasses. Keeley (2002) also implies that the current mosaic of grassland is likely a result of historic vegetation management that favored open grasslands over chaparral.

Another human-made change to the landscape was initiated with the introduction and spread of many nonnative plants throughout California. The invasions began in 1769, when the first Spanish settlements were established at Monterey and San Diego, or possibly earlier. These introductions occurred by unassisted migration or by transport in the belongings or livestock of travelers from the Spanish settlements outside of California or in ship's cargo of coastal explorers. These non-native plant invaders included very aggressive annual grasses and forbs from the grasslands of the Mediterranean region that quickly replaced the natives, both with and without the influence of livestock grazing (Hendry 1931; Blumler 1992; Bartolome et al. 2007). The grazing of livestock in the study area by European settlers became more widespread after the gold rush of the 1850s. The combination of livestock grazing, drought, and spread of aggressive grasses and herbs dramatically reduced the abundance of native grasses and the extent of native grasslands throughout California (Bartolome et al. 2007). Grazing by livestock and wildlife continues today in almost all of the grasslands and other natural communities linked to grasslands (woodlands, riparian woodlands, and shrublands) of the County, although less intensively than in the past. While most grasslands in the County are now dominated by nonnative annuals, small patches of native grasses, below the resolution of the land cover map in this Plan, are found in many of these grasslands. There is some controversy over whether perennial grasses ever dominated California grasslands. It is likely that the Spanish mostly encountered annual grasslands that had a small representation of perennial species intermixed (Blumler 1992).

Further, recent scientific research suggests many of California's modern grasslands were not "grasslands," but might have been dominated instead by shrubs or annual forbs during the Native American period before arrival of the settlers and most of the invading non-native grasses (Hopkinson and Huntsinger 2005; D'Antonio et al. 2007). Schiffman (2007) suggests that drier valley and interior Coast Range "grassland" habitats were dominated by forbs during prehistoric times. Thus, without further study, we cannot be certain of the locations or extents of prehistoric grasslands in the County.

Common Wildlife Associations

Characteristic wildlife species in grasslands include reptiles such as western fence lizard (*Sceloporus occidentalis*), common garter snake (*Thamnophis sirtalis*), and western rattlesnake (*Crotalis viridis*); mammals such as black-tailed jackrabbit (*Lepus californicus),* California ground squirrel (*Spermophilus beecheyi*), Botta's pocket gopher (*Thomomys bottae*), western harvest mouse (*Reithrodontomys megalotis*), California vole (*Microtus californicus*), American badger (*Taxidea taxus*), and coyote (*Canis latrans*); and birds such as burrowing owl (*Athene cunicularia*), short-eared owl (*Asio flammeus*), horned lark (*Eremophila alpestris*), and western meadowlark (*Sturnella neglecta*). Annual grassland also provides important foraging habitat for turkey vulture (*Cathartes aura*), northern harrier (*Circus cyaneus*), American kestrel (*Falco sparverius*), white-tailed kite (*Elanus leucurus*), and red-tailed hawk (*Buteo jamaicensis*).

Grassland-associated wildlife species covered under this Plan that are known to occur in the study area include San Joaquin kit fox (*Vulpes macrotis mutica*), western burrowing owl (*Athene cunicularia hypugea*), California red-legged frog (*Rana draytonii*), California tiger salamander (*Ambystoma californiense*), western pond turtle (*Clemmys marmorata*), and tricolored blackbird (*Agelaius tricolor*) (**Table 3-5**). California red-legged frog and California tiger salamander breed in aquatic habitats (e.g., ponds) within grasslands, and use grasslands as movement and aestivation (summer hibernation) habitat. Western pond turtle use grassland land cover adjacent to aquatic habitat as year-round and movement habitat. Serpentine grassland provides valuable habitat in the study area for all life stages of the federally threatened Bay checkerspot butterfly (*Euphydryas editha bayensis*) (see the species account in **Appendix D** for more information). The butterfly also uses grasslands as movement corridors between isolated serpentine grassland patches. These grasslands also provide unique habitat for a variety of special-status invertebrates that are not covered by this plan, including several butterfly species and Hom's microblind harvestman (*Microcina homi*).

Grassland Land Cover Types

Within the Plan study area, California annual grassland was identified by its smooth, pale signature on aerial photograph, lacking the dark green signatures of woody plants taken during the summer months. Native grasslands could not be distinguished reliably on the available imagery.

California Annual Grassland

Annual grassland or *nonnative grassland* is an herbaceous plant community dominated by nonnative annual grasses (Holland 1986; Sawyer and Keeler-Wolf 1995). In the study area, annual grassland was mapped where grasses and forbs dominate the land cover and where trees and shrubs comprise less than 10% canopy cover. The dominant grasses in the study area generally consist of introduced annual grasses from the Mediterranean basin, including wild oats (*Avena barbata* and *A. fatua*), soft brome (*Bromus hordeaceus*), foxtail chess (*B. madritensis*), leporinum barley (*Hordeum murinum* ssp. *leporinum*), Italian ryegrass (*Festuca perennis* [*Lolium multiflorum*]), barbed goatgrass (*Aegilops triuncialis*), harding grass (*Phalaris aquatica*), shiver grass (*Aira caryophyllea*), rat-tail fescue (*Festuca* [*Vulpia*] *myuros*), ripgut brome (*Bromus diandrus*), nit grass (*Gastridium phleoides* [*G. ventricosum*]), bentgrass (*Polypogon* [*Agrostis*] *viridis*), and small fescue (*Festuca* [*Vulpia*] *microstachys*) (Evens and San 2004). The associated herbaceous cover includes native and nonnative forbs. Common species in the study area include many clover species (*Trifolium* spp.), filaree species (*Erodium* spp.), lupine species (*Lupinus* spp.), four-spot (*Clarkia purpurea* ssp. *quadrivulnera*), California poppy (*Eschscholzia californica*), purple owl's-clover (*Castilleja exserta*), Ithuriel's spear (*Triteleia laxa*), black mustard (*Brassica nigra*), starthistle species (*Centaurea* spp.), wavyleaf soap plant (*Chlorogalum pomeridianum*), common yarrow (*Achillea millefolium*), and common fiddleneck (*Amsinckia menziesii*).

California annual grassland occupies an estimated 81,795 acres (18%) of the study area (**Table 3-7** and **Figure 3-10**). This land cover type is generally found in valley bottoms. In the study area, it is found at low elevations along the eastern side of the Santa Clara Valley bordering the foothills, and on ridges on dry south- and west-facing slopes. Annual grassland is also common on both sides of the Pacheco Pass in the southern portion of the County. It is often found intermingling with oak woodlands and chaparral/scrub communities.

One covered plant that may be found on this land cover type is fragrant fritillary (*Fritillaria liliacea*). This species is restricted to specific habitat elements and micro-site characteristics within California annual grassland.

Native Grassland (Non-Serpentine)

Native, *non-serpentine grasslands* are patchily distributed in the study area and generally occur as small patches within the larger annual grassland complex. Accordingly, *native grassland* contains an abundance of nonnative annual grasses mixed with perennial grasses and forbs. Native grassland could not be distinguished from annual grassland on aerial photographs of the study area. Consequently, this land cover type was mapped as annual grassland.

Soils which support populations of native non-serpentine grasslands tend to be deep (50–100 cm), high in clay content with few rocks, and mostly on north-and east-facing slopes (Keeley 1993). There are several types of native grasses present in the study area, including purple needlegrass (*Stipa* [*Nassella*] *pulchra*), big squirreltail (*Elymus multisetus*), Torrey's melicgrass (*Melica torreyana*), creeping ryegrass (*Elymus* [*Leymus*] *triticoides*), small fescue, small-flowered needlegrass (*Stipa* [*Nassella*] *lepida*), one-sided bluegrass (*Poa secunda*), blue wildrye (*Elymus glaucus*), and California melica (*Melica californica*). Native, non-serpentine grasslands in the study area are characterized by the following grassland associations based on quantitative vegetation sampling conducted by the CNPS along extensive areas of Coyote Ridge (Evens and San 2004).

- **Italian ryegrass-purple needlegrass-Gambel's dwarf milkvetch-shining pepperweed (*Lepidium nitidum*) grassland association.** This association can be found on both serpentine and non-serpentine soils but typically occurs in herbaceous stands that have deep soils with high clay content (Evens and San 2004). Plants characteristic of this community are Italian ryegrass, purple needlegrass, hayfield tarweed (*Hemizonia congesta* ssp. *luzulifolia*), beaked cryptantha (*Cryptantha flaccida*), Douglas' microseris (*Microseris douglasii*), blue dicks (*Dichelostemma capitatum*), dwarf plantain (*Plantago erecta*), California poppy, Gambel's dwarf milkvetch, calf lotus (*Acmispon* [*Lotus*] *wrangelianus*) and reticulate seeded spurge (*Euphorbia spathulata*).
- **Italian ryegrass-purple needlegrass-coast range false bindweed grassland association.** This association can be found on both serpentine and non-serpentine soils but typically occurs in herbaceous stands that have deep soils with high clay content (Evens and San 2004). Plants characteristic of this community are Italian ryegrass, purple needlegrass, dwarf plantain, coast range false bindweed (*Calystegia collina*), California poppy, and common yarrow.
- **Creeping ryegrass-Italian ryegrass grassland association.** This association is found in the study area in both serpentine and non-serpentine soils of marine origin that experience seasonal flooding (Evens and San 2004). Characteristic species are creeping ryegrass, Italian ryegrass, common fiddleneck, wild oat, soft brome, reticulate seeded spurge, prickly lettuce (*Lactuca serriola*), and California blue-eyed grass (*Sisyrinchium bellum*).
- **Torrey's melicgrass grassland association.** This association is found on both non-serpentine and serpentine soils. Common species are Torrey's melicgrass, Italian ryegrass, soft brome, common yarrow, coast range false bindweed, shooting star species (*Dodecatheon* sp.), naked wild buckwheat (*Eriogonum nudum*), California poppy, and small fescue.
- **Big squirreltail (*Elymus multisetus*)-dwarf plantain-Italian ryegrass association.** Big squirreltail grassland is generally found on sedimentary and serpentine soils. Characteristic species are big squirreltail grass, Italian ryegrass, purple needlegrass, pine bluegrass, soft brome, California poppy, beaked cryptantha, dwarf plantain, California goldfields (*Lasthenia californica*), common yarrow, and wavyleaf soap plant.
- **Small fescue-dwarf plantain grassland association.** Small fescue grassland is typically found on well-developed soils on serpentine and on sedimentary soils that are mesic in spring. Common species are small fescue, common yarrow, soft brome, naked wild buckwheat, California poppy, Italian ryegrass, dwarf plantain, wavyleaf soap plant, Italian ryegrass, and common California-aster (*Corethrogyne* [*Lessingia*] *filaginifolia*).

The extent of non-serpentine native grassland in the study area is unknown.

No covered plants may be found on this land cover type.

Serpentine Bunchgrass Grassland

Serpentine bunchgrass grassland occurs on ultramafic soils derived from serpentinite. Serpentine soils generally have lower overall cover of vegetation as well as lower cover of nonnative species than annual grasslands, and are characterized by low plant growth and productivity (McNaughton 1968; Holland 1986). This is due in large part to the high content of heavy metals in the soil such as chromium, nickel, and cobalt which are toxic to most plants, very low calcium/magnesium ratios, unusually high levels of iron, and limiting levels of nitrogen, phosphorous, potassium, and calcium, all of which are important plant nutrients (Kruckeberg 1984). Many serpentine species are partially or completely confined to growing on this substrate (Safford et al. 2005). Native bunchgrasses in serpentine habitat are generally similar to those in non-serpentine habitats, although serpentine populations may be more tolerant of heavy metals present in the soil and may have lower growth rates compared to non-serpentine populations (Huntsinger et al. 1996).

Serpentine bunchgrasses typically occur in patches of both single and multiple species (McCarten 1987). As noted above, nonnative annuals are much less dominant in serpentine areas, although increasing nitrogen deposition from air pollution has increased the productivity of serpentine soils and allowed a greater number of nonnatives to invade (Evens and San 2004; Harrison et al. 2003; Weiss 1999). Native grasses typically found on serpentine soils in the study area include big squirreltail, creeping ryegrass, purple needlegrass, Torrey's melicgrass, and small fescue. Some common herbaceous species are fringed sidalcea (*Sidalcea diploscypha*), jeweled onion (*Allium serra*), serpentine linanthus (*Leptosiphon* [*Linanthus*] *ambiguus*), and Franciscan wallflower (*Erysimum franciscanum*) (Evens and San 2004).

Although the total coverage of serpentine soils is relatively small state-wide (1.5%), 13% of plant species endemic to California are serpentine endemics (Safford et al. 2005). Many of these occur in the San Francisco Bay area. There are a variety of ultramafic affinities for serpentine species that can vary by geography. For instance, serpentine species can be strict endemics (95% of the time they are found growing on serpentine), strong indicators (about 70% of the time they are found growing on serpentine), and weak indicators (about 60% of the time they are found growing on serpentine). The herbaceous species listed above have serpentine affinities that fall between strict endemic and strong indicator.

Serpentine grasslands in the study area are characterized by the following associations based on quantitative vegetation sampling conducted by CNPS along extensive areas of Coyote Ridge (Evens and San 2004).

- **Italian ryegrass-purple needlegrass-Gambel's dwarf milkvetch-shining pepperweed grassland association.** Plants typical of this association can be found above in native grasslands. Additional species characteristic of this association on serpentine soils are smooth lessingia (*Lessingia micradenia* var. *glabrata*), most beautiful jewel-flower (*Streptanthus albidus* ssp.

peramoenus), and Santa Clara Valley dudleya (*Dudleya abramsii* ssp. *setchellii*).

- **Italian ryegrass-purple needlegrass-coast range false bindweed grassland association.** Plants typical of this association can be found above in native grasslands. Additional species characteristic of this association on serpentine soils are smooth lessingia, Mt. Hamilton thistle (*Cirsium fontinale* var. *campylon*), and jeweled onion.
- **Creeping ryegrass-Italian ryegrass grassland association.** Plants typical of this association can be found above in native grasslands. An additional species characteristic of this association on serpentine soils is smooth lessingia.
- **Torrey's melicgrass grassland association.** Plants typical of this association can be found above in native grasslands. Additional species characteristic of this association on serpentine soils are smooth lessingia, jeweled onion, and Santa Clara Valley dudleya.
- **Big squirreltail (*Elymus multisetus*)-dwarf plantain-Italian ryegrass association.** Plants typical of this association can be found above in native grasslands. Additional species characteristic of this association on serpentine soils are jeweled onion and most beautiful jewel-flower. Other occasional associates are Santa Clara Valley dudleya and serpentine linanthus.
- **Small fescue-dwarf plantain grassland association.** Plants typical of this association can be found above in native grasslands. Additional species characteristic of this association on serpentine soils are Franciscan wallflower, jeweled onion, and most beautiful jewel-flower. Fragrant fritillary and serpentine linanthus also occasionally may be present.

Covered plants that may be found in serpentine bunchgrass in the study area include the following: Tiburon Indian paintbrush (*Castilleja affinis* ssp. *neglecta*), coyote ceanothus (*Ceanothus ferrisiae*), fragrant fritillary, Santa Clara Valley dudleya, smooth lessingia, Mt. Hamilton thistle , Metcalf canyon jewel-flower, and most beautiful jewel-flower (Evens and San 2004; California Natural Diversity Database 2008, 2012; also see **Table 3-6**). These species are restricted to specific habitat elements and micro-site characteristics within serpentine bunchgrass grassland.

Certain species not considered serpentine endemics or indicators but commonly found in serpentine soil areas, host or provide nectar for the federally threatened Bay checkerspot butterfly. Such species include dwarf plantain, purple owl's-clover, California goldfields, common muilla (*Muilla maritima*), and lomatium species (*Lomatium* spp.) (Weiss 1999).

Serpentine bunchgrass grassland occupies approximately 10,308 acres (2.2%) of the study area (**Table 3-7** and **Figure 3-10**). This land cover type was mapped where grasslands intersected either serpentine soils or serpentine bedrock (**Figure 3-4**). In the study area, serpentine bunchgrass grassland is found primarily northwest of Anderson Lake along Coyote Ridge and the Silver Creek Hills. Smaller patches of serpentine bunchgrass grassland can be found in the

Santa Theresa Hills, on Communications Hill, Tulare Hill, and west of Morgan Hill.

Serpentine Rock Outcrop / Barrens

Serpentine rock outcrops are exposures of serpentine bedrock that typically lack soil and are sparsely vegetated. Serpentine barrens are areas of exposed serpentine soil that support little vegetation. They were identified based on visible rock outcroppings or barren areas on the aerial imagery intersecting with the serpentine rock or serpentine soils layers respectively; there was no minimum mapping unit. Covered plants that may be found on this land cover type include Metcalf canyon jewel-flower, most beautiful jewel-flower, smooth lessingia, and Santa Clara Valley dudleya (California Natural Diversity Database 2008, 2012; California Native Plant Society 2007).

This land cover type is likely underrepresented in the land cover map for the study area (Kruckeberg 1984; Wagner et al. 1991) because these features are difficult to see on aerial photographs, and were difficult to recognize in the field from a distance.

Covered plants that may be found in serpentine rock outcrop/barrens in the study area include the following: Tiburon Indian paintbrush, Santa Clara Valley dudleya, smooth lessingia, Metcalf canyon jewel-flower, and most beautiful jewel-flower (**Table 3-6**). These species are restricted to specific habitat elements and micro-site characteristics within serpentine rock outcrop.

Serpentine rock outcrops occupy an estimated 260 acres (0.05 %) of the study area (**Table 3-7** and **Figure 3-10**). This land cover type is found strictly in areas of serpentine soils or geology. In the study area, serpentine rock outcrops are found in the same locations as serpentine bunchgrass grassland.

Serpentine Seep

Seeps are otherwise dry areas where water penetrates the surface and creates a small wetland habitat that supports wetland vegetation. These provide a source of drinking water for wildlife in the area. Serpentine seeps typically occur within a matrix of serpentine grassland so they are discussed in the grassland natural community. Serpentine seep vegetation associations found in the Plan study area are described below (Evens and San 2004).

- **Mt. Hamilton thistle-twotooth sedge (*Carex serratodens*)-meadow barley forbland[14] association.** This association is found exclusively on serpentine seeps. Plants characteristic of this association are Mt. Hamilton thistle, twotooth sedge, meadow barley (*Hordeum brachyantherum*), hayfield tarweed, narrow-leaved wild-lettuce (*Lactuca saligna*), common yarrow, California poppy, Italian ryegrass, meadow barley, irisleaf rush (*Juncus xiphioides*), and seep monkey flower (*Mimulus guttatus*). Additional common species in this association are bentgrass, purple needlegrass, hoary coffeeberry (*Frangula californica* ssp. *tomentella* [*Rhamnus tomentella*]),

[14] A *forb* is another term for an herbaceous plant. A *forbland* is a vegetation association dominated by forbs (similar in concept to a grassland).

rabbit's foot (*Polypogon monspeliensis*), smooth lessingia, and most beautiful jewel-flower.

- **Mt. Hamilton thistle-hayfield tarweed forbland association.** This association is found exclusively on serpentine seeps. Plants characteristic of this association are Mt. Hamilton thistle, hayfield tarweed, irisleaf rush, rabbit's foot, hoary coffeeberry, and smooth lessingia.
- **Mt. Hamilton thistle-seep monkey flower-short-spiked hedge nettle forbland association.** This association is found exclusively on serpentine seeps. Plants characteristic of this association are Mt. Hamilton thistle, sourclover (*Melilotus indicus* [*M. indica*]), seep monkey flower, short-spiked hedge-nettle (*Stachys pycnantha*), yellow star thistle (*Centaurea solstitialis*), soft brome, California poppy, irisleaf rush, Italian ryegrass, common yarrow, California sagebrush (*Artemisia californica*), foxtail chess, Pacific false bindweed (*Calystegia purpurata*), medusa-head (*Elymus* [*Taeniatherum*] *caput-medusae*), and most beautiful jewel-flower.
- **Irisleaf rush herbaceous association.** This association is found exclusively on serpentine seeps. Plants characteristic of this association are irisleaf rush, Italian ryegrass, twotooth sedge, Mt. Hamilton thistle, Baltic rush (*Juncus balticus*), hyssop loosestrife (*Lythrum hyssopifolia*), and rabbit's foot.
- **Leather oak-hoary coffeeberry-bigberry manzanita shrubland.** This association is found in serpentine seeps and in riparian drainages on serpentine. Leather oak (*Quercus durata*) and hoary coffeeberry are co-dominant, followed by bigberry manzanita (*Arctostaphylos glauca*). The shrub layer has sparse to dense coverage (9–70% on Coyote Ridge) of Italian ryegrass, slender wild oat, ripgut brome, hayfield tarweed, seep monkey flower, and Mt. Hamilton thistle are all common in the open herb layer.

One covered plant, Mt. Hamilton thistle, is restricted to serpentine seeps and streams and drainages through serpentine soils (**Table 3-6**). Serpentine seeps were mapped on 34 acres (0.01%) of the study area (**Table 3-7** and **Figure 3-10**).

Rock Outcrop (Non-Serpentine)

Frequently encountered features in grasslands are *rock outcrops*, which are exposures of bedrock that typically lack soil and have sparse vegetation. Within the study area, several types of rock outcrops are present and are derived from sedimentary, volcanic, and metamorphic sources. Rock outcrops identifiable on aerial photographs were mapped based on their unique aerial photograph signatures. Rock outcrop signatures appear as textured areas with mottled coloring that contrasted in color and texture with the surrounding cover types on aerial photographs. There was no minimum mapping unit.

Rock outcrops host common wildlife species such as western fence lizard and western rattlesnake. These species may use outcrops for basking and as foraging areas. Common birds include rock wren (*Salpinctes obsoletus*) and several species of raptors that use rock outcrops for nesting or roosting. Rock outcrops with crevices or caves could host roosting bats.

Most beautiful jewelflower may be found on non-serpentine rock outcrops (**Table 3-6**).

Rock outcrops are a rare land cover type, totaling 87 acres (0.02%) of the study area (**Table 3-7** and **Figure 3-10**). They are primarily found in annual grasslands although they also can be present in chaparral and oak woodlands. This land cover type is likely underrepresented in the land cover map because these features are difficult to see on aerial photographs, particularly if they were below a chaparral or woodland canopy, and were difficult to recognize in the field from a distance. Accordingly, many small areas of rock outcrops are likely included in the chaparral/scrub, grassland, and oak woodland land cover types.

Ecosystem Functions

Function and Integrity

The grassland types within the study area function as a dominant natural community, linking small and large patches of all other natural communities in the landscape such as oak woodland, riparian and aquatic communities, northern mixed chaparral/chamise chaparral, and northern coastal scrub/Diablan sage scrub. Rock outcrops, barrens, and seeps are contained within the larger matrix of grasslands, and in some cases, the functions and threats to the integrity of these land cover types differs from the larger grassland matrix. This section primarily addresses the grassland types. Differences, where relevant, are noted for the small-scale land cover types contained within grasslands.

Grasslands provide critical upland habitat for a variety of amphibians dependent on adjacent aquatic habitats such as ponds and seasonal wetlands. These amphibians move through grasslands during the rainy season to disperse to other aquatic sites, and may reside in moist refuges, such as burrows and piles of litter and debris, within grasslands during the dry season. Grasslands are important for burrowing rodents such as ground squirrels and gophers. Rodent burrows, in turn, provide key habitat for a variety of other species, including burrowing owls. The diverse and abundant rodent community supports an assemblage of raptors that feed on them, including golden eagle (*Aquila chrysaetos*), northern harrier, and white-tailed kite. Serpentine grasslands are important habitat for all life stages of the federally threatened Bay checkerspot butterfly, and a host of other rare species.

Grasslands also help maintain water supplies and water quality through soil moisture retention and infiltration and by filtering out sediment, nutrients, and pathogens from run-off. They provide wildlife habitat, storage of carbon, and forage for grazing livestock. The key characteristics of grassland habitat that contribute to these functions are a high cover of herbaceous vegetation. A mix of woody cover in grassland (mosaic of shrubs or savanna) is also important to resist soil erosion and mass-wasting, and benefits some special-status animals.

The replacement of native grasses and herbs by fast-growing nonnative annual grasses and herbs has had a profound effect upon ecosystem functions in grasslands. The complex system of native grasses, forbs, shrubs, and animals of grassland habitats, plus the effects of lightning-caused wildfire and Native American management during prehistoric times has been dramatically altered. For example, the exotic annuals germinate and grow faster and can deplete soil moisture and reduce light and nutrient availability to the natives. However, seed limitation due to low production or small populations may also limit native grass establishment. Both native and non-native shrubs and trees can invade California grasslands, causing changes in fire fuel structure, carbon storage, animal habitat, and facilitation of the establishment of other woody plants. The exotic grasses and forbs have a larger and more persistent seed bank than the natives, and distribute seeds abundantly as seed rain. The exotic species can thus rapidly colonize disturbance areas, such as gopher mounds, and inhibit establishment of the native species. Grazing livestock are likely to be important dispersal agents for the exotic plants, but grazing intensity has not been linked by scientific evidence to current invasions of exotic plants into California grasslands (Jackson and Bartolome 2007).

The widespread occurrence of non-native species has altered the response of California grasslands to burning. Increased fuel loading around trees and native grasses can result in reduced survival of the native grasses. Non-native grasses are favored where atmospheric nitrogen deposition has increased or where nitrogen-fixing shrubs, such as brooms (*Genista* spp. or *Cytisus* spp.) have invaded and elevated soil nitrogen. Serpentine soils are particularly vulnerable to such means of invasion. Phenology of the converted grassland is dramatically different from that of the prehistoric native grasslands. The exotic annual grasses germinate and grow in synchrony with the rains of fall through spring, while the native perennial grasses extend their growth and transpiration of soil moisture into the summer months. The roots of the exotic annual grasses are generally less deep that those of the native perennial grasses, which can tap deeper soil moisture. The absence of perennial grasses in the converted grasslands can lead to reservoirs of deep soil moisture during the summer, which may be accessed by deep-rooted pest plants, such as yellow starthistle. Different microbial compositions have been found in the soils of California grasslands and planted containers with exotic annual versus native perennial grasses, but less is known about nutrient feedbacks and effects on soil structure. In a few cases, pathogens of grassland plants also appear to facilitate dominance of the exotic species.

Natural Disturbance

The key natural disturbances that have shaped and continue to influence grassland composition and extent are fire and grazing. **Figure 3-11** shows areas currently grazed in the study area. Both of these disturbances are now largely controlled by humans. Therefore, by extension, the continuing introductions and naturalization of aggressive non-native plants should also be considered an important factor influencing grasslands, and one also largely controlled by humans (Randall and Hoshovsky 2000). Nitrogen deposition into grasslands near air pollution sources and the resultant increase in productivity of the soils that has facilitated the increased invasion by nonnative species is a relatively recent anthropogenic disturbance. The disturbances related to nitrogen deposition and non-native plant introductions are discussed further under *Threats* below.

Periodic fire is an important influence on the grassland community. Historically and prehistorically, fires from both lightning strikes and human ignition kept woody vegetation from invading grassland (where the soil conditions are appropriate) and converting it to coastal scrub or oak woodland. Grassland was likely the dominant vegetation community, especially near prehistoric and historic settlements and travel routes, and in association with brush clearing for "rangeland improvements" to increase livestock forage (Reiner 2007; Tyler, Odion, and Callaway 2007). The prehistoric burning apparently resulted in spatially patchy grasslands in a mosaic with woody vegetation (Keeley 2002). The grasslands were kept open by fire, drought, and possibly some influence of native grazers, such as tule elk and pronghorn. However, prior to Native American occupancy and their frequent burning, Ford and Hayes (2007) speculate that many of the grasslands within the range of coyotebrush would have been brushlands. Today, in the absence of frequent extensive fire and moderate or higher intensity livestock grazing, the grasslands within the range of coyotebrush have succeeded or will succeed in the future to northern coastal scrub and eventually mixed woodland, except on the hottest south-facing slopes and shallow soils.

Prescribed burning is considered an important management tool in grasslands and other natural communities, but it has significant practical limitations. Such burning is becoming increasingly difficult to implement due to cost, safety concerns from expanding urban and rural development, and difficulty obtaining permits because of air quality concerns. It has not been feasible in most places to burn frequently enough to control the spread of woody species into existing grassland, or to reduce the cover of woody vegetation within grasslands, because of the natural resistance and resilience of the woody plants to a single burn (Ford and Hayes 2007). Attempts to restore pre-historic or historic fire regimes in grasslands in order to increase native grassland plants is not recommended due to uncertainties of the prehistoric grassland characteristics and the risk of facilitating invasions by non-native plants (Reiner 2007). However, livestock grazing has continued on most rangelands of the study area (see **Figure 3-11**) since introduction by the Spanish settlers, and its effects on both fire hazard reduction and shrub invasion are understood and can be prescribed (Ford and Hayes 2007). While early livestock grazing practices are acknowledged to have been excessive and damaging to grasslands and associated resources in some places, they are far less so today. In fact, livestock grazing in the region is regarded as generally beneficial and has maintained suitable habitat conditions for many special-status grassland-dependent species since the conversion from native species to exotic annuals in the grasslands in the 18th century or earlier.

Grassland is considered a fire-tolerant community. The direct effect of fire on grassland is to remove much or nearly all of the aboveground herbaceous biomass, depending on fire severity. Often the low-intensity prescribed fire moves so quickly and the residue (or thatch) is moist enough that the fire burns only above the lower few centimeters of material, leaving much unburned or only charred on the ground. Fires in grassland are described as *stand-replacing fires*. However, the immediate effect of this biomass removal on annual grasses is negligible, as they have typically completed their growth cycle before fires occur (Howard 1998). Their seeds are typically well dispersed, and many can be protected by the cover of litter and in cracks in the soil surface over which a fire passes. Perennial bunchgrasses suffer a temporary loss of foliage, but typically regenerate immediately through tillering and regrowth of green foliage that typically remains in the center of grass tussocks (Steinberg 2002).

The immediate effect of a fire in grasslands is typically an increase in annual forb germination and flowering and an increase in overall productivity in response to the light and nutrients made available by the removal of the thatch layer during the following growing season (Harrison et al. 2003). In the two to three years following a fire, the elimination of the thatch layer (if present) may shift the species composition of grasslands towards annual forbs and small-seeded species such as purple needlegrass and little quaking grass (*Briza minor*) (Howard 1998; Steinberg 2002). In the absence of grazing, however, a thatch layer can re-establish (depending on favorable weather), and this effect will disappear. Burning appears to have little long-term effect on annual grassland (Heady 1988; Paysen et al. 2000; Kyser and Di Tomaso 2002). In grasslands that are already dominated by nonnative annual grasses, nonnatives may increase their dominance following fire by outcompeting natives for the newly available space and light. Native grasses may increase their dominance in serpentine grasslands following fire through the same mechanism (Harrison et al. 2003).

Livestock grazing within grasslands is an important disturbance that mimics some of the functions of fires and of native herbivores that are no longer present (e.g., Tule elk, pronghorn). Livestock grazing is also an important management tool to combat relatively new threats such as loss of suitable habitat for special-status species due to dense growth during wet years and invasions of woody plants (Ford and Hayes 2007), and increased invasive nonnative plants in serpentine grasslands due to atmospheric nitrogen deposition (Weiss 1999). The primary drivers of annual grassland composition are the environmental conditions of each site, including soils and annual weather. Bartolome (2011) has estimated that annual weather fluctuations cause about 80% of the shifts in composition of California annual grasslands. Management, including grazing systems, therefore has a limited influence. As a result, studies of grazing effects on native species populations have mixed results, and must be interpreted carefully.

Properly timed grazing can be used to suppress non-native herbaceous competition with native plants, and may favor native grasses and wildflowers. The density and vigor of native perennial grasses can be improved when intensive spring grazing is curtailed just before the existing native perennial grasses re-grow, flower, and set seed (Menke 1992). This specialized grazing removes much of the density and mass of the non-native annual grasses through their growing season, which is shorter than for the native perennial grasses. Curtailing grazing at that time simultaneously allows the native perennial grasses to grow, flower, and set seed before the soil moisture is exhausted. Other research has shown mixed results, and suggests caution in grazing prescriptions to favor native grasses. A study at Jepson Prairie by Dyer, Fossum, and Menke (1996) found that grazing was not effective to increase purple needlegrass and that climate is the more influential factor. Hatch et al. (1999) suggest that different native grasses and forbs have different and sometimes conflicting responses to management, and therefore more research is needed to guide grazing and burning practices. In a study of coastal prairie, Hayes and Holl (2003) found that native grasses were not more abundant where grazed than where ungrazed. However they found native forbs were more abundant where grazed due the suppression of non-native herbaceous competition and build-up of thatch. Spring and summer wildflowers of grasslands are typically more showy where grazing has occurred (Edwards 1992). Furthermore, Hayes and Holl (2011) found that stands of native grasses are slow to respond to treatments, and fluctuated in response to multiple factors other than management, including annual weather patterns; and that grazing, even when controlled with specific frequencies, holds little promise for increasing native species over the long term.

Grazing may have little effect on species diversity in serpentine grasslands (Harrison 1999). In one case in Santa Clara County reported by McCarten (1987), grazing was associated with a decrease in native bunchgrass species compared to recently ungrazed sites, but that could have been related to non-grazing management or microhabitat differences. Because invasive nonnatives are generally not tolerant of serpentine soils, these species are less invasive in serpentine bunchgrass grasslands than in non-serpentine grasslands (Harrison 1999). Studies in Bay checkerspot butterfly habitat have found that livestock grazing is necessary to prevent nonnative species from becoming dominant, and promote the establishment and persistence of nectar species preferred by the Bay checkerpot butterfly (Harrison 1999; Weiss 1999; Weiss and Wright 2005, 2006; Weiss, Wright, and Niederer 2007). Harrison and Viers (2007) caution that the known invasions of non-natives into serpentine grasslands can be partly a result of slower rates of spread, and that factors other than nitrogen deposition could undermine the resistance of these grasslands, including evolution of serpentine-tolerance in existing non-natives, arrival of new serpentine tolerant non-natives (notably goatgrass [*Aegilops cylindrica*] and medusa-head), and modification of the soils to favor more invasions. They also caution that livestock grazing and infrequency of fire in serpentine grasslands can contribute to declines in native species.

In general, livestock grazing has been associated with benefits to serpentine grasslands (Harrison and Viers 2007). Reported studies indicate that removal of grazing had either no effect on plant species composition or the abundance of native forbs decreased, while grazing increased diversity of native annual forbs. Low-statured native annual forbs are expected to benefit from moderate grazing by reducing the thatch produced by the non-native annual grasses.

Grazing might have a negative effect on the physical structure and native seed banks of serpentine seeps, serpentine rock outcrops, and serpentine barrens that are contained within the larger grassland matrix, but no scientific research has been published on this topic. These small land cover types might be somewhat sensitive to cattle traffic. Most seep soils are moist or saturated for most or all of the year, while rock outcrop/barrens usually have low plant cover and minimal soil and seed bank accumulations. Depending on intensity and frequency of grazing traffic, this can be a long-term effect that is very difficult to restore. Fencing can be used to eliminate or minimize access by livestock to sensitive serpentine seeps, rock outcrops, or barrens.

Threats

The primary known threats to conservation of California grasslands are: climate change; human development (habitat destruction and fragmentation); invasive species (pathogens, plants, animals); altered disturbance regimes; and air pollution.

The conservation threats associated with human development, including habitat destruction and fragmentation due to conversion of natural grasslands to residential and commercial development, conversion to cultivated agriculture, road construction, and the patterns of such development across the landscape, are the subjects of this Habitat Plan, and are discussed in other chapters.

The threats to conservation of grasslands posed by continuing invasions and infestations of aggressive non-native plants have been described above. In general, and perhaps most significantly, the non-native grasses and forbs of modern grasslands now pose the threat of significant habitat degradation if not grazed by livestock or otherwise treated to maintain suitable habitat structure and reduce competition.

Atmospheric nitrogen enrichment fosters the invasion of nonnative species, which replace native species. This is a threat in all grasslands downwind of air pollution sources, but particularly in serpentine grasslands, where the nectar plant hosts to the bay checkerspot butterfly are affected (Weiss 1999). Absence of grazing thus threatens the butterfly populations. In Santa Teresa County Park and other locations, several populations of Bay checkerspot butterfly declined substantially after grazing was halted. Once grazing ceased, the numerous non-native grasses and forbs present in the serpentine grasslands grew tall and dense each year, and through competition reduced the butterfly's host plants (U.S. Fish and Wildlife Service 2001). The USFWS recognizes activities that threaten the butterfly's critical habitat, include ground disturbance, removing vegetation, altering or removing grazing practices, application of pesticides and biological agents, and some recreational activities. In the case of Santa Teresa County Park, the USFWS recognized that re-introduction of grazing would be needed to ensure recolonization of the butterfly.

In addition, introduced pathogens can indirectly facilitate the invasions of non-native plants, reduce savanna and woodland canopies and thus expand grasslands, and reduce populations of key native grassland birds and rodents (D'Antonio et al. 2007). The threats to conservation of grasslands posed by altered disturbance regimes due to fire and grazing have been discussed above. Studies have demonstrated that well-managed livestock grazing within grasslands is critical to maintain populations of Bay checkerspot butterfly (Harrison et al. 2003; Weiss and Wright 2005, 2006; Santa Clara Valley Transportation Authority 2006). However, as noted above, grazing might be detrimental to serpentine seeps and most rock outcrop/barrens. The threat of reduction or elimination of grazing as a habitat management has also been discussed above.

Serpentine seeps are a type of wetland and many of the threats discussed in the wetland section below are applicable to seeps within grasslands. In particular, alteration of hydrologic regimes by adjacent land uses and development can change and in some case remove the water source for these seeps. This can result in partial or complete loss of seep wetlands.

Other threats to grasslands include feral pigs, power lines, off-road vehicle activity, improper burning regimes, and road and trail construction (Evens and San 2004).

Chaparral and Northern Coastal Scrub

Chaparral shrub communities are found throughout California on rocky, porous, nutrient-deficient soils and on steep slopes up to 2000 m in elevation (Keeley 2000). These communities are dominated by densely packed and nearly impenetrable drought-adapted everygreen woody shrubs, 1.5–4 meters tall, that possess small, thick, leathery sclerophyllous leaves (Hanes 1988; Keeley 2000). Herbaceous and arboreal growth forms are often lacking or play minor roles in this community (Keeley 2000). Chaparral species have both deep and shallow roots that allow them to tap water in several soil layers (Schoenherr 1992). The deep roots also allow chaparral to tolerate summer drought conditions and stay active during this period of water stress. Chaparral is divided into two land cover types for this Plan.

- Northern mixed chaparral/chamise chaparral.
- Mixed serpentine chaparral.

CDFG considers the latter a sensitive biotic community (California Department of Fish and Game 2007). *Northern coastal scrub*, in comparison, is generally characterized by low shrubs, usually 0.5–2 meters tall with soft non-scerophyllous leaves, interspersed with grassy openings (Holland 1986). Although coastal scrub is found in both northern and southern California, the form and variety of species varies greatly between the two regions. Coastal sage scrub in southern California is characterized by drought-deciduous shrubs that lose their leaves with the onset of arid summer conditions. In southern California this community lacks a significant herb layer. Northern coastal scrub is characterized by the absence of drought-deciduous shrubs and the presence of an herb-rich community, which is likely a result of plentiful annual rainfall and regular summer fog (Heady et al. 1988; California Partners in Flight 2004). Northern coastal scrub is also less diverse floristically than coastal sage scrub and shrubs are generally taller and more densely spaced (California Partners in Flight 2004). The range of this northern community can be defined as a narrow coastal strip from southern Oregon to Pt. Sur in Monterey County (Holland 1986; Heady et al. 1988). Northern coastal scrub in this study was divided into two land cover types.

- Northern coastal scrub/Diablan coastal scrub.
- Coyote brush scrub.

Historical Extent and Composition

Native Americans frequently burned shrublands to encourage grass and forb development as dense scrub or chaparral had little value to them (Keeley 2002). A fire-return interval of more than once or twice per decade is detrimental to non-sprouting shrubs such as most *Ceanothus* and *Arctostaphylos* species and tends to promote the reduction of shrublands in favor of grasslands (Keeley 2002). With the Spanish and Mexican settlement, most of the burning by native Americans stopped and fire frequency declined (Greenlee and Langenheim 1990); however, ranchers still burned chaparral areas to expand the prairie for pasture (Greenlee and Langenheim 1990). With the influx of people from the Gold Rush of 1849, rangelands became crowded and settlers increased the conversion of shrublands to nonnative grasslands (Keeley 2004). The historic extent and composition of shrublands in the study area is unknown. However, the fact that chaparral and shrublands are so common today suggests that the study area may not have seen the type conversion of chaparral to grassland experienced in other parts of California.

Common Wildlife Associations

Common wildlife species that use chaparral and scrub habitats in the study area include gopher snake (*Pituophis melanoleucus*), western rattlesnake, western fence lizard, brush rabbit (*Sylvilagus bachmani*), California pocket mouse (*Perognathus californicus*), Botta's pocket gopher, California ground squirrel, spotted skunk (*Spilogale gracilis*), mule deer, coyote, and bobcat (*Lynx rufus*). Common bird species include mourning dove (*Zenaida macroura*), California quail (*Callipepla californica*), Anna's hummingbird (*Calypte anna*), western scrub-jay, Bewick's wren (*Thryomanes bewickii*), California towhee (*Pipilo crissalis*), lesser goldfinch (*Carduelis psaltria*), fox sparrow (*Passerella iliaca*), white-crowned sparrow (*Zonotrichia leucophrys*), and dark-eyed junco (*Junco hyemalis*).

Chaparral and Northern Coastal Scrub Land Cover Types

Northern Mixed Chaparral/Chamise Chaparral

Northern mixed chaparral/chamise chaparral is classified by Holland (1986) as "broad-leaved sclerophyll shrubs, 2–4m tall, forming dense, often nearly impenetrable vegetation…[with] usually little or no understory vegetation [and] often considerable accumulation of leaf litter." Northern mixed chaparral/chamise chaparral apppeared darker green in color than other chaparral types in all seasons, and frequently occupied larger areas. Chamise chaparral was originally split into a separate land cover type but could not be distinguished on the aerial photograph from northern mixed chaparral.

Dominant shrubs in this community in the study area are chamise (*Adenostoma fasciculatum*), manzanita (*Arctostaphylos* spp.), scrub oak (*Quercus berberidifolia*), and ceanothus (*Ceanothus* spp.). Other important species are toyon (*Heteromeles arbutifolia*), coffeeberry (*Frangula* [*Rhamnus*] *californica*), madrone (*Arbutus menziesii*), California bay (*Umbellularia californica*), birchleaf mountain-mahogany (*Cercocarpus betuloides*), poison-oak (*Toxicodendron diversilobum*), bush monkey flower (*Mimulus aurantiacus*), and California yerba santa (*Eriodictyon californicum*). Some chaparral stands may be almost entirely composed of dense stands of chamise (Holland 1986). Northern mixed chaparral/chamise chaparral in the study area includes the following shrubland associations based on quantitative vegetation sampling conducted by the CNPS along extensive areas of Coyote Ridge (Evens and San 2004):

- **Chamise (pure) shrubland association.** Chamise is the dominant species in this association of dense shrubs[15] that generally occurs on extremely dry sites on south-facing, moderately steep to steep slopes. The herbaceous component is minor and sometimes absent in this association. Additional species which may have sparse representation are black sage (*Salvia mellifera*), coast live oak (*Quercus agrifolia*), wild mustard (*Hirschfeldia incana*), toyon, California cudweed (*Pseudognaphalium* [*Gnaphalium*] *californicum*), Napa star thistle (*Centaurea melitensis*), coyote brush (*Baccharis pilularis*), buck brush (*Ceanothus cuneatus*), California yerba santa, and silk tassel species (*Garrya* spp.).
- **Chamise-bigberry manzanita-bush monkey flower shrubland association.** This association of open to dense shrubs can be found on both serpentine and non-serpentine soils. The understory herbaceous layer is a small component of the community and is relatively open. The dominant shrubs are chamise and bigberry manzanita. Bush monkey flower and redberry buckthorn (*Rhamnus crocea*) are present in this shrubland. Other species that sometimes are present in this association are Torrey’s melicgrass, California sagebrush, woolly-fruited lomatium (*Lomatium dasycarpum*), chaparral silk tassel (*Garrya congdonii*), hounds tongue (*Cynoglossum grande*), wavyleaf soap plant, coyote brush, scarlet pimpernel (*Anagallis arvensis*), and shiver grass.
- **Chamise-black sage (pure) shrubland association.** This association features chamise and black sage as co-dominants on south-facing slopes. Bigberry manzanita is present with lower coverage. There may also be a small open hardwood overstory component and herbaceous layer. Other species which may be present but sparse are slender wild oats, lichen, small-flowered needlegrass, California sagebrush, ceanothus species and coast live oak.
- **Bigberry manzanita-mixed (California sagebrush-black sage) shrubland association.** This mixed shrubland is found on serpentine and non-serpentine soils. Bigberry manzanita is dominant in a layer of somewhat openly spaced to more densely packed shrubs. There is an herbaceous understory layer and a small tree layer comprising conifers and hardwoods. Additional shrubs that may be found are California sagebrush, black sage, and less frequently chamise. Grasses commonly present are small-flowered

[15] On Coyote Ridge, chamise has an absolute cover of 50–60% (Evens and San 2004).

needlegrass, foxtail chess, slender wild oats, and Italian ryegrass. Coast live oak and foothill pine (*Pinus sabiniana*) may be present in the overstory.

- **Coyote brush/annual grass shrubland association.** This association consists of coyote brush, which is dominant in an open canopy, and a continuous herbaceous understory composed primarily of grasses with wild oats as the dominant. Additional grasses include ripgut brome, soft chess, Italian ryegrass, foxtail chess, and purple needlegrass. Other herbaceous elements include turkey mullein (*Croton* [*Eremocarpus*] *setigerus*), yellow star thistle, common yarrow, bull thistle (*Cirsium vulgare*), Kellogg's yampah (*Perideridia kelloggii*), California cudweed, gumweed (*Grindelia* spp.), hayfield tarweed, wild mustard, and wavyleaf soap plant.
- **Coyote brush-California sagebrush-toyon shrubland association.** This association occurs both on serpentine and non-serpentine soils generally on southeast- to southwest-facing slopes. The shrub layer can be more openly spaced or have denser coverage (30–80% on Coyote Ridge) and has an open herbaceous understory layer. Coyote brush is the dominant shrub, with toyon, California sagebrush, and bush monkey flower as associates. Other characteristic species are moss and California cudweed. Also frequently present are lichen, foxtail chess, and California figwort (*Scrophularia californica*). Black sage, deerweed (*Acmispon glaber* [*Lotus scoparius*]), and nit grass are less frequently encountered in this association.
- **Birchleaf mountain mahogany-chamise-bush monkey flower association.** This is a mixed shrub association with open cover (30% on Coyote Ridge). Birchleaf mountain mahogany, chamise, and bush monkey flower are dominants. The herbaceous layer is open and is composed primarily of Torrey's melic grass. An open hardwood layer may also be present. Other species that may be present in small numbers are hollyleaf cherry (*Prunus ilicifolia*), poison-oak, bedstraw (*Galium* spp.), sticky cinquefoil (*Drymocallis* [*Potentilla*] *glandulosa*), goldenback fern (*Pentagramma triangularis*), common yarrow, nit grass, purple sanicle (*Sanicula bipinnatifida*), foxtail chess, shiver grass, and Spanish broom (*Spartium junceum*).

Northern mixed chaparral/chamise chaparral occupies an estimated 23,763 acres (5.2%) of the study area (**Table 3-7** and **Figure 3-10**). This land cover type is found in the northeastern part of the study area in the Western Diablo and Diablo Ranges (**Figure 3-10**). It is also found in the central western portion of the study area. Northern mixed chaparral may intermingle with northern coastal scrub/Diablan sage scrub, foothill pine and oak woodlands, and mixed oak woodland and forest.

The covered plant that may be found on this land cover type is Loma Prieta hoita (*Hoita strobilina*), which grows in loose talus in chaparral (**Table 3-6**). Several wildlife species may be found in this land cover type as well. Given the presence of adjacent aquatic habitat, California tiger salamander, California red-legged frog and western pond turtle may use northern mixed chaparral/chamise chaparral as movement, avesiation, or foraging habitat (**Table 3-5**).

Mixed Serpentine Chaparral

Mixed serpentine chaparral consists of fire-adapted shrubs found on serpentine soils (California Partners in Flight 2004). Serpentine chaparral is generally more open than other chaparral types and shrubs tend to be shorter and have leaves which are reduced, curled, or thickened (Hanes 1988; California Partners in Flight 2004). Species present in mixed serpentine chaparral with a high affinity for serpentine are coyote ceanothus, Calistoga navarretia (*Navarretia heterodoxa*), Santa Clara Valley dudleya, Mt. Hamilton thistle, smooth lessingia, and Tiburon Indian paintbrush (*Castilleja affinis* ssp. *neglecta*).

Mixed serpentine chaparral in the study area includes the following associations based on quantitative vegetation sampling on Coyote Ridge (Evens and San 2004):

- **Bigberry manzanita/Torrey's melic grass shrubland association.** This association is found on serpentine soils with bigberry manzanita as the dominant shrub in an open shrub layer. Species that follow in dominance are Torrey's melic grass and soft brome. Other species that may be present in the understory are foxtail chess, small fescue, Italian ryegrass, slender wild oats, California sagebrush, and leather oak. Less frequently encountered species are purple needlegrass, toyon, rat-tail fescue, dwarf plantain, one-sided bluegrass, and ripgut brome.
- **Hollyleaf cherry-poison-oak/grass shrubland association.** The dominant shrub in this open serpentine shrub association is hollyleaf cherry. Coast live oak and valley oak (*Quercus lobata*) are often present in the overstory. Scrub oak and poison-oak are ubiquitous but in low cover. Other commonly associated shrubs with higher cover are bush monkey flower, bigberry manzanita, and California sagebrush. The most common species in the herbaceous layer, which is scattered to more frequent in coverage, include Italian ryegrass and soft brome. Foxtail chess, slender wild oats, wild mustard, Napa star thistle, phlox-leaved bedstraw (*Galium andrewsii*), Torrey's melic grass, ripgut brome, and common yarrow may also be present.
- **Leather oak-bigberry manzanita-chaparral silktassel/Torrey's melic grass shrubland.** This association occurs on north-facing rocky slopes on serpentine parent material. It has also been documented on talus deposits in the Mt. Hamilton Range. Leather oak is the dominant species in the shrub layer, which tends to be open to more continuously present (30–78% cover on Coyote Ridge). Bigberry manzanita and chaparral silktassel are also characteristic, with the former sometimes occurring as a co-dominant with leather oak. Other shrubs sporadically but frequently present are redberry buckthorn, poison-oak, toyon, hoary coffeeberry, hollyleaf cherry, and birchleaf mountain mohagany. The hardwood overstory tree layer may include scattered coast live oak.
- **Leather oak-bigberry manzanita-coast sagebrush/grass shrubland.** This serpentine shrubland association can be found on all aspects. Leather oak and bigberry manzanita are co-dominants in a shrub layer that is open to more continously present (12–45%). California sagebrush has the third greatest shrub coverage in the association. In the herb layer, Torrey's melic

grass, slender wild oat, and soft brome are characteristic species. Other grasses and herbs that may be present are Italian ryegrass, ripgut grass, foxtail chess, small-flowered needlegrass, poison-oak, California poppy, scrub oak, and hayfield tarweed. Santa Clara Valley dudleya may occur on rock outcrops within this association.

- **Leather oak-toyon-California bay shrubland association.** This association is found on north-facing slopes on serpentine parent material. The shrub layer is discontinuous to continuous and is dominated by leather oak. Poison-oak, bigberry manzanita, and toyon are subdominant but can be dominant in certain stands. This association is also characterized by an emergent layer of California bay. Additional characteristic shrubs are hoary coffeeberry, birchleaf mountain mahogany, bush monkey flower, California gooseberry (*Ribes californicum*), chaparral mallow (*Malacothamnus fasciculatus*), and blue elderberry (*Sambucus nigra* ssp. *caerulea* [*S. mexicana*]). Torrey's melic grass, soft brome, Italian ryegrass, and reddened clarkia (*Clarkia rubicunda*) are often present in low cover.
- **Hoary coffeeberry-Mt. Hamilton thistle-seep monkey flower shrubland.** This association occurs on northwest- and southwest-facing slopes in wetlands and seeps on serpentine soils. The shrub layer is open to more continuous with hoary coffeeberry as the dominant shrub. Italian ryegrass dominates a semi-continuous herbaceous layer but Mt. Hamilton thistle, seep monkey flower, hayfield tarweed, and common yarrow are also characteristic. Barley species (*Hordeum* spp.), bentgrass, irisleaf rush, and California poppy are frequently encountered as well.

Associations that occur both in serpentine and non-serpentine soils and are described above under *northern mixed chaparral/chamise chaparral* include

- **Chamise-bigberry manzanita-monkey flower shrubland association.**
- **Bigberry manzanita-mixed (California sagebrush-black sage) shrubland association.**
- **Coyote brush-California sagebrush-toyon shrubland association.** Coyote ceanothus is often present when this association occurs on serpentine soils.

Mixed serpentine chaparral occupies an estimated 3,712 acres (0.8%) of the study area (**Table 3-7** and **Figure 3-10**). Mixed serpentine chaparral is found east of U.S. 101 in the small canyons along Coyote Ridge and in small patches at higher elevations mostly in Henry W. Coe State Park. Small patches are also found on either side of Highway 152 near Pacheco Peak, in the upper Llagas Creek watershed, and in the vicinity of Anderson Reservoir and Dam. Mixed serpentine chaparral is most abundant (although never common) in the Santa Cruz Mountains south of Calero Reservoir and west of Morgan Hill.

Covered plants that may be found on this land cover type include, coyote ceanothus, Loma Prieta hoita, and most beautiful jewel-flower (**Table 3-6**). Several covered wildlife species may be found in this land cover type as well. Given the presence of adjacent aquatic habitat, California tiger salamander, California red-legged frog and western pond turtle may use mixed serpentine chaparral as movement, aestivation, or foraging habitat. Bay checkerspot butterfly uses mixed serpentine chaparral as movement habitat (**Table 3-5**).

Northern Coastal Scrub/Diablan Coastal Scrub

Northern coastal scrub/Diablan coastal scrub is composed primarily of evergreen shrubs with an herbaceous understory in openings. This land cover type is usually found at elevations below 300 feet (California Partners in Flight 2004).

On aerial photographs, Northern Coastal Scrub appeared a distinctive shade of pale turquoise-green in summer images and pale tan in fall and winter images; this land cover type typically occurs on south facing slopes, often in relatively small stands interspersed with annual grassland and oak woodland.

Northern coastal scrub/Diablan coastal scrub communities are dominated by California sagebrush and black sage, with associated species including coyote brush, California buckwheat (*Eriogonum fasciculatum*), poison-oak, and bush monkey flower (Holland 1986). Northern coastal scrub/Diablan coastal scrub occurs on both serpentine and non-serpentine substrate; however Northern coastal scrub that occurred on mapped serpentine soils was mapped as serpentine chaparral. The dominant woody plants in this land cover type are nearly the same among different soil types. Northern coastal scrub/Diablan coastal scrub in the study area includes the following vegetation associations based on quantitative vegetation sampling conducted on Coyote Ridge (Evens and San 2004).

- **California sagebrush-coyote ceanothus shrubland.** This association is found on serpentine and on the edges of serpentine on non-marine sedimentary substrate. California sagebrush and coyote ceanothus dominate the sparse shrub layer. Foothill pine is found in the sparse conifer tree layer. Toyon is also common. California yerba santa, Torrey's melic grass, bigberry manzanita, slender wild oats, coyote brush, small-flowered needlegrass, Napa star thistle, common yarrow, woolly-fruited lomatium, hoary coffeeberry, California bee-plant, blue elderberry, and lichen may be present in low amounts. Coyote ceanothus has a strong affinity for serpentine substrates.
- **California sagebrush/California poppy-grass shrubland**. This association is found on serpentine and on the edges of serpentine (on non-marine sedimentary substrate). California sage is the dominant shrub in a relatively open shrub layer (5–45% cover on Coyote Ridge). Slender wild oat, foxtail brome, California poppy, soft brome, and purple needlegrass are common associates. Common yarrow, Santa Clara Valley dudleya, nude buckwheat, Torrey's melic grass, Italian ryegrass, woolly-fruited lomatium, small-flowered needlegrass, Napa star thistle, and blue dicks may also be present.
- **California sagebrush-black sage shrubland.** This association, characterized by California sagebrush and black sage, is also found on serpentine and diabase. The shrub layer is relatively open (30–40% cover on Coyote Ridge) and the herbaceous layer is a minor component. Species

present include bigberry manzanita, coyote brush, toyon, foxtail brome, chaparral mallow, bush monkey flower, and coast live oak.

- **Black sage (pure) shrubland association.** This association occurs on serpentine on northwest- and southwest-facing slopes. Black sage forms a sparse to relatively dense cover of shrubs (average 54% cover on Coyote Ridge). California sage may be present at very low cover. The herbaceous layer is almost non-existent. Other species occasionally encountered are coast live oak, chamise, bigberry manzanita, blue elderberry, poison-oak, Napa star thistle, and scarlet pimpernel.

Northern coastal scrub/Diablan coastal scrub occupies an estimated 10,306 acres (2.2%) of the study area scattered throughout the Santa Cruz Mountains and Diablo Range (**Table 3-7** and **Figure 3-10**).

Covered plants that may be found on this land cover type fragrant fritillary, and most beautiful jewel-flower (**Table 3-6**). Several wildlife species may be found in this land cover type as well. Given the presence of adjacent aquatic habitat, California tiger salamander, California red-legged frog and western pond turtle may use northern coastal scrub/diablian coastal scrub as movement, upland, or foraging habitat (**Table 3-5**).

Coyote Brush Scrub

Coyote brush scrub is a type of northern coastal scrub dominated by coyote brush. Common associated shrub species in Santa Clara County include California sagebrush, California lilac (*Ceanothus* spp.), lupine species, bush monkey flower, hoary coffeeberry, and poison-oak. This land cover type is generally found on windy, exposed sites with shallow, rocky soils (Holland 1986); it also occurs on river terraces. Typically it represents the first stage (and least mature in terms of composition development) of scrub occupation of former grassland sites in the succession stage described above (Ford and Hayes 2007). Coyote brush scrub occupies an estimated 180 acres (0.04%) of the study area (**Table 3-7** and **Figure 3-10**). In the study area, it is found adjacent to a few riparian areas and on mid-slopes in the northeastern portion of the study area.

Several wildlife species may be found in this land cover type. Given the presence of adjacent aquatic habitat, California tiger salamander, California red-legged frog and western pond turtle may use northern mixed chaparral/chamise chaparral as movement, upland, or foraging habitat. Bay checkerspot butterfly uses this land cover as movement habitat (**Table 3-5**).

Ecosystem Functions

Function and Integrity

Northern coastal scrub/Diablan sage scrub and coyote brush scrub intermingle with California annual grassland, northern mixed chaparral/chamise chaparral, coastal prairie (grassland), and mixed evergreen forest (Ford and Hayes 2007) and serve as an important corridor for wildlife. In addition, small mammals tend to forage on grassland species that are close to shrub canopies because they afford greater protection (Keeley 2000). Because sage scrub species are less woody than chaparral species and tend to direct their energy to leaf growth, the structure of coastal scrub communities tends to be open with an herbaceous ground layer (California Partners in Flight 2004). This open structure is important to the white-crowned sparrow (*Zonotrichia leucophyrys nuttalli* and *Z. l. pugetensis*) and the sage sparrow (*Amphispiza bellii*). The Allen's hummingbird (*Selasphorus sasin*) and the orange-crowned warbler (*Vermivora celata lutescens*) are also associated with this land cover type. The leaves of sage scrub contain important nutrients for herbivorous insects, more so than northern mixed chaparral/chamise chaparral. Peak leaf nutrient levels in scrub appear to coincide with the height of bird breeding season and may be an important food source (California Partners in Flight 2004). California sage and black sage, members of both northern coastal scrub/Diablan sage scrub and northern mixed chaparral/chamise chaparral communities, are important food resources for small mammals, reptiles, and bird species. In addition, both communities have a relatively low proportion of nonnative species due to dense shrub canopies, soil types, and dry conditions, and thus are important resources to wildlife.

The fire-following forbs associated with northern mixed chaparral/chamise chaparral are abundant for one or more years after a fire and provide high-quality habitats for a diversity of insects and other wildlife. The unique flora of post-fire chaparral contributes to its trait of supporting the highest concentration of special-status plants of any community in California (California Native Plant Society 2001). Many species that inhabit chaparral also inhabit adjacent grassland and oak woodlands; however, some birds and mammals are found largely in the dense cover and shade of mature chaparral stands.

Natural Disturbance

Many of the plants in the chaparral and northern coastal scrub communities have evolved to be dependent on periodic fire for regeneration (Holland 1986; Hanes 1988; Schoenherr 1992). In fact, communities dominated entirely by chamise cannot sustain themselves in the absence of fire (U.S. Fish and Wildlife Service 2002). Some species of chaparral have peeling bark or volatile oils that promote fire (Schoenherr 1992). Many of the dominant shrubs, such as manzanita and ceanothus, have adapted to fire by resprouting from basal burls or woody root crowns following a fire event. Other species have seeds that require fire to initiate growth (U.S. Fish and Wildlife Service 2002; Rundel and Gustavson 2005). Regrowth is triggered by removal of the overstory, typically by fire. Chemicals in smoke and charred wood also stimulate germination in a wide variety of native forbs that lie dormant as seeds in the soil for decades before a fire. Fire occurrence that is too frequent, however, can lead to the elimination of these communities altogether and promote annual grassland succession.

Ford and Hayes (2007) described the dynamic successional relationship between California grasslands and northern coastal scrub. Frequent fire, rodent herbivory, livestock grazing and trampling, and drought tend to maintain grassland and limit succession from grassland to northern coastal scrub as well as the succession from scrub to mixed oak woodland. The succession from grassland to scrub can be as rapid as >5% per year after suppression of fires and livestock grazing, and the succession from scrub to woodland can occur within 50 years after that.

Returning such sites to grassland would typically require management that included manual clearing and herbicides or repeated burning at times of maximum herbaceous understory and dry weather, followed by at least moderate intensity summer seasonal or year-long livestock grazing.

Threats

Threats to chaparral and northern coastal scrub include habitat fragmentation and loss due to urbanization, fire suppression, competition, and/or hybridization with nonnative plants, trampling, and natural events (U.S. Fish and Wildlife Service 2002).

Fire-suppression policies and growth of human habitation in chaparral and shrub communities pose a great threat to these communities. With buildup of fuel over many years, the risk of catastrophic fire is greatly increased (U.S. Fish and Wildlife Service 2002). Such a fire can kill threatened and endangered wildlife, which might otherwise be able to escape. Severe topsoil erosion is also a problem after these intense fires (Schoenherr 1992). Native serpentine chaparral is threatened by air pollution and resultant nitrogen deposition. Nitrogen enrichment fosters the invasion of nonnative species that replace native ones (Weiss 1999).

Oak Woodland

The most common land cover types in the study area are dominated by upland hardwood trees, usually various species of oaks (*Quercus* sp.). These land cover types were defined as part of the *oak woodland* natural community, an upland tree-dominated community with at least 10% cover of hardwood tree species. The oak-dominated land cover types that occur in the study area are listed below.

- Valley oak woodland.
- Mixed oak woodland and forest.
- Coast live oak woodland and forest.
- Blue oak woodland.
- Foothill pine-oak woodland.
- Mixed evergreen forest.

CDFG considers valley oak woodland and blue oak woodland sensitive biotic communities (California Department of Fish and Game 2007).

Historical Extent and Composition

Oak woodland land cover types were historically more extensive and less fragmented relative to current conditions. The deep alluvial soils found throughout the lowland areas of the Santa Clara Valley formerly supported a wide range of oak forests and woodlands. Historical photos, maps, and observational accounts indicate that large areas of the Santa Clara Valley within the Coyote Watershed were dominated by Valley oak woodland, all of which has been converted to urban development and agricultural uses (Grossinger et al. 2006).

Native Americans and European settlers manipulated local oak woodlands, through burning, grazing, and planting, to serve their needs. Large shifts in the composition and function of oak woodland communities began with the gold rush and increased in the latter part of the 20^{th} century when previously grazed oak woodlands were converted to rural residential parcels leading to a decline in abundance and distribution of these oak communities (Pavlik et al. 1991). Recent studies show that the median parcel size in parts of California once dominated by oaks has decreased exponentially, from 550 acres in 1957 to just nine acres in 2001. As a result, the urban interface with oak woodlands is much more pervasive than at any other time in history (Giusti et al. 2004).

Common Wildlife Associations

Oak woodlands provide food and cover for many species of wildlife (County of Santa Clara 2005). Mature oak trees bear natural cavities, which are important resources for cavity-nesting birds and small mammals. Also, mature oak forests typically contain snags (standing dead trees), which are valuable resources for woodpeckers because they prefer dead trees and limbs for excavation of roost and nest sites (Thomas 1961). Snags receive high levels of use by secondary cavity-nesting birds (e.g., chickadees and wrens) and mammals. Snags also support wood-boring insects that provide food for bark-gleaning insectivorous birds. Oak forests also provide acorns, which as a seasonal food are important for the survival of many species of wildlife in fall and winter. Birds that are dependent on acorns as a seasonal food include acorn woodpeckers, scrub-jays, band-tailed pigeons, and California quail.

Characteristic wildlife species that can be found in these land cover types include amphibian species such as California red-legged frog and California tiger salamander that use these habitat types for summer aestivation and movement when aquatic habitats are present; reptile species such as gopher snake and western fence lizard; bird species such as red-tailed hawk, American kestrel, barn owl (*Tyto alba*), great horned owl (*Bubo virginianus*), acorn woodpecker (*Melanerpes formicivorus*), Nuttall’s woodpecker (*Picoides nuttallii*), northern flicker (*Colaptes auratus*), white-breasted nuthatch (*Sitta carolinensis*), California quail, spotted towhee (*Pipilo maculatus*), Bewick’s wren, and bushtit (*Psaltriparus minimus*); and mammal species such as deer mouse (*Peromyscus maniculatus*), western gray squirrel (*Sciurus griseus*), mule deer, and coyote (County of Santa Clara 2005).

Oak woodland-associated wildlife species covered by the Plan include Bay checkerspot butterfly, California tiger salamander, California red-legged frog, western pond turtle, tricolored blackbird, and San Joaquin kit fox (**Table 3-5**).

California tiger salamanders use the grassy understory of open woodlands for terrestrial aestivation or refuge and aquatic sites for breeding. The California red-legged frog uses this habitat type for breeding, foraging, and refugia. The western pond turtle utilizes aquatic habitat often found in oak woodlands. The turtle is known to overwinter in leaf litter or soil at upland sites. San Joaquin kit foxes may use this community for movement through the study area. The western burrowing owl uses open woodlands, with low-stature vegetation for foraging and burrowing. Bay checkerspot butterfly may use this community for movement between habitat patches.

Oak Woodland Land Cover Types

The six different oak woodland land cover types mapped showed quite different signatures on aerial photographs, in terms of color and texture, and each typically occupied different landscape positions.

Valley Oak Woodland

Valley oak woodland was distinguished by a combination of crown size and spacing and landscape position. In the Plan study area, valley oak tree crowns are typically larger than any other oak species except some blue oaks, and are typically well-spaced; valley oak woodland is almost always adjacent to annual grassland and either mixed oak or blue oak woodland types.

Although valley oak is typically found in alluvial soils in California, it also occurs in nonalluvial sites on broad ridgetops and mid-slope benches. *Valley oak woodland* is characterized by a fairly open canopy of mature valley oaks with a grassy understory, generally on valley bottoms and north-facing slopes (Griffin 1971; Holland 1986; Sawyer and Keeler-Wolf 1995). Valley oak woodlands often form a mosaic with annual grasslands, and are also found adjacent to other land cover types, including mixed oak woodland, blue oak woodland, and riparian woodland types. Valley oak woodland is generally denser on valley bottoms where the tree roots can penetrate to the groundwater, and less dense on ridges where trees need wider spacing to develop larger root systems (Griffin 1973).

Trees in the valley oak community are typically mature and well spaced. They are usually the only trees present in this open-canopy woodland, have no shrub layer, and the understory is dominated by nonnative annual grasses. As with most oak communities, regeneration typically is episodic, occurring periodically in “mast years” when acorn production is high and some acorns germinate by avoiding acorn predators such as acorn woodpeckers and California ground squirrels. Creeping wild rye, poison-oak, mugwort (*Artemisia douglasiana*), and California rose (*Rosa californica*) are common native species in riparian portions of valley oak woodland.

Covered plants that may be found within the valley oak woodland include Santa Clara Valley dudleya, fragrant fritillary, and Loma Prieta hoita (**Table 3-6**). These species are restricted to specific habitat elements and micro-site characteristics within this land cover. Valley oak woodland occupies approximately 12,895 acres (2.8%) of the study area (**Table 3-7** and **Figure 3-10**). This land cover type is most common on the valley floors of the southeast corner of the study area, but it also occurs on ridgetops in the central eastern portion of the study area.

Mixed Oak Woodland and Forest

The *mixed oak woodland and forest* land cover type is a significant land cover type in the study area. It contains oak woodland habitats where no species is clearly dominant, or where different types of oak woodlands are present in a small-scale mosaic and each type occurs in patches too small to map. It includes a mixture of live and deciduous oaks; foothill pine may be present as scattered individuals.

Mixed oak woodland and forest in the Plan study area is generally a closed-canopy woodland, with the signature on aerial photographs showing a variety of colors and textures of the different oak species; winter images clearly show that deciduous and evergreen oaks are mixed. This land cover type occurred on a variety of aspects and slope positions, and was typically adjacent to other oak woodland types.

Covered plants that may be found within mixed oak woodland and forest include Santa Clara Valley dudleya, fragrant fritillary, and Loma Prieta hoita (**Table 3-6**). These species are restricted to specific habitat elements and micro-site characteristics within this land cover. Mixed oak woodland and forest occupies approximately 84,488 acres, (18.4%) of the study area (**Table 3-7** and **Figure 3-10**). It is found predominantly at middle elevations in the foothills of the Diablo and Santa Cruz Mountains on either side of Santa Clara Valley. It is, taxonomically, the broadest and most geographically widespread of the oak woodland land cover types in the study area. It was mapped in most areas within the study area where oaks are found, with the exception of an eastern portion of the study area where foothill pine-oak woodland is dominant.

Coast Live Oak Woodland and Forest

The *coast live oak woodland and forest* land cover type mostly includes stands of coast live oak, although California bay is often a major component, and other live oaks and scattered deciduous trees are often present.

Coast live oak woodland and forest was identified by its closed canopy and even dark green color that was the same in all seasons, and by its landscape position, occurring generally on north-facing valley slopes and valley bottoms. There was often an abrupt transition between annual grassland and coast live oak woodland, with coast live oak woodland occupying valley slopes and annual grassland occurring on the surrounding ridges. Coast live oak woodland also occurred adjacent to other oak woodland types.

Grasses and herbs are common in this land cover type. Other species found in this cover type include coffeeberry, bush monkey flower, redberry buckthorn, and California sagebrush (Allen-Diaz et al. 1999). In addition, California blackberry (*Rubus ursinus*), bugle hedge nettle (*Stachys ajugoides*), wood fern (*Dryopteris arguta*), and poison-oak are often present.

Across the Central Coast Ranges, stands occur at lower elevations (200–3,250 feet, mean 1,205 feet) on north and northeast aspects. Slopes are generally steep (36% on average), and parent material is primarily sedimentary sandstone and shale, with loam soils (Allen-Diaz et al. 1999).

Covered plants that may be found within coast live oak forest and woodland include Santa Clara Valley dudleya, fragrant fritillary, and Loma Prieta hoita (**Table 3-6**). These species are restricted to specific habitat elements and micro-site characteristics within this land cover.

Coast live oak woodland and forest occupies approximately 31,652 acres of the study area (6.9%) of the study area (**Table 3-7** and **Figure 3-10**).

Blue Oak Woodland

Blue oak woodland is highly variable in the study area, occurring as single-species canopy stands with virtually no shrub layer understory or with a shrub layer of California sage, as open-canopy stands of widely spaced, mature trees on broad ridges, and as more mixed overstory stands with a dense and diverse shrub understory.

Blue oak woodland was identified by the color of the canopy: pale to mid green in summer imagery in contrast to coast live oak, and leafless in winter imagery. The canopy of blue oak woodland could be closed or relatively open. Aspect was important in distinguishing blue oaks from other deciduous oak species: blue oak woodland in the study area typically occurred on south-facing aspects; however, ridge-top stands of large, well-spaced blue oaks also occurred, and could be difficult to distinguish from valley oaks.

Blue oak woodland is dominated by blue oak (*Quercus douglasii*), a highly drought-tolerant species adapted to growth on thin soils in the dry foothills. Blue oaks grow slowly in these soils and may take decades to reach maturity. They generally occur on sites that are drier and have lower levels of nitrogen, phosphorus, and organic matter than those where valley oak or coast live oak are found (Griffin 1973; Baker et al. 1981). Although blue oaks can become established on south-facing slopes during wetter years or where mesic conditions are present, they are generally found on north-facing slopes (Griffin 1971). However, in the Central California Coast Ranges, blue oak woodland is more common on south-facing slopes (Miles and Goudey 1997). California buckeye and foothill pine are associate tree species in this community.

The understory varies from shrubby to open, with a composition similar to that of the adjacent nonnative grassland. Understory species include annual grasses, hollyleaf cherry, poison-oak, and coffeeberry. Blue oak woodland is considered a sensitive community by CDFG (California Department of Fish and Game 2007) when the following species are present: blue oak, valley oak, and coast live oak.

Fragrant fritillary is the only covered plant that may be found within blue oak woodlands (**Table 3-6**). This species is restricted to specific habitat elements and micro-site characteristics within this land cover.

Blue oak woodland and forest occupies approximately 11,160 acres (2.4%) of the study area (**Table 3-7** and **Figure 3-10**). It is present in scattered locations mostly in the low to mid-elevation hills of the watershed on dry or well-drained north or northeast facing slopes.

Foothill Pine-Oak Woodland

Foothill pine-oak woodland was identified by the obvious signatures on aerial photographs of well-spaced emergent foothill pine crowns, which appear pale gray-green with clear shadows over the lower canopy of contrasting darker green evergreen oaks. Foothill pine-oak woodland often occurred along valley floors within chaparral communities in the eastern foothills, and also occurred adjacent to other oak land cover types and on serpentine soils.

Found at elevations ranging from 200–2,100 feet, foothill pine integrates with blue oak and mixed oak woodlands at higher elevations, forming the *foothill pine-oak woodland* land cover type. Here, the canopy is dominated by emergent foothill pine with a typically dense understory of scattered shrubs, often those found in adjacent chaparral and scrub communities, and nonnative annual grasses and forbs. Oaks become more prevalent at lower elevations, often forming a closed canopy layer below the emergent pines, and the understory lacks an appreciable shrub layer. In the foothills to the east, associated canopy species include blue oak, interior live oak, coast live oak, and California buckeye (Griffin 1977). Closer to the coast, coast live oak, valley oak, blue oak, and California buckeye are typically found.

Associated shrub species include ceanothus species, bigberry manzanita, California coffeeberry, poison-oak, silver lupine (*Lupinus albifrons*), blue elderberry, California yerba santa, rock gooseberry (*Ribes quercetorum*), and California redbud (*Cercis occidentalis* [*C. orbiculata*]).

Covered plants that may be found within foothill pine-oak woodlands include fragrant fritillary and Loma Prieta hoita (**Table 3-6**). These species are restricted to specific habitat elements and micro-site characteristics within this land cover.

Foothill pine-oak woodland occupies approximately 10,960 acres (2.4%) of the study area (**Table 3-7** and **Figure 3-10**). It is found throughout the hills of the Diablo range in the eastern pocket of the study area, interspersed with stands of blue oak.

Mixed Evergreen Forest

Mixed evergreen forest was identified on aerial photographs primarily by its geographic location and aspect; it occurred on the west side of the valley usually on north-facing slopes. The closed canopy was dark green on imagery from any season, but appeared less even in texture than coast live oak woodland because of the mix of different tree species.

Dominant species in the *mixed evergreen forest* land cover type are evergreen broadleaved trees, such as California bay, madrone, tanoak (*Notholithocarpus* [*Lithocarpus*] *densiflorus*), and all three species of live oak: coast live oak, interior live oak (*Quercus wislizenii*), and canyon live oak (*Quercus chrysolepis*).

Conifers—Douglas fir (*Pseudotsuga menziesii*), Coulter pine (*Pinus coulteri*), and foothill pine—occur occasionally as scattered individuals. Deciduous species such as California buckeye and bigleaf maple (*Acer macrophyllum*) frequently occur in this land cover type. The transition between oak woodland and mixed evergreen forest land cover types in the study area is gradual and is characterized by a decrease in cover of live oaks and an increase in California bay, madrone, and tanoak.

Similar to the understory of oak woodlands, the understory of mixed evergreen forest varies from dense shrub thickets to areas dominated by sparse grass and forb cover. Water and light availability appear to be the controlling factors in determining the density of understory vegetation. Mixed evergreen forests lack drought adaptations and generally grow in more mesic habitats (Griffin 1971, 1973). North-facing slopes with well-drained, coarse soils provide ideal substrate conditions. The understory vegetation of mixed evergreen forests consists primarily of shade-tolerant species, such as toyon, poison-oak, and various species of ferns, due to low light levels underneath the canopy (Parker and Muller 1982; Marañón and Bartolome 1994).

Covered plants that may be found within mixed evergreen forest include Santa Clara Valley dudleya, fragrant fritillary, and Loma Prieta hoita (**Table 3-6**). These species are restricted to specific habitat elements and micro-site characteristics within this land cover.

Mixed evergreen forest occupies approximately 5,775 acres (1.3%) of the study area (**Table 3-7** and **Figure 3-10**). In the study area, it occurs on slopes with north and northeast aspects, almost exclusively at the western boundary of the study area, along high-elevation ridges in the Santa Cruz mountains.

Ecosystem Functions

Function and Integrity

Oak woodlands perform a variety of ecological functions, including nutrient cycling, water storage and transport, and wildlife habitat (Giusti et al. 2004). Oak woodlands share many of the same functions as the adjacent grassland and chaparral communities. However, the structure and food provided by the dominance of oak trees in this community distinguish it from the other natural community types. Oak woodland is one of the most biologically diverse communities in California, providing essential habitat for approximately 2,000 plant, 5,000 insect, 80 amphibian and reptile, 160 bird, and 80 mammal species (Merelender and Crawford 1998). Large acorn crops and a diverse insect fauna provide high-quality food for a wide variety of amphibians, reptiles, birds, and mammals.

Dense oak woodlands provide cool, shady refugia for wildlife during the hot, dry summer, and more sparse oak woodlands offer raptors ideal hunting perches. Open-canopy oak woodlands provide critical upland habitat for California tiger salamander, which aestivates in burrows in the grassland understory or beneath isolated oaks. These oak woodlands also provide nesting and foraging habitat for a variety of bird species. The grassland understory provides habitat for fossorial rodents such as ground squirrels and gophers, which are prey for red-tailed hawks, coyotes, and great horned owls. Rodent burrows, in turn, provide habitat for a variety of other species, including burrowing owls.

Natural Disturbance

Oak woodland is a fire-adapted ecosystem, and fire has likely played a large role in maintaining this community type in the study area. Fire creates the vegetation structure and composition typical of oak woodlands, and this natural community has experienced frequent, low-severity fires that maintain woodland or savannah conditions. In the absence of fire, the low or open understory that characterizes the land cover type is lost. Ultimately, closed-canopy oak forests are replaced by shade-tolerant species because oaks cannot regenerate and compete in a shaded understory. Soil drought may also play a role in maintaining open-tree canopy in dry woodland habitat.

Grazing, including precolonial grazing by deer and elk, may also have helped to maintain a more open understory that favors oaks and grasses.

Threats

The two main processes influencing the prevalence of oak woodlands in California are land conversion (for development and intensive agriculture) and the parcelization of large blocks of contiguous habitat for urban development (Giusti et al. 2004).

A lack of oak regeneration, which may be related to development pressures, is also a serious threat for some species. Shortages of apparent regeneration are reported for stands of valley oak, blue oak, and coast live oak. Where regeneration is a problem, mature trees and seedlings are usually adequately abundant, but intermediate-sized trees and saplings are rare or uncommon, suggesting the mature trees will not be replaced (McCreary 2009). Research on the causes of this decline has yet to identify a single causal mechanism. However, potential interacting mechanisms include livestock herbivory and trampling, fire suppression, noxious weed invasion, herbivory by small mammals, and the dominance of annual grasses (over native perennial grasses) that compete with the oak seedlings for soil moisture during the critical early spring period. McCreary (2009) provides a decision-key for determining whether a stand of oaks has a regeneration problem.

Recent research on the effects of wild pigs in California showed that they can disturb up to 35–65% of the ground annually where they occur in high densities, and that they significantly reduce acorn survival (Sweitzer and Van Vuren 2002). In addition to feral pigs, a high density of invasive weeds and nonnative plants in the understory affect oak regeneration. Some studies have found browsing by deer livestock, or other large mammals to be an important factor negatively impacting recruitment (Borchert et al. 1989; Bartolome et al. 2002). Another study found that herbivory by small mammals (Tyler et al. 2002) is very detrimental to oak recruitment. Recruitment in many tree species, particularly oaks, can be highly cyclical and dependent on long-term rainfall patterns.

A more recent influence on oak woodlands is sudden oak death. The disease, first identified in 1995, has since spread to 12 counties and killed tens of thousands of oaks. Research indicates that coast live oaks and black oaks appear to be the most susceptible to this disease (Rizzo et al. 2003). Sudden oak death, caused by the pathogen *Phytophthora ramorum*, is a serious threat to oak woodlands and mixed evergreen forests in northern California. The pathogen can kill adult oaks and madrone; California bay, buckeye, and maple host the pathogen without being killed by it. Blue oak and valley oak have not shown symptoms of the pathogen. Sudden oak death has been confirmed in San Mateo, Santa Cruz, Alameda, Contra Costa, and Santa Clara Counties. It is unknown whether climatic or other factors will limit the spread of sudden oak death into the study area.

Due to the rarity and slow regeneration of some species of oak, several oak-dominated land cover types are considered sensitive communities by CDFG (**Table 3-1**).

Additionally, when urban land is in close proximity to these land cover types, there is a considerable reduction in habitat value. Noise, light, irrigation, and frequent disking for fire protection can substantially degrade habitat conditions. Habitat is also threatened by invasion of exotic plant species in the understory.

Riparian Forest and Scrub

Riparian vegetation in the study area was classified into three land cover types.

- Willow riparian forests, woodlands, and scrub.
- Central California sycamore alluvial woodland.
- Mixed riparian woodland and forest.

CDFG considers central California sycamore alluvial woodland a sensitive biotic community (California Department of Fish and Game 2007).

Because stream systems are so closely tied to riparian forest and scrub land cover, the *riverine* land cover type is also discussed in this section.

Historical Extent and Composition

From the foothills to the valley floor, riparian forest, woodland, and scrub communities surround riverine watercourses, thriving along stream banks and floodplains. While the largest and most diverse riparian forests occurred on mainstem rivers with natural levees, well-developed riparian forest and scrub was found along virtually all watercourses in central California (Katibah 1984). Historically, riparian vegetation was shaped by its proximity to streams and was maintained by seasonal flooding in the winter and spring and by summer drought. Riparian forests developed on the natural levees of river-deposited silt, lining many of the study area's drainages. Virtually all streams supported dense vegetation from the water's edge to the outer moist-soil zone, whether or not natural levees were present. Precolonial riparian vegetation was characterized by corridors of dense, broadleaf vegetation of varying widths bounding the stream channel with widths determined by local geologic and hydrologic conditions (Katibah 1984).

With the gold rush in 1849, rapid development of some portions of California began. Riparian vegetation removal was one of the first significant losses in the natural environment. Although they are more fragmented today, these land cover types still support many plant species and a diverse collection of birds, amphibians, and mammals. Significant impacts have also resulted from the expansion of agriculture and livestock grazing, along with water diversion and flood control projects (Katibah 1984).

Historically, most of Coyote Creek along the valley floor may have been intermittent (often with isolated persistent pools) or dry during dry years and droughts while in wet years much of the stream may have been perennial. Streams draining the Diablo Range traveled overland, down the mountain slopes until reaching the valley floor where water spread out over the loose alluvial soils, percolating into the groundwater basin (Grossinger et al. 2006). Water traveled underground until reaching the main stem of Coyote Creek, where it surfaced and continued to drain through the salt marshes and into the San Francisco Bay. As land was claimed for agriculture, streams leading from the mountains were channelized into ditches to be used for drinking water and irrigation. The modern-day network of constructed drainage ditches and channels took place largely prior to 1900. Today nearly 50% of the valley floor watercourses draining into Coyote Creek are constructed channels (Grossinger et al. 2006).

The two main tributaries to the Guadalupe River, Guadalupe Creek and Los Gatos Creek, were historically connected to the Guadalupe River much as they are today. Much like the small tributaries of Coyote Creek, smaller tributaries of the Guadalupe River, such as Ross Creek, historically percolated into the valley floor but were not connected via surface flow to the Guadalupe River. Today, many of these small tributaries are now connected to the Guadalupe River via man-made channels (Oakland Museum of California n.d.). The Guadalupe River historically flowed into Guadalupe Slough but has since been redirected to Alviso Slough for navigation purposes.

As discussed above, the existing stream network was largely developed through human intervention and has been manipulated by the introduction of canals and ditches to provide additional flexibility in water supply, to increase the amount of developable land around streams, and to reduce flooding in the valley. As such, channels and ditches now cross between previously disparate riverine systems. One example of this is the Coyote-Alamitos Canal that was built to carry water from the Coyote Canal along Coyote Creek to Alamitos Creek and the Guadalupe percolation basin in the Almaden Valley (Horii 2004).

Historically, the defining feature of the Pajaro River watershed was a broad lowland basin that straddled the south Santa Clara County/north San Benito

County border. Covering 14 miles between Gilroy and Hollister, the remnants of this natural basin are now referred to as the Soap Lake floodplain. This historical basin was fed by the converging alluvial fans of Llagas Creek, Uvas/Carnadero Creek, and Pacheco Creek. As the streams left their steeper alluvial fans and converged into the basin, they tended to have less well defined channels than at present. Streamflow spread into an array of wet meadows, freshwater marshes and ponds, and willow swamps, and eventually coalesced again into a well-defined channel—the origin of the Pajaro River (San Francisco Estuary Institute 2007).

The head of the Pajaro River was originally wetlands associated with San Felipe Lake, a sag pond within the greater Soap Lake floodplain, located near Highway 152 east of Gilroy. When the Soap Lake floodplain was inundated, the lake and wetlands drained into the river. To facilitate agricultural development in the late 19th century, Miller Canal was constructed from San Felipe Lake directly to a downstream portion of the Pajaro River near its confluence with Llagas Creek, bypassing the flat, meandering wetland channel (San Francisco Estuary Institute 2007). The canal allowed for quicker spilling of the lake at a lower elevation, allowing farming around the lake. The original upper Pajaro River channel is now a shallow, seasonal ditch. Additional channelization of both Lower Llagas Creek and Cardanero (Uvas) Creek in the late 1800's eliminated much of the historic seasonal flows received by the Soap Lake Basin.

Common Wildlife Associations

Riparian habitats provide food, water, migration and dispersal corridors, and nesting and cover habitat for numerous wildlife species (Grenfell 1988). These habitats have high value due to their limited extent and widespread use by an abundant and diverse assemblage of wildlife species.

Wildlife species that are often associated with this land cover type include amphibians such as Pacific tree frogs (*Pseudacris regilla*), California newts (*Taricha torosa*), and California slender salamander (*Batrachoseps attenuatus*); reptiles such as western aquatic garter snake (*Thamnophis couchii*) and San Francisco garter snake (*Thamnophis sirtalis tetrataenia*); birds such as Wilson's warbler (*Wilsonia pusilla*), Swainson's thrush (*Catharus ustulatus*), California yellow warbler (*Dendroica petechia brewsteri*), green heron (*Butorides striatus*), wood duck (*Aix sponsa*), spotted towhee, and red-shouldered hawk (*Buteo lineatus*); and mammals such as long-tailed weasel (*Mustela frenata*), San Francisco dusky-footed woodrat (*Neotoma fuscipes annectens*), gray fox (*Urocyon cinereoargenteus*), mountain lion (*Puma concolor*), and California myotis (*Myotis californicus*).

Riverine systems, particularly healthy riverine systems, provide habitat for aquatic macroinvertebrates, which are an important food source for local and downstream populations of birds and other animals.

Bay checkerspot butterfly and California tiger salamander use riparian forest and scrub land cover as movement habitat. California red-legged frog uses riparian habitat type for breeding, foraging, and refugia. Foothill yellow-legged frog (*Rana boylii*) and western pond turtle utilize aquatic habitat for thermoregulation, foraging, and avoidance of predators. The turtle is also known to overwinter in leaf litter or soil at upland sites and uses sparsely-vegetated upland sites for nesting. Least Bell's vireo has been found foraging in riparian areas in the southern portion of the county and may be nesting, especially when a dense shrub layer exists, although no confirmed nests have been found. Tricolored blackbird uses this land cover type as breeding and year-round habitat. San Joaquin kit fox has been known to use this land cover as movement habitat.

Loma Prieta hoita is the only covered plant associated with riparian forest and scrub land cover types (**Table 3-6**).

Riverine associated wildlife species covered under this Plan that are known to occur in the study area include Bay checkerspot butterfly (for movement), California red-legged frog, foothill yellow-legged frog, western pond turtle, least Bell's vireo (*Vireo bellii pusillus*), tricolored blackbird, and San Joaquin kit fox (**Table 3-5**).

Riparian Forest and Scrub Land Cover Types

Within the Plan study area, riparian forest and scrub land cover types were identified primarily by their landscape position along creeks and around open water bodies. Several common riparian trees species—willows, cottonwood, and sycamore—appeared to hold their leaves after they turn color in fall, and early winter imagery clearly showed these distinctive yellow crowns, either in pure stands or mixed with the dark green canopies of coast live oak and bay in more mixed riparian woodland. The plant assemblage and width of riparian corridors found along the banks and floodplains of rivers and streams, vary. Dominant influencing factors include the steepness of the channel, the frequency of disturbance, and the hydrologic regime present.

The *riparian forest and scrub* land cover type is dominated by woody vegetation associated with permanent water sources. Riparian woodland is dominated by trees and contains an understory of shrubs and forbs. Riparian scrub is dominated by young willow trees and shrubs, typically representing an early successional stage of riparian woodland.

At the state level, riparian plant communities are considered sensitive because of habitat loss and their value to a diverse community of plant and wildlife species. Additionally, CDFG has identified them as a sensitive natural community (California Department of Fish and Game 2007).

Willow Riparian Forests, Woodlands, and Scrub

Willow riparian forests, woodlands, and scrub land cover types occur in and along the margins of active channels on intermittent and perennial streams. Yellow willow (*Salix lasiandra*), red willow (*Salix laevigata*), arroyo willow (*Salix lasiolepis*), and narrowleaf willow (*Salix exigua*) are the dominant canopy species in this habitat. In addition, Fremont cottonwood, white alder (*Alnus* *rhombifolia*), bigleaf maple, California sycamore (*Platanus racemosa*), and coast live oak are often found in these communities.

A range of conditions exists among the willow riparian forest, woodland, and scrub communities. Forests are typically composed of dense, mature willows integrating with central coast live oak riparian forest and white alder riparian forest on well-established stream terraces, often with scattered California sycamore trees. Woodland communities contain dense willow riparian scrub, dominated by young trees and shrubs, on young and dynamic alluvial deposits. Scrub communities typically consist of scattered willows and mulefat (*Baccharis salicifolia*) occurring in and along the margins of open sandy washes. Understory development in willow forest or scrub land cover types is controlled by canopy density.

Willow riparian forests, woodlands, and scrub occupy approximately 2,544 acres (0.6%) of the study area (**Table 3-7** and **Figure 3-10**). This land cover type is associated with streams throughout the study area. Particularly large stands of this land cover types are found along the major creek and streams including Guadalupe River, Coyote Creek, Uvas Creek, Llagas Creek, Pacheco Creek, and the Pajaro River along the county line.

Willow riparian forests, woodland, and scrub provide important habitat for many covered wildlife species (**Table 3-5**). For example, this land cover type provides the primary habitat for least Bell's vireo in the study area. California red-legged frog and western pond turtle will also utilize this land cover type within the aquatic systems. The California tiger salamander moves through or forages in this land cover type.

Central California Sycamore Alluvial Woodland

Central California sycamore alluvial woodland was readily identified by the large well-spaced sycamore crowns. In early winter aerial imagery the large pale branches and halo of fallen golden-yellow leaves were visible. The landscape position, on broad alluvial valley floors, was also indicative of this land cover type.

The *central California sycamore alluvial woodland* land cover type is generally present on broad floodplains and terraces along low gradient streams with deep alluvium. Areas mapped as sycamore alluvial woodland are generally open canopy woodlands dominated by California sycamore, often with white alder and willows (*Salix* spp.). Other associated species include bigleaf maple, valley oak, coast live oak, and California bay.

The understory is disturbed by winter flows, and herbaceous vegetation is typically sparse or patchy. Typically, plants such as willows, coyote brush, mulefat, California buckeye, blackberry, Italian thistle (*Carduus pycnocephalus*), poison-oak, common chickweed (*Stellaria media*) and bedstraw (*Galium aparine*) populate the stream banks.

Central California sycamore alluvial woodland occupies 367 acres (0.1%) of the study area (**Table 3-7** and **Figure 3-10**). All stands of this land cover type are found along Coyote Creek and Pacheco Creek. Air photos and field mapping conducted by CDFG of this land cover type in 1992 identified only 17 major stands statewide occurring on 2,032 acres (Keeler-Wolf et al. 1997). Among the stands mapped by this project were three sites in the study area on Coyote Creek (40.1 acres between Ogier Ponds and Anderson Dam), Upper Coyote Creek (49.2 acres above Coyote Reservoir), and on Pacheco Creek along Highway 152 (135.4 acres). At that time, the study area supported 11% of this land cover type in the state. All stands were also quantitatively sampled by CDFG, providing a basis for a detailed description of this land cover type in California. Results from the CDFG study differ from the mapping conducted for the HCP/NCCP (225 acres vs. 374 acres[16]). Sycamore woodland is also found along lower Cedar Creek (a tributary to Pacheco Creek) and the North Fork of Pacheco Creek upstream of Pacheco Reservoir.

California red-legged frog and western pond turtle may be found in this land cover type year-round, while California tiger salamander and foothill yellow-legged frog may move through this land cover type (**Table 3-5**). Least Bell's vireo may forage in this land cover type.

Mixed Riparian Woodland and Forest

Mixed riparian woodland and forest land cover types are similar to willow riparian forests and woodlands in species occurrences. They are found in and along the margins of the active channel on intermittent and perennial streams. Generally, no single species dominates the canopy, and composition varies with elevation, aspect, hydrology, and channel type. This land cover type captures much of the riparian woodland and forest in the study area and includes several associations that could not be distinguished on the aerial photographs. The major canopy species throughout the study area are California sycamore, valley oak, coast live oak, red willow, and California bay. Associated trees and shrubs include California black walnut, other species of willow, California buckeye, Fremont cottonwood, and bigleaf maple. Nonative invasive species that may be present include giant reed (*Arundo donax*) and Himalayan blackberry (*Rubus armeniacus* [*R. discolor*]).

Covered plants that may be found within mixed riparian forest and woodlands are limited to Loma Prieta hoita (**Table 3-6**). This species is restricted to specific habitat elements and micro-site characteristics within this land cover.

Mixed riparian woodland and forest occupies approximately 3,717 acres (0.7%) of the study area (**Tables 3-7** and **Figure 3-10**). Mixed riparian is found in association with streams throughout the study area.

Covered species associated with this land cover type are the same as willow riparian forests, woodlands, and scrub (**Table 3-5**).

[16] Differences in results are likely due to differences in mapping techniques, differences in air photos used, and changes in environmental conditions over the 13 years between the studies.

Riverine (Streams)

The *riverine* land cover type includes perennial, intermittent, and ephemeral watercourses characterized by a defined bed and bank. *Perennial streams* support flowing water year-round in normal rainfall years. These streams are often marked on USGS quadrangle maps with a blue line, known as *blue-line* streams. In the semi-arid Mediterranean climate of the study area with its wet and dry seasons, perennial stream flows are enhanced in the dry season through groundwater aquifer contributions, flows from shallower springs/seeps, and reservoir releases. *Intermittent (seasonal) streams* carry water though most of the wet season (November–April) and are dry through most or all of the dry season (May–October) in a normal rainfall year. More specifically, in the wet season, intermittent streamflow occurs when the water table is raised, or rejuvenated, following early season rains that fill shallow subsurface aquifers. Intermittent flows can also be considered as the 'baseflows' between storm events that continue on through much of the winter season. *Ephemeral streams* carry water only during or immediately following a rainfall event. The principal named waterways in the northern half of the study area (the Santa Clara Basin) are perennial due to urban runoff, reservoir releases, and/or high groundwater (Santa Clara Basin Watershed Management Initiative 2003). The principal waterways in the Pajaro River Basin have some perennial reaches due to a combination of high groundwater levels (primarily in headwater reaches of tributaries and in the Pajaro River), agricultural runoff, and releases from dams in the valley floor reaches.

The riverine land cover type is most closely associated with riparian plants (see the *Riparian Forest and Scrub* section above for discussion of riparian land cover types). The riparian plant composition and width of the riparian corridor vary depending on channel slope, magnitude and frequency of channel and overbank flows, and the frequency/duration of flooding flows that inundate the broader floodplain. Some of the riverine areas in the study area, particularly on the valley floor streams include braided stream forms with multiple channel threads and swales, intermediary channel bars, raised side channel benches (that are still actively flooded), and higher terrace sequences that may no longer be actively flooded. In such systems where there is frequent flooding, gravel bars with mulefat scrub occur as an early seral community (Santa Clara Basin Watershed Management Initiative 2003). Willows may become established in-channel in areas of sediment deposition, unless suppressed by intensive browsing by wildlife or livestock, lack of water, or high flows. Woody debris, such as fallen trees that are submerged in streams, provides good habitat and shelter for aquatic invertebrates.

Several invasive, nonnative plant species are found in riverine land covers within the study area. One of the most prevalent is giant reed, which is often found in large pure stands. Other invasive, nonnative plants potentially found in the study area include blue gum eucalyptus, acacia, fennel (*Foeniculum vulgare*), periwinkle, English ivy, French broom, black locust, Algerian ivy (*Hedera canariensis*), Cape ivy, Himalayan blackberry, weeds, curly dock (*Rumex crispus*), thistle, blackwood acacia (*Acacia melanoxylon*), tree-of-heaven (*Ailanthus altissima*), glossy privet (*Ligustrum lucidum*), fig, poison hemlock, black mustard, black walnut, and almond (Santa Clara Basin Watershed Management Initiative 2003).

Major streams in the study area include Coyote Creek, Guadalupe River, Uvas Creek, Llagas Creek, Pajaro River, Pacheco Creek, and their various tributaries (**Figure 3-6**). Riverine habitats were not mapped as polygons but are derived from USGS and SCVWD stream data. Based on this information there are an estimated 3,032.2 miles of riverine habitat in the study area.

Wildlife species covered by this Plan that may be found living in or nearby the riverine land cover type include California tiger salamander, California red-legged frog, foothill yellow-legged frog, and western pond turtle (**Table 3-5**).

Common fish species found in the watersheds draining towards San Francisco Bay (Guadalupe River and Coyote Creek) include native species such as California roach (*Lavinia symmetricus*), hitch (*L. exilicauda*), Sacramento sucker (*Catostomus occidentalis*), threespine stickleback (*Gasterosteus aculeatus*), resident rainbow trout and anadromous steelhead (*Oncorhynchus mykiss*), prickly sculpin (*Cottus asper*), and riffle sculpin (*Cottus gulosus*), and introduced fishes such as green sunfish (*Lepomis cyanellus*), largemouth bass (*Micropterus salmoides*), and mosquitofish (*Gambusia affinis*). Common native fish species found in the Pajaro River Watershed including Uvas, Llagas, and Pacheco Creek, include resident rainbow trout and anadromous steelhead, hitch (*Lavinia exilicauda*), California roach (*Lavinia symmetricus*), Sacramento blackfish (*Orthodon microlepidotus*), Sacramento sucker, threespine stickleback, Sacramento pikeminnow (*Ptychocheilus grandis*), riffle sculpin and prickly sculpin (J. Smith pers. comm. 2007).

Native and nonnative fish assemblages and in-stream aquatic habitat types throughout the major stream systems in the study area are shown in **Figure 3-12** and described in detail in **Appendix L**. The figure illustrates the distribution of the native fish assemblages and riverine habitat types developed for the Science Advisors report (Spencer et al. 2006) and updated by SCVWD fisheries biologist Jae Abel for the GIS layer. **Table 3-8** documents the relationship of the native fish communities to native fish.

Canals and ditches were included in the riverine land cover type due to their similar function to degraded streams and their very low acreage in the study area. Due to the nature of these man-made structures, canals and ditches are often managed for minimal vegetation to enhance the flow of water through the channels. Vegetated canals and ditches that cross serpentine areas (e.g., Coyote Ridge, Santa Teresa Hills) often support several covered species including Santa Clara Valley dudleya, most beautiful jewelflower, smooth lessingia, Mt. Hamilton thistle, and California red-legged frog. Garter snakes and some ducks use canals and ditches throughout the study area.

Ecosystem Functions

Function and Integrity

While riparian land cover types occupy a very small percentage of the total land cover in the study area, they are particularly important because they are among the most structurally complex and richly diverse habitat types in terms of plant and animal associations.

Riparian communities support both terrestrial and aquatic species by providing movement corridors across the landscape and both nesting and foraging habitat. They can also support high levels of invertebrate production; provide moist, cool refugia during the hot, dry summer; have moderate stream temperatures; help armor stream banks; and support the aquatic food chain by means of input of vegetative and other detritus.

Riparian areas are integrated into the working rangelands of the study area. They are typically managed in conjunction with adjacent grasslands, shrublands, and oak woodlands. They are often used by livestock for forage, shade and drinking water.

Denser canopies reduce direct solar radiation to streams and creeks, thereby lowering water temperatures and may increase habitat value for aquatic wildlife. However, algal growth, which increases aquatic insects, requires a partially open canopy for light. Differences in vegetative structure between riparian communities lead to varying effectiveness in providing these ecosystem functions. For example, riparian scrub, with its lower vegetation structure, is often less effective in reducing stream temperatures than riparian woodland. On the other hand, riparian scrub may provide better nesting and foraging habitat for migratory passerine birds that prefer the dense thicket habitat provided by scrub. Living and dead woody debris that enter the stream channel from the riparian forest provides valuable habitat benefits for native fish.

Physically, riverine systems, most notably natural streams, provide the essential conduits to convey flows, sediments, and nutrients across the watershed. Streams transport weathered minerals and eroded sediments from upper watershed source areas through intermediate watershed positions ultimately to lower watershed depositional areas or discharges beyond the watershed. While the general, and classical, characterization of watersheds into ‘upper erosional’, ‘middle transitional’, and ‘lower depositional’ areas may often hold true; in greater detail, all areas of the watershed can witness erosion, transport, or storage functions. Nutrients from exposed soil and decomposed organic matter are also carried downstream with the sediment, across the valley floor and finally into the estuary. Alluvial soils, high in organic content and nutrients, are excellent for agriculture. Sediment influx to estuaries helps maintain a marshland buffer along the shoreline that supports a myriad of wildlife.

Streams provide ecosystem functions and values much greater than the proportion of the landscape they occupy. Streams provide habitat for a wide array of aquatic insects that, in turn, function as food for amphibians, birds, and other insectivorous species. Perennial streams function as permanent water sources in an otherwise dry landscape. Streams also provide movement corridors between different terrestrial communities. In this way, networks of ephemeral, seasonal, and perennial streams link chaparral/scrub, oak woodland, oak savanna, riparian woodland, and grassland habitats. These links are not only important for the movement of wildlife, but also represent the fastest means of transporting energy and nutrients through a watershed. Thus, it is through stream networks that organic matter and minerals are transported from the highlands and deposited in the lowlands.

Stream channels are modified for a variety of purposes. In the study area, stream channels are modified primarily for flood conveyance, ground water percolation, and agricultural and drinking water distribution. Canals and ditches are usually hardened structures for the transport of water for agricultural irrigation and urban and suburban uses. Earthen levees or channel walls are a common, engineered stream channel modification to protect property adjacent to streams from flooding. Most stream channel alterations, whether hardened structures like canals, or earthen structures such as some ditches and levees, are designed to convey water quickly, to either reduce evapotranspiration (water lost to the atmosphere) during transport, costs associated with water delivery, or to increase the flow, and thus the volume of runoff, that can be moved out of areas prone to flooding. Regardless of the type of modification, the result is often the same—a more linear alignment that does not allow a channel to meander as it would in its natural state. This results in higher flows and potential scour of the stream channel, in hardened structures such as canals, this scour typically occurs upstream and/or downstream of the solid infrastructure. Channel modifications and/or solid infrastructure such as canals also disconnect the stream from the floodplain, resulting in the loss of nutrient delivery upstream and increased sediment deposition downstream.

Agricultural ditches often play a key role in providing connectivity between larger open space areas, especially in urbanizing areas such as the Santa Clara Valley. Maintaining connectivity between open space patches that provide habitat supports a diversified genetic pool due to the ability of populations to disperse and co-mingle. Agriculture also often is associated with streams, canals, and ditches used for irrigation that may support riparian vegetation, trees (planted as windbreaks), and shrubs. These areas may provide habitat to songbirds, raptors, amphibians and reptiles, as well as provide a movement corridor for other species.

Natural Disturbance

Riparian communities are shaped by their proximity to water and by periodic flooding that maintains the structure and composition of this land cover type. Wet-season flooding replenishes alluvial soils that are deficient in minerals and organic matter. Flooding also subjects riparian forest to frequent disturbance that benefits regeneration of certain species, including California sycamore, white alder, and black willow. Regeneration from seed appears to occur in pulses correlated with large flood events (Shanfield 1984). Additionally, trees that are damaged by flooding can resprout from the roots and trunk (Shanfield 1984).

The flowing nature of streams encourages regular mixing as water flows over rocks, tree stumps, and changes gradient. Depending on other environmental influences including temperature and dissolved oxygen levels, mixing may also trigger the hatching of larvae that will become food for fish, birds, and bats. Erosion and sedimentation processes are forms of natural and artificial disturbance in the area. Flood and drought cycles of natural streams tend to result in a mosaic of structure and composition in riparian plant communities (this mosaic may be lost in altered flow regimes downstream of reservoirs). Flooding is also a key disturbance process that has largely been eliminated from portions of the study area. For example, large flood-control projects on the Guadalupe River and Coyote Creeks have greatly reduced flooding frequency and intensity. Similarly, channelization of Llagas Creek and portions of Uvas Creek has reduced (but not eliminated) flooding in Morgan Hill and Gilroy, respectively. Flooding still occurs regularly in the Soap Lake area (lower Llagas Creek, lower Pacheco Creek, and upper Pajaro River).

Threats

In the greater Bay Area, flood control activities, cultivated agriculture, aggregate mining, and urban development have significantly reduced the distribution of this land cover type. Riparian forest can also be severely impacted by improper grazing management. Therefore it is possible that this cover type was much more abundant prior to the onset of intensive livestock grazing. Finally, seedling establishment and growth is heavily dependent on access to surface water or shallow groundwater during the majority of the year (Sacchi and Price 1992). As such, water operations and land alterations that result in reduced stream baseflows and/or increased depth to the water table will have a significant negative effect on this land cover type. Sycamores in the study area, including those that dominate Sycamore alluvial woodland, are frequently infected by Sycamore anthracnose (*Apiognomonia veneta*), a fungal disease that affects trees throughout the state (Keeler-Wolf et al. 1997).

Livestock grazing can substantially degrade riparian woodland and scrub communities when cattle and other livestock have uncontrolled access to streams. However, modifying traditional grazing practices can protect riparian areas. Using shortened grazing periods during times of increased vulnerability (late summer and fall) can reduce damage to the vegetation, eliminate or reduce impacts to soils, and buffer the overland transport of sediments and nutrients from grazed lands into the surface water.

All riverine systems within the study area have been altered significantly by human impacts including impoundments, creation of permanent or temporary barriers to movement, water diversions, channelization, flood control projects, loss of riparian vegetation, and increased rates of sedimentation. These impacts reduce habitat complexity and habitat quality, affecting such things as pool/riffle relationships, level of dissolved oxygen, and substrate composition. Loss of riparian vegetation results in decreased shading, increased water temperatures, reduced cover, and decreased input of nutrients (Santa Clara Basin Watershed Management Initiative 2003). Trash and other pollutants that are washed into streams may degrade water quality to the point the aquatic life cannot persist.

Aquatic invertebrates, often sensitive to water quality, may die off, thus disrupting the food chain.

Conifer Woodland

In addition to hardwood-dominated upland land cover types, conifer dominated land cover types also occur in the study area. The three conifer-dominated communities listed below occur in the study area.

- Redwood forest.
- Ponderosa pine woodland.
- Knobcone pine woodland.

Historical Extent and Composition

Prior to European settlement, the Santa Clara Valley supported a mosaic of plant and wildlife communities. Upland regions were heavily forested with redwoods that flanked creeks and rivers as they traversed the landscape to lower elevations. Under mesic habitat conditions, pine and oak forests dotted the land (Bolton 1927, 1930). The foothill forests and woodlands were heavily thinned in the mid- to late-1800s to house and support the growing population in the region. With habitat alterations came the replacement of native plant communities with nonnative, invasive species. These new communities contain lower quality habitat for native wildlife species.

Common Wildlife Associations

Wildlife species often found in conifer dominated upland land cover types include: birds such as acorn woodpecker, scrub-jay (*Aphelocoma californica*), California quail, golden eagle, Cooper's hawk (*Accipiter cooperii*), olive-sided flycatcher (*Contopus cooperi*), and sharp-shinned hawk (*Accipiter striatus*); amphibians such as arboreal salamanders (*Aneides* spp.), California slender salamander, and California newt; reptiles such as common king snake (*Lampropeltis getula*), garter snake (*Thamnophis* spp.), and ringneck snake (*Diadophis* spp.); and mammals such as broad-footed mole (*Scapanus latimanus*), deer mouse, western gray squirrel, gray fox, and striped skunk (*Mephitis mephitis*).

Associated wildlife species covered under this Plan that are known to occur in the study area include California tiger salamander, foothill yellow-legged frog and western pond turtle (**Table 3-5**).

California tiger salamanders use the grassy understory of open woodlands for terrestrial aestivation or refuge and aquatic sites for breeding. Foothill yellow-legged frogs and western pond turtles utilize aquatic habitat often found in redwood forest and oak woodlands. The turtle is also known to overwinter in leaf litter or soil at upland sites.

Conifer Woodland Land Cover Types

Coast redwood (*Sequoia sempervirens*) forests are primarily distributed in the Santa Cruz Mountains. They occur in ravines, along streamsides, and in areas that are moistened by coastal fog (Thomas 1961). At higher elevations of the Diablo Range, stands of ponderosa pine (*Pinus ponderosa*) are found. Stands of knobcone pine (*Pinus attenuata*) occur on ridgetops of the Santa Cruz Mountains at the western edge of the study area.

Redwood Forest

Redwood forest was identified on aerial imagery by the large, irregular crown outlines formed by the whorled branches, and by the landscape position along creeks and valleys and on lower north- and east-facing slopes in the foothills on the western side of the valley. The irregular crown signatures on aerial photographs contrasted with the adjacent land cover types, usually mixed oak woodland or mixed evergreen woodland.

The *redwood forest* land cover type is dominated by an overstory of redwood with a variety of associated tree, shrub, and forb species in the understory. This land cover type is uncommon in the study area, only occurring in the Santa Cruz Mountains in the west portion of the study area along creeks and valleys, generally on north-facing slopes. Stands of redwoods are found along Uvas (Uvas Canyon County Park), Llagas, and Arthur Creeks. Most redwood forests have been logged since the second half of the nineteenth century, and most of the existing trees are stump sprouts. However, in many areas, particularly along creeks, dense cover of redwood trees has been maintained. Areas that were burnt following logging now support chaparral or oak-dominated communities. Redwood forests occur in areas that receive substantial rainfall, generally more than 35 inches per year. Common plants associated with these forests include trees such as tanoak, madrone, and California bay; the shrub layer include species such as hazelnut (*Corylus cornuta* var. *californica*), thimbleberry (*Rubus parviflorus*), and black huckleberry (*Vaccinium ovatum*). In riparian areas, California bay and bigleaf maple are common, California nutmeg (*Torreya californica*) may occur, and ferns such as sword fern (*Polystichum munitum*) often form a dense layer.

Redwood forest occupies approximately 9,628 acres (1.9%) of the study area (**Table 3-7** and **Figure 3-10**). This land cover type is found in the study area exclusively in the Santa Cruz Mountains, mostly along drainages and near ridgelines.

Covered wildlife species that may be found in this land cover type California red-legged frog, foothill yellow-legged frog, and western pond turtle (**Table 3-5**).

Fragrant fritillary and Loma Prieta hoita may occur within redwood forest landcover, however, data is insufficient for the study area (**Table 3-6**). These species would be restricted to specific habitat elements and micro-site characteristics within this land cover.

Ponderosa Pine Woodland

Ponderosa pine woodland has a very restricted distribution within the Plan study area and was identified by the widely-scattered dark green crowns of individual Ponderosa pine trees, which cast long oblong shadows across the adjacent grassland.

The *Ponderosa pine woodland* type is dominated by an overstory of ponderosa pine, with oaks and oak woodland understory species as associates. This land cover type is uncommon in the study area, only occurring on three high elevation ridges in Henry W. Coe State Park—Pine Ridge, Middle Ridge, and Blue Ridge—and extending downslope into north-facing canyons and valleys. On the ridges, Ponderosa pine trees are often large and well spaced, forming very open stands over annual grassland. Regeneration is often common and many age classes are present. Associated tree species include black oak (*Quercus kelloggii*), coast live oak, and Pacific madrone. Few shrubs are present, although bigberry manzanita is common in some areas. Ponderosa pine is uncommon in the Coast Ranges; these stands are likely relicts of a wider distribution in the past when the climate was cooler.

Ponderosa pine woodland occupies approximately 419 acres (0.1%) of the study area (**Table 3-7** and **Figure 3-10**).

California tiger salamander, California red-legged frog and western pond turtle may move through this land cover type during dispersal events (**Table 3-5**).

Loma Prieta hoita may occur within ponderosa pine woodlands, however, data is insufficient for the study area (**Table 3-6**). This species would be restricted to specific habitat elements and micro-site characteristics within this land cover.

Knobcone Pine Woodland

Knobcone pine woodland was identified by its geographical location on ridges in the western portion of the Plan study area and the mid-green, relatively even signature on aerial photographs contrasting with adjacent signatures of redwood forest, northern mixed chaparral, and mixed evergreen forest.

Knobcone pine woodland land cover types consist of dense stands of knobcone pines that regenerate following fire. This land cover type is uncommon in the study area, occurring only in the Santa Cruz Mountains on ridgetop sites, often on serpentine-derived soils. It is thought that the water-retaining properties of serpentinite, combined with the pine's ability to intercept marine fog, allow knobcone pine to persist in these locations (Vogl 1973). Knobcone pine is an obligate fire-climax species—fire is required to melt the resin that seals the cones, releasing the seed, and fire also creates the bare mineral soil required for the seeds to germinate. Stands of knobcone pine are therefore even-aged, dating back to the last stand-replacing fire. Knobcone pine is fast growing, with a relatively short lifespan of 75 to 100 years, although approximately half the trees may die by 60 years of age (Vogl 1973). Knobcone pine woodland is replaced by chaparral at lower elevations and by conifers (redwood or Douglas fir) at higher elevations, and it may occur as a mosaic with chaparral, conifer- and oak-dominated woodlands. Although knobcone pine usually occurs as dense, monodominant stands, it can also be associated with chaparral species such as manzanitas, bush poppy (*Dendromecon rigida*), and bush chinquapin (*Chrysolepis chrysophylla* var. *minor*) that form a sparse to dense understory layer.

Knobcone pine woodland occupies an estimated 711 acres (0.1%) of the study area (**Table 3-7** and **Figure 3-10**). This land cover type is found along the summit of the Santa Cruz mountains at the western edge of the study area.

Covered species do not forage and breed in this land cover type. Species that may move through this land cover type include California red-legged frog and western pond turtle (**Table 3-5)**.

Fragrant fritillary and Loma Prieta hoita may occur within land cover type; however, data is insufficient for the study area (**Table 3-6**). These species would be restricted to specific habitat elements and micro-site characteristics within this land cover.

Ecosystem Functions

Function and Integrity

Similar to oak woodland, these forests and woodlands provide food, nesting, and cover to a variety of wildlife. However, the structure and food resources that conifer-dominated forests provide make them a valuable resource. Evergreen oaks such as coast live oak, as well as California bay, madrone, and foothill pine, provide year round shelter unlike the largely deciduous vegetation of riparian forest and scrub. A largely continuous, dense leaf canopy and abundant tree cavities act to shade wildlife, provide habitat for nesting, and offer protection from predators. In addition, thick layers of leaf litter, ephemeral ponds, and wetlands can provide secondary habitat for soil invertebrates and amphibians by offering protection from desiccation and foraging habitat.

Natural Disturbance

A major factor influencing the distribution of conifer-dominated land cover types is fire intensity and frequency. The combination of logging and burning at the end of the nineteenth century resulted in the conversion of conifer-dominated forests (redwood and Douglas fir) in the Santa Cruz Mountains to chaparral and oak-dominated woodlands. Periodic stand-replacing fire is required for the regeneration of knobcone pine woodland.

Threats

Conifer-dominated land cover types have been heavily affected by timber harvesting, urban development, and agricultural conversion. When urban land is adjacent to or surrounds these natural communities, there is a significant reduction in habitat value. Noise, light, irrigation, and frequent disking for fire protection can substantially degrade habitat conditions and the chance of fire increases. Habitat is also threatened by invasion of exotic plant species in the understory.

Wetlands

Wetland habitat includes areas subject to seasonal or perennial flooding or ponding, or that possess saturated soil conditions and that support predominantly hydrophytic or "water-loving" herbaceous plant species. Because wetlands are periodically waterlogged, the plants growing in them must be able to tolerate low levels of soil oxygen associated with waterlogged or hydric soils. The presence of flood-tolerant species is often a good indication that a site is a wetland even if the ground appears to be dry for most of the year (Barbour et al. 1993; Santa Clara Valley Water District 2002a), or if hydrologic influences are less obvious.

Wetland habitat in the study area was classified into two land cover types.

- Coastal and valley freshwater marsh.
- Seasonal wetland.

In general, wetlands represent a sensitive biotic community due to their limited distribution and importance to special-status plant and wildlife species.

Historical Extent and Composition

Wetland habitats, in particular seasonal wetlands, were almost certainly more abundant in the study area than they are today. Historically, vernal pools and other seasonal wetlands and ponds were likely scattered throughout the lowland portions of the study area and streams flowed unimpeded by the channels, water diversions, and barriers that are present today. At the time of the Portola expedition in 1769, large marshes, especially near the lower portions of Coyote Creek and the Guadalupe River, reportedly made overland travel by foot very difficult (Santa Clara Basin Watershed Management Initiative 2003).

Two large freshwater wetland areas, Laguna Socayre and Laguna Seca, were located within the Coyote Watershed prior to reclamation activities. These lagunas were a type of perennial emergent freshwater wetland that has groundwater at or near the surface through most, if not all of the year. Laguna Socayre, located east of downtown San José, above and below Capitol Expressway between Story and Tully Road, was a series of historic freshwater wetlands, which included a large freshwater marsh which partly overlaps with modern-day Lake Cunningham (Grossinger et al. 2006). It was created by an old levee of Coyote Creek and intercepted flood flows from the surrounding distributary creeks and may have received emergent groundwater as well. Laguna Seca in Coyote Valley, was an approximately 1,000-acre spring-fed perennial wetland complex formed as the Santa Teresa Hills forced groundwater to the surface. Drainage was blocked by the bedrock of the Santa Teresa Hills and the natural levees of Coyote Creek (Grossinger et al. 2006). In certain years during the dry season, Laguna Seca would dry up completely. It was reclaimed from 1916–1917.

In the low-lying bottomlands, poorly drained basin areas between alluvial fans, flooded wet meadows or marshes sometimes were formed around smaller perennial freshwater marshes and lagunas. In addition, the heavy organic clay soils characteristic of the bottomland areas, often referred to as “black adobe” soils resulted in surface expression of groundwater in seasonally flooded wet meadows and perennial wetland complexes (Grossinger et al. 2006). In addition, bedrock hills prevented drainage of the lower Coyote Valley, which created vast wet meadows with perennial marshes and ponds. The natural levees of Coyote Creek and flat topography also prevented surface runoff and helped created these wet meadows. The dominant plant species in wet meadows or marshes were probably rhizomatous ryegrasses (*Elymus* spp.) (Grossinger et al. 2006). Large stands of saltgrass and alkali meadow were also extensive in the Coyote Watershed, particularly in the lowlands near lower Penitencia Creek and downgradient from Laguna Socayre (Grossinger et al. 2006). Remnant stands of alkali meadows are still present around the fringes of Lake Cunningham in San José. Historic patterns of wetlands in the Guadalupe Watershed are likely to be similar to those in the Coyote Creek Watershed. In the Uvas/Llagas/Pacheco/Pajaro watersheds seasonal or perennial wetlands were present near the mouths of Uvas and Llagas creeks, and the Soap Lake wetland complex of wetlands, vernal pools and alkali meadows was much more extensive than at present in the upper Pajaro River/lower Pacheco Creek area (San Francisco Estuary Institute 2008).

In a statewide study of vernal pools, CDFG identified large portions of Santa Clara County as potentially supporting vernal pools based on the presence of vernal pool species[17] (California Department of Fish and Game 1998). Vernal pools recognized in Santa Clara County are fault-zone sag-pond pools and serpentine vernal pools (California Department of Fish and Game 1998; Santa Clara Basin Watershed Management Initiative 2003). A vernal pool just north of the study area in southern Alviso is known to have existed prior to urban development in the area (Sally Casey pers. comm. 1998 in Santa Clara Basin Watershed Management Initiative 2003). Detailed investigations of historic records of wetlands and other land cover types in the Coyote Creek Watershed revealed no evidence of historic vernal pools (R. Grossinger pers. comm.). Vernal pools may have always been rare in the study area.

European settlement saw the introduction of nonnative aquatic species such as the bullfrog, into wetland habitats. Those areas whose hydrology has been altered by damming (e.g., stock ponds) or channelization have been particularly impacted.

[17] Vernal pools in most other regions were identified based on the unique signature on air photos of vernal pool landscapes and wetland complexes.

Common Wildlife Associations

Wetland land cover types provide drinking water, as well as foraging, breeding, and resting habitat for many forms of fish and wildlife, including birds, amphibians, reptiles and mammals. Wetlands provide stopovers for many species of waterfowl and songbirds. Many wildlife species, particularly invertebrates, spend their entire lives in wetlands.

Perennial wetlands are important habitat for a wide variety of wildlife species. Representative waterbirds that forage and rest in permanent wetlands and associated open-water areas include great blue heron (*Ardea herodias*) and great egret (*Ardea alba*); as well as various ducks, including wood duck, green-winged teal (*Anas crecca*), mallard (*Anas platyrhynchos*) and American coot (*Fulica americana*); killdeer (*Charadrius vociferus*); and greater yellowlegs (*Tringa melanoleuca*). Typical amphibians and reptiles in this cover type include red-legged frog, western pond turtle, and garter snakes. Many of the larger mammals, such as mule deer, may frequent permanent wetlands and use them as a source of drinking water.

Seasonal wetlands (i.e., wet meadows, seeps) are commonly used by a variety of wildlife during the wet season, including various amphibians such as Pacific chorus frog (*Pseudacris regilla*), western toad (*Bufo boreas*), and California tiger salamander; shorebirds such as killdeer, black-necked stilt (*Himantopus mexicanus*), and American avocet (*Recurvirostra americana*); and passerines such as Brewer's blackbird (*Euphagus cyanocephalus*), red-winged blackbird (*Agelaius phoeniceus*), brown-headed cowbird (*Molothrus ater*), and American pipit (*Anthus rubescens*). During the dry season, a variety of small mammals may use seasonal wetland areas as forage source, including deer mouse, California vole, and long-tailed weasel; however, wet meadows and seeps are generally too wet to provide suitable habitat for small mammals. Raptors such as white-tailed kites, northern harrier, and red-tailed hawk may forage in this land cover type.

Wetland-associated wildlife species covered under this Plan include bay checkerspot butterfly, California tiger salamander,California red-legged frog, western pond turtle, western burrowing owl, tricolored blackbird (*Agelaius tricolor*), and San Joaquin kit fox (**Table 3-5**).

Wetland Land Cover Types

Within the study area, wetlands were identified and mapped on the basis of their aerial photograph signatures and landscape positions that would support wetland hydrology. In late season imagery, wetlands appear greener than surrounding annual grassland. The minimum mapping unit for all wetland land cover types was 0.25 acre, with the exception of serpentine seeps (see *Grasslands*), which had no minimum mapping unit. Wetland subtypes were distinguished based on the color and texture of the signature on air photos.

On early spring imagery, coastal and valley freshwater marsh appeared pale brown and rough in texture because the emergent plants (cattails and bulrushes) have died back and have not yet started to grow. In contrast, at this time of year, seasonal wetlands appeared dark green, but are difficult to distinguish from the surrounding annual grassland, which also appears dark green at this time of year. In early winter imagery, both types of wetlands appear dark green, the color of the seasonal wetlands contrasting with the adjacent annual grasslands, which at that time of year appeared brown.

The USFWS's National Wetlands Inventory (NWI) data layer was examined and compared with the aerial photographs to assist in the recognition of additional wetland areas, particularly seasonal wetlands with ambiguous signatures.

Coastal and Valley Freshwater Marsh

Coastal and valley freshwater marsh is dominated by emergent herbaceous plants (reeds, sedges, grasses) with either intermittent flooded or perennially saturated soils. Freshwater marshes are found throughout the coastal drainages of California wherever water slows down and accumulates, even on a temporary or seasonal basis. A freshwater marsh usually features shallow water that is often clogged with dense masses of vegetation, resulting in deep peaty soils. Plant species common to coastal and valley freshwater marsh predominantly consist of cattails (*Typha* spp.), bulrushes (*Schoenoplectus* and *Bolboschoenus* spp.), sedges (*Carex* spp.), and rushes (*Juncus* spp.). Dominant species in perennial freshwater wetland in the study area include rabbitsfoot grass (*Polypogon* sp.), nutsedge (*Cyperus eragrostis*), willow weed (*Persicaria lapathifolia* [*Polygonum lapathifolium*]), and water cress (*Rorippa* spp.). Broadleaf cattail (*Typha latifolia*) and water-primrose (*Ludwigia* spp.) are common associates (Jones & Stokes 2000). Dominant species in nontidal freshwater marsh are narrow-leaved cattail (*Typha angustifolia*), rice cutgrass (*Leersia oryzoides*), bur-reed (*Sparganium eurycarpum*), alkali bulrush (*Bolboschoenus* [*Scirpus*] *robustus*), and perennial peppergrass (*Lepidium latifolium*) (Jones & Stokes 2002).

Coastal and valley freshwater marsh occupy an estimated 381 acres (0.1%) of the study area (**Table 3-7** and **Figure 3-10**). This land cover type is generally found in lowland areas adjacent to diked tidal wetlands, along the margins of lakes and reservoirs, and along the lower reaches of the Guadalupe River and Coyote Creek, upstream of tidal influence (Santa Clara Basin Watershed Management Initiative 2003). Wetlands in the study area range in size from less than an acre to up to 42 acres. The largest wetland can be found along Coyote Creek north of Morgan Hill and just west of U.S. 101. Along the lower reaches of the Guadalupe River and Coyote Creek, freshwater wetlands transition downstream into wetlands influenced by brackish water with less cattail and other freshwater-adapted species to more salt-tolerant species such as California bulrush.

One of the largest freshwater wetlands in southern Santa Clara County is San Felipe Lake, immediately adjacent to the study area in San Benito County and adjacent to Highway 152. San Felipe Lake, sometimes referred to as Soap Lake, is a natural, seasonal lake, fed by Ortega Creek, Pacheco Creek, and Tequisquita Slough. The lake drains through Millers Canal in San Benito County, which in turn feeds the Pajaro River. The lake is part of a large floodplain called Bolsa de San Felipe (RMC 2005).

Covered species that may be found breeding in the coastal and valley freshwater marsh land cover type (**Table 3-5**) include tricolored blackbird, California red-legged frog, California tiger salamander, and western pond turtle. In addition, Bay checkerspot butterfly may move through this land cover type.

Seasonal Wetlands

Seasonal wetlands are freshwater wetlands that support ponded or saturated soil conditions during winter and spring and are dry through the summer and fall until the first substantial rainfall. The vegetation is composed of wetland generalists, such as hyssop loosestrife, cocklebur (*Xanthium* spp.), and Italian ryegrass that typically occur in frequently disturbed sites, such as along streams. Common species in seasonal wetlands within the study area include water cress, water speedwell (*Veronica anagallis-aquatica*), and smartweeds (*Persicaria* [*Polygonum*] spp.) (Jones & Stokes 2000). Other dominant species are California aster (*Symphyotrichum chilense* [*Aster chilensis*]), white sweet clover (*Melilotus albus*), and narrow-leaved cattail (Santa Clara Valley Water District 2002a).

Seasonal alkali wetlands historically occurred in two locations in the study area, around what is now Lake Cunningham in San José (San Francisco Estuary Institute 2006) and in the Soap Lake area near the Pajaro River (San Francisco Estuary Institute 2008). Small remnant stands of seasonal alkali wetlands may still persist in these areas but they were too small to be mapped in our regional mapping effort.

Vernal pools are seasonal wetlands that pond water on the surface for extended durations during winter and spring and dry completely during late spring and summer. They support a typical flora largely composed of native wetland plant species. Vernal pools in eastern Alameda and Contra Costa Counties occur in distinctive topography with low depressions mixed with hummocks or mounds.

Vernal swales and pools have been documented from one location in the study area, on private ranches north of Gilroy (WRA Environmental Consultants 2008). These swales and pools are dominated by meadowfoam (*Limnanthes* spp.), button celery (*Eryngium aristulatum* var. *hooveri*), and calicoflower (*Downingia* spp.).

"Vernal basins," which are seasonal wetland habitats found in grassland swales, have been documented in Coyote Lake-Harvey Bear Ranch (Rana Creek Habitat Restoration 2004)[18]. These basins host a limited flora that includes species such as coyote thistle (*Eryngium vaseyi*), African pricklegrass (*Crypsis vaginiflora*), and flowering quillwort (*Triglochin* [*Lilaea*] *scilloides*). Historically, there may have been more vernal pools and vernal basins in the study area.

[18] Features such as these vernal basins or swales may have been the source of the vernal pool records in California Department of Fish and Game (1998).

Seasonal wetlands were first mapped using only air photo interpretation. When only 25 acres were mapped using this method, we supplemented this approach with additional data (NWI data and large project mapping). As a result, 201acres, (0.04%) of the study area, of seasonal wetlands were mapped in the study area **Table 3-7** and **Figure 3-10**). Seasonal wetlands are likely still underrepresented in the land cover map because of their typically small size, isolated locations, and difficulty in interpreting the photographic signature of individual features. Because the land cover mapping was conducted primarily using aerial photos taken in December (2003 and 2005), some seasonal wetlands may have been mapped as coastal and valley freshwater marsh.

Western burrowing owl, San Joaquin kit fox, and Bay checkerspot butterfly may use seasonal wetlands as movement habitat. Both California tiger salamander and California red-legged frog use this land cover type for breeding and foraging (**Table 3-5**). Western pond turtle uses this land cover type for foraging. Tricolored blackbirds are known to use seasonal wetlands for foraging and breeding habitat.

Fragrant fritillary may occur within seasonal wetland land cover, however, data is insufficient for the study area (**Table 3-6**). This species would be restricted to specific habitat elements and micro-site characteristics within this land cover.

Ecosystem Functions

Function and Integrity

Wetland functional values are provided through several physical and biological processes (National Research Council 2001). Perennial and seasonal wetlands function as essential habitat for amphibians that depend on aquatic environments for reproduction and juvenile development. These wetlands also provide high levels of insect production, which in turn creates a major food source for amphibians, birds, and other insectivorous species. The cyclical nature of inundation and drought in seasonal wetlands allows these systems to support a unique suite of highly adapted biota. Perennial wetlands are permanent water sources during the dry season in an otherwise arid landscape and thus function as essential habitat for a wide variety of water-dependant wildlife.

Wetlands also perform important functions with regard to physical processes. For example, wetlands play an important role in regulating biogeochemical cycles such as the nitrogen cycle. Wetlands also mediate flows in local streams and springs by providing temporary surface water storage and gradual recharge to local aquifers. On a small scale, wetlands in the study area also reduce erosion and sedimentation by reducing surface runoff.

Marshes recharge groundwater supplies and moderate streamflow by providing water to streams. This is an especially important function during periods of drought. The presence of marshes in a watershed helps to reduce damage caused by floods by slowing and storing floodwater. As water moves slowly through a marsh, sediment and other pollutants settle down to the bottom of the marsh. Marsh vegetation and microorganisms also use excess nutrients for growth that can otherwise pollute surface water such as nitrogen and phosphorus from fertilizer.

Natural Disturbance

Seasonal flooding is a key natural disturbance in seasonal wetlands. Marsh and other wetland plant species must tolerate flooding during the growing season and thus be able to tolerate anoxic conditions. Prolonged flooding can kill off wetland plants if the shoots have been destroyed by grazing or fire prior to the flood event (Keddy 2000). Dry periods can function as a disturbance as well. Sediment deposition is a key feature of wetland communities. Seedlings are sensitive to sediment burial, which can prevent or reduce germination (Keddy 2000). As a marsh ages, vegetation accumulates and may fill the pools of open water present which can eventually lead to meadow creation (Faber 1982).

Threats

Threats to wetland land cover types include pollution, grazing, changes in hydrologic regime, conversion to other land uses such as agriculture or urban development, nonnative species invasion, and natural processes such as fire or flood. Fertilizer, pesticides, and untreated sewage contribute to pollution and result in a decrease in oxygen, which can kill vegetation within wetlands. Grazing disturbs the vegetation around marshes and can result in invasion of nonnative plant species into the marsh area (Holland and Keil 1995). The establishment and spread of invasive nonnative species can also result from urban ornamental landscape species (e.g., weeping willow [*Salix babylonica*], red sesbania [*Sesbania punicea*]) that are transported or reseed within drainages and watersheds, ultimately finding their way into downstream wetlands. Hydrologic regime changes can result from the construction of dams and weirs, extraction of groundwater and the creation of artificial drainages. Conversion of land to other uses can lead to the direct loss of wetland habitats as such lands are regraded and/or filled for such uses. In addition, increased stormwater runoff from impermeable surfaces can flow so rapidly into adjacent wetlands that it causes excessive scour and wetland habitat loss. Excessive sediment deposition following fire can virtually fill in wetlands, burying marsh vegetation.

Open Water

Open water land cover types consist of open water or aquatic habitats such as lakes, reservoirs, water-treatment ponds, sloughs, and ponds (including percolation and stock ponds) that do not support emergent vegetation. Open water habitat in the study area is classified into two land cover types.

- Pond.
- Reservoir.

Natural lakes were originally included as a separate land cover type. However, no natural lakes were mapped in the study area and therefore are not discussed below.

Historical Extent and Composition

Open water land cover types were historically less prevalent than they are currently. With only a few exceptions, lakes, reservoirs, and ponds did not exist in the Plan study area until they were built to support livestock and provide a water supply for the population of Santa Clara County.

Very few naturally occurring ponds existed historically in the study area. At least two large perennial freshwater ponds were located along the valley floor in the Coyote Watershed (Grossinger et al. 2006). Beginning in earnest in the mid-1800s with the advent of the gold rush, the population of the Santa Clara Valley grew rapidly. With this growth came ranchers who built hundreds of stock ponds in the study area to water grazing livestock, largely with technical and financial assistance from the U.S. Department of Agriculture (USDA) Soil Conservation Service. Stock ponds continue to dot the study area, including in now-protected open spaces.

Percolation ponds were also built throughout the study area to recharge the groundwater basin during wet and dry seasons. Currently, 71 percolation ponds are managed by SCVWD in the county for this purpose (Santa Clara Valley Water District 2002b). They are actively managed as “industrial water production facilities,” and most are in urbanized areas.

At least one seasonal lake, Laguna Seca, was located at the north end of the area now known as Coyote Valley at the base of the saddle between Tulare Hill and the Santa Theresa Hills (Grossinger et al. 2006). One or two perennial freshwater wetlands, which may have functioned more as a lake than a wetland during the wet season, also existed along the valley floor in the Coyote Creek watershed (Grossinger et al. 2006). These features were drained in 1919 to allow farming in the area.

Most lakes in the study area are man-made reservoirs that were built in the 1930s and 1950s, mostly for water supply purposes. SCVWD owns and operates seven dams and associated reservoirs (Almaden, Anderson, Calero, Coyote, Guadalupe, and Uvas, and Vasona) in the study area for water supply, and one reservoir, Chesbro Reservoir built in 1955, for flood protection and water supply purposes (Santa Clara Valley Water District 2005). Other reservoirs in the study area include the North Fork Pacheco Reservoir (built for agricultural water supply) and several small reservoirs located in unincorporated areas of the County along the western foothills of the Diablo Range.

Common Wildlife Associations

Open water land cover types provide drinking water, as well as foraging, breeding, and resting habitat for a variety of terrestrial and aquatic wildlife, including birds, amphibians, reptiles, and large mammals. Reptiles such as western pond turtle and garter snakes use available water resources and the vegetation surrounding open waters as habitat. Mammals use all types of open water resources for drinking and hunting.

All open water land cover types support a variety of ducks including mallard, green-winged teal, cinnamon teal (*Anas cyanoptera*), gadwall (*A. strepera*), American wigeon (*A. americana*), and American coot. Raccoons forage for adult and larval amphibians, fish, and crayfish.

Ponds attract many birds that are normally found in the adjacent grasslands; for example, California quail, mourning dove, and barn and cliff swallows (*Hirundo rustica* and *H. pyrrhonota*) all require daily water and are known to use ponds as water sources. The tricolored blackbird relies on vegetation associated with ponds (cattails and bulrush) for nesting. Many covered species, including California tiger salamander, California red-legged frog, and western pond turtle, use ponds as essential habitat; western pond turtle can be found inhabiting perennial ponds year-round and nesting in adjacent upland habitat during the nesting period. Ponds that contain either submerged or emergent vegetation are of particular importance to native amphibians as breeding habitat, although in ponds with little or no vegetation, California tiger salamander females may attach eggs to objects, such as rocks and boards on the bottom (Jennings and Hayes 1994). In perennial ponds, nonnative bass (*Micropterus* ssp.) and bullfrog (*Rana catesbeiana*) are common and are often prevalent wildlife species. Bass and bullfrog are known to prey on special-status California red-legged frog and California tiger salamander and, as such, the presence of bullfrogs and bass limits the opportunity for success of these covered species.

Percolation ponds have minimal habitat values due to their location in urban areas. Percolation ponds require aggressive maintenance to maintain percolation capacity and preserve groundwater recharge for the water supply. Ponds with wetland fringe habitat (i.e., emergent vegetation) provide potential habitat for western pond turtle, California red-legged frog, and California tiger salamander. Most percolation ponds have only marginal habitat value for the covered species.

Reservoirs support several gull species as well as raptors that fish out of the lake and often nest in tall trees nearby. Shore and wading birds including killdeer, black-necked stilt, greater yellowlegs, and several gull species are found in and at the edges of reservoirs within the study area. Reservoirs provide habitat for some native fish such as hitch, Sacramento blackfish, California roach, and Sacramento sucker, but favor nonnative fish such as bluegills, sunfish, brown bullheads, carp, goldfish and largemouth bass. Reservoirs can also provide suitable rearing habitat for non-migratory rainbow trout if conditions are favorable. Reservoirs also promote the presence of nonnative fish in the watershed by providing suitable habitat. Nonnative fish often prey on native fish; for example, largemouth bass may prey on juvenile steelhead trout (Santa Clara Basin Watershed Management Initiative 2003).

Covered species found within the open water community include Bay checkerspot butterfly (for movement), California tiger salamander, California red-legged frog, western pond turtle, and tricolored blackbird.

Open Water Land Cover Types

Ponds

Ponds are small (less than 20 acres) perennial or seasonal water bodies with little or no vegetation. If vegetation is present, it is typically submerged or floating. Ponds may occur naturally or may be created or expanded for livestock use (stock ponds). All ponds discernible on aerial photographs were mapped.

Ponds were easily discernible on the basis of two distinctive aerial photograph signatures. One signature—smooth, uniform, and dark black—indicates deeper and less turbid ponds. The other signature—light gray-brown—generally indicates a shallower or more turbid pond. The latter signature was more difficult to discern on the aerial photographs and in some cases required field verification or corroboration with other wetland mapping (e.g., National Wetland Inventory). Where discernible, this land cover type was mapped to the high water line. Some wetland land cover types were likely included as ponds if vegetation was sparse or not visible on photos. The minimum mapping unit was 0.25 acre.

Off-stream groundwater recharge ponds, (commonly referred to as *percolation ponds*) are used in the study area in the following locations (Santa Clara Basin Watershed Management Initiative 2003):

- along Los Gatos Creek downstream of Lexington and Vasona Reservoirs;
- along Alamitos Creek, Guadalupe Creek, and the Guadalupe River downstream of Almaden, Calero, and Guadalupe Reservoirs;
- along Coyote Creek downstream of Anderson Reservoir; and
- along Llagas Creek downstream of Chesbro Reservoir.

Percolation ponds are located at sites where gravels and sands have been naturally deposited at or near ground level and where water can soak down most easily into the aquifer(s) (Santa Clara Valley Water District 1978 as cited in Santa Clara Basin Watershed Management Initiative 2003). These ponds are designed to allow infiltration of water at specified rates and must be cleaned out periodically when fine sediments build up, impeding percolation. These off-stream ponds are filled in the winter months with natural flow from rainwater. During the drier months, the SCVWD augments groundwater recharge in percolation ponds with imported water, including water from the Central Valley Project (Santa Clara Basin Watershed Management Initiative 2003).

Stock ponds are also used throughout the study area to provide water to grazing livestock. Lands historically used for grazing, but currently protected as open space, also contain old stock ponds that may be in disrepair. One example is in Henry W. Coe State Park where many stock ponds still exist (A. Palcovik pers. comm.). Many of these ponds currently support California red-legged frog or California tiger salamander. Park managers have reclaimed some ponds, returning them to a more natural state. Pond reclamation typically includes removal of the dam. The result is a shortened or eliminated hydroperiod of standing water, which may reduce the habitat value for covered species.

Pond vegetation is influenced by surrounding land use, livestock and wildlife activity, and site soil and hydrology. Plants often associated with ponds include floating plants such as duckweed (*Lemna* spp.) or rooted plants such as cattails, bulrushes, sedges, rushes, water cress, and water-primrose. Stock ponds are often surrounded by grazing land with grazing livestock. Immediately adjacent to the stock pond, soil may be exposed due to the continued presence of livestock or wildlife (e.g., feral pigs). As a result, many stock ponds are devoid of vegetation. Covered species, such as California tiger salamander may still use this habitat for breeding. Females may attach eggs to objects, such as rocks and boards on the bottom (Jennings and Hayes 1994). Stock ponds, removed from grazing pressures or excessive wildlife activity, may be surrounded by wetland vegetation including willows, cattails, reeds, bulrushes, sedges, and tules (*Schoenoplectus* [*Scirpus*] *californicus*) if the appropriate soil and hydrology is also present. Land uses surrounding percolation ponds may vary depending on the location of the pond. Percolation ponds are often found in more urbanized areas; therefore, the vegetated buffer may be narrower than it would be in a natural setting or managed for weed abatement.

Ponds are scattered throughout the study area, with the heaviest concentrations in the southeast corner of the study area, away from urbanized areas. **Figure 3-13** depicts the distribution of pond density in the study area. There are an estimated 716 ponds that occupy approximately 1,110 acres (0.2%) of the study area (**Table 3-7** and **Figure 3-10**).

Several species covered by this Plan can be found in or using ponds including California tiger salamander, California red-legged frog, western pond turtle, and tricolored blackbird. Bay checkerspot butterfly may pass over ponds on their way to habitat patches.

Reservoirs

Reservoirs are large open water bodies, greater than 20 acres that are highly managed for water storage, water supply, flood protection, or recreational uses. These features were easily targeted on aerial photographs based on the smooth, uniform, dark signatures of open water. Where discernible, reservoirs were mapped to the high water line. The high water line was observed on the aerial photographs as either obvious rings of sparse vegetation or an open water signature.

Plants often associated with reservoirs include those plants common to deep water systems. Algae are the predominant plant life found in the open waters of reservoirs. Depending on reservoir temperature, water level, and other environmental conditions, algal blooms may occur, resulting in thick algal maps on the surface of the reservoir. If the reservoir edges are shallow, plant species similar to those found in ponds may be present. If the reservoir has steeper edges, water depth and fluctuations in reservoir height may prevent the establishment of vegetation. Upland and riparian trees that were not removed during the construction of the reservoir, or that were planted afterwards, may be present around the perimeter of the reservoir. Fluctuations in water levels may also affect the type of shoreline habitat that occurs around reservoirs (Santa Clara Basin Watershed Management Initiative 2003). The upstream end of several reservoirs including Coyote Reservoir support large and important stands of riparian forest and woodland (these areas were mapped as riparian woodland).

Surrounding land uses at reservoirs vary depending on the location of the reservoir and the land cover type present in the area prior to reservoir development. Reservoirs are dispersed throughout the study area. Vasona, Guadalupe, and Almaden Reservoirs are located on the western border of the study area. Calero, Chesbro, and Uvas Reservoirs are located in the foothills of the Santa Cruz Mountains, west of Coyote Valley, Morgan Hill, and San Martin. Anderson and Coyote Reservoirs are located in the foothills of the Diablo Range, east of Morgan Hill and San Martin. Pacheco Reservoir is located in the southeast corner of the County, north of SR 152. Reservoirs occupy approximately 2,767 acres (0.6%) of the study area in 18 locations (**Table 3-7** and **Figure 3-10**).

Species covered by this Plan that may be found living in or using reservoirs are western pond turtle and tricolored blackbird.

Ecosystem Functions

Function and Integrity

Open water land cover types perform a variety of functions in both biological and physical terms. Biologically, water is the most critical component required to support the lifecycle of all aquatic and terrestrial species. Open water land cover types support the species at the lowest level of the food chain, algae. Aquatic invertebrates feed on algae and other plant debris in creeks, ponds, and reservoirs. In turn, these invertebrates become food for fish, birds, bats, and other insect-feeding species. The cycle continues, supporting species of the highest trophic levels including coyotes, mountain lions, and humans.

Ponds enhance all other habitats in terms of value for wildlife. Mammals, birds, reptiles, and amphibians from adjacent habitats are likely to use ponds en route to surrounding areas (Santa Clara Basin Watershed Management Initiative 2003). Many upland species rely on streams and ponds as water sources, especially during the dry summer months.

Percolation ponds, while often seasonally stable in water level, are highly manipulated and provide varying degrees of habitat value. While emergent vegetation frequently develops along the shoreline of percolation ponds, the buffer zone between these emergent wetlands and adjacent urban land uses, such as parks or housing, limit wildlife access and use of these ponds by mammals, amphibians, and reptiles. While birds maintain access to percolation ponds, human activity and domestic pets around the shoreline limit nesting by waterfowl and other birds (Santa Clara Basin Watershed Management Initiative 2003). Periodic maintenance of percolation ponds can interrupt aquatic system functions, resulting in the loss of those primary food chain constituents such as detritus, algae, and emergent vegetation.

Reservoirs are sediment sinks, obstructing the natural sediment transport of streams. Through natural processes, streams erode sediment from stream banks and move it down stream. In an unimpeded setting, sediment carried from the upper watershed is deposited along the length of the stream, thus creating an equilibrium of eroded and deposited sediment. When a dam is built across a stream, all but some of the finest sediment transported from the upper watershed drops out of suspension in the reservoir, where velocities are too low to maintain the sediment load. The resulting effect is that downstream reaches are sediment-starved, and no new sediment is available to replace eroded sediment downstream of the dam. This results in the stream downcutting and deepening and also results in a reduction in gravels downstream of reservoirs. In addition, large reservoirs fill with and store large amounts of turbid storm runoff. Settling of the finer clay and silt particles may take months, resulting in persistent releases of turbid water in winter and early spring. The slowly settling materials may also result in much higher turbidities near the bottom outlet valve than in the surface waters. While the natural streams upstream of reservoirs rapidly clear between storms, the streams downstream of reservoirs may be persistently turbid. In addition, the slowly released fine sediments may result in silty substrate below the reservoirs, reducing abundance of insects. During parts of the year, the reservoir conditions may produce bioturbidity from organic production in the water column. Turbidity can also be caused by bio-productivity in the water column, which may affect the efficiency of visual feeding organisms.

Reservoirs disrupt the natural flow cycle of streams. In addition, because the reservoirs are deep and store cool winter runoff, the water released out of the bottom of the reservoir can be much cooler than the surface water and also cooler than the stream upstream of the reservoir in late spring and summer.

Natural Disturbance

The role of disturbance in open water land cover types focuses on the mixing of water from the surface to the bottom. Wind contributes heavily to mixing of water in ponds and lakes. Mixing brings oxygen to the bottom of ponds and lakes while releasing nutrients into the water column that will feed plants and invertebrates. Disturbances to standing water bodies often relate to *eutrophication*, the natural processes by which excessive nutrients are deposited into the water body, stimulating plant growth. This rapid plant growth, often referred to as an *algal bloom*, reduces dissolved oxygen in the water as anaerobic microbes break down dead plant material. Reduced levels of dissolved oxygen, as well as reduced penetration of sunlight into the water, often lead to the die-off of other aquatic organisms. Eutrophication eventually leads to the filling in of the water body. Both ponds and reservoirs are susceptible to rapid eutrophication. In urbanized areas, or in areas with septic tanks or grazing livestock, this process is enhanced by excess nutrient input. Oxygen-depleting algal blooms may lead to fish kills.

Reservoirs may also suffer from a lack of mixing surface waters with water at deeper depths. Mixing distributes oxygen to the reservoir floor, preventing anaerobic conditions that may reduce the dissolved oxygen in the reservoir. Maintaining appropriate levels of dissolved oxygen is important for aquatic life in the reservoir and downstream of the reservoir, as well as for drinking water supplies. Dissolved oxygen levels are also affected by water temperature. Warmer water contains lower levels of dissolved oxygen.

Threats

Open water land cover types are threatened by pollution; livestock disturbance, including trampling and excessive nutrient inputs leading to rapid eutrophication; high water flows which cause erosion; habitat destruction; and unnatural channel modification resulting from the need to contain flows. The manipulation of otherwise natural processes (flooding, natural stream meandering) changes the ecosystem function of aquatic communities and generally reduces overall biodiversity and native survivorship by eliminating a dynamic component of the ecosystem. The various open water land cover types have different primary threats, as described below.

Pond breaching, berm failure, livestock and wildlife impacts, including feral pigs, and inadequate management practices can increase soil erosion and result in increased sedimentation of the pond (Hamilton and Jepson 1940; Prunuske 1987). This reduces habitat quality for amphibian habitat. Alternatively, ponds with insufficient turbidity provide inadequate cover for California tiger salamander larvae (69 FR 47216). Heavy livestock and excessive wildlife use (e.g., feral pigs) use can degrade ponds quickly, leading to loss of emergent vegetation and eutrophication from increased nitrogen due to cattle urine. High flows cause erosion, unless fully cemented channels are in place. To control flooding, channels are modified in an unnatural way (i.e., placement of rip rap, lined with concrete) and results in a decrease of riparian vegetation and aquatic habitat for fish and other species. Some cities are working to address this issue. For example, the City of San José requires that riparian vegetation be avoided during construction activities, and if it cannot be avoided, mitigation is required. Mitigation requires replacement of riparian vegetation and/or compensation for any adverse affects to creeks (City of San José 2005). Additionally, pollution sources along the channels can degrade water quality within riverine systems.

Irrigated Agriculture

Irrigated agriculture encompasses all areas where the native vegetation has been cleared for irrigated agricultural use. This natural community does not include rangeland, which is often characterized as an agricultural land use. The irrigated agriculture community is classified into four land cover types.

- Orchard.
- Vineyard.
- Agriculture developed.
- Grain, row-crop, hay and pasture, disked/short-term fallowed[19].

In all of these cases, the land may have been irrigated in the past but show little or no sign of irrigation currently (e.g., fallow fields). In some instances these

[19] This land cover type may or may not be irrigated.

land cover types were indistinguishable on aerial photographs (e.g., newly planted orchards strongly resemble row crops). In such cases the area in question was mapped as grain, row-crop, hay and pasture, and disked/short-term fallowed.

Historical Extent and Composition

Father Junípero Serra gave Santa Clara Valley its name when he consecrated the Mission Santa Clara de Asis in 1777 (National Park Service 2006). The establishment of the mission also heralded the beginning of large-scale agriculture in the Santa Clara Valley. Soon, the Guadalupe River dam (located near Mission Santa Clara) was constructed for irrigation of wheat, corn, bean, and other crops. Fruit trees and grapes were also cultivated. Settlers' accounts during 1850 describe the whole plain of Alameda County to San José as a vast unfenced field of grain (Santa Clara Basin Watershed Management Initiative 2003).

The Santa Clara Valley has experienced continued population growth since 1850. By 1866, artesian wells could no longer meet water demands. In 1870, Los Gatos Creek was diverted in order to meet the water demands for agriculture and a booming population (Santa Clara Basin Watershed Management Initiative 2003). Agricultural success in the Santa Clara Valley was supported by access to railroads that could take goods to port. Large aquifers were also discovered underlying the valley and were tapped by artesian wells. These two factors bolstered a rapid increase in agriculture in the region. The area produced carrots, almonds, tomatoes, prunes, apricots, plums, walnuts, cherries, and pears for the world market (National Park Service 2006). In 1870, seed farms became another dominant form of agriculture in the valley. Other agricultural commodities harvested from the Santa Clara Valley included lumber and grapes for wineries (National Park Service 2006).

By 1930, there were 120,000 acres of orchards in production (Santa Clara Basin Watershed Management Initiative 2003). The Santa Clara Valley remained largely rural and agricultural, supporting farms, orchards, wineries, and ranches until after World War II (National Park Service 2006). Due to an increased demand for urban services, there was a one-third reduction in the amount of cultivated lands between 1947 and 1961 (Santa Clara Basin Watershed Management Initiative 2003). Despite these changes, the South Valley in Santa Clara County continues to support rural homesteads and agriculture.

Common Wildlife Associations

Some native wildlife, such as small mammals, certain raptors, and migratory waterfowl, utilize irrigated agriculture seasonally or year-round. Year-round activity tends to be concentrated along the margins of active farmland where vegetation is less disturbed or where trees and shrubs tend to occur (some are planted deliberately as windbreaks). Open fields that are irrigated for forage crops are also used by wildlife. Cultivated agriculture is bisected by streams, ditches, and channels. Some amphibians and reptiles utilize these linear aquatic features and the adjacent upland habitat.

Orchard and vineyard fruits attract common wildlife species such as scrub-jay, European starling (*Sturnus vulgaris*), western tanager (*Piranga ludoviciana*), Brewer's blackbird, American crow, yellow-billed magpie (*Pica nuttalli*), raccoon, opossum, California vole, and coyote. Orchards and vineyards that are not plowed provide foraging, cover, and denning sites for native gray fox and nonnative red fox (*Vulpes vulpes*), burrowing owl, California ground squirrel, and various gophers, mice, and snakes (Santa Clara Basin Watershed Management Initiative 2003). Insects are important pollinators of blossoms to ensure fruit. Owls and other raptors such as white-tailed kite, red-shouldered hawk, red-tailed hawk, and burrowing owl feed on rodents and insects found in orchards and vineyards. Old buildings and barns may provide shelter for bats and owls (Santa Clara Basin Watershed Management Initiative 2003).

Data collected in Sonoma County indicate that vineyards generally support a far higher abundance of nonnative predators such as red fox and feral cats than do adjacent natural habitats (Hilty and Merenlender 2004). Other common wildlife species found in most vineyards include California ground squirrel, European starling, and Brewer's blackbird. As in other forms of agriculture, site-specific production methods are directly correlated with wildlife use. Some vineyard practices may encourage habitat use by birds of prey such as American kestrel and great horned owl (Locke 2002). Wildlife use of vineyards may be related to the timing and intensity of pesticide application with heavy pesticide use decreasing wildlife use and reproductive success.

Dryland crops are usually established on fertile soils that have historically supported a variety of wildlife (Mayer and Laudenslayer 1988). Although grain cropland cover supports reduced wildlife habitat richness and diversity for native species, it does support a greater variety of wildlife species than traditional irrigated agricultural land cover (e.g., vineyards and orchards). Short-grass habitat associated with dryland grain production is compatible with foraging by raptors such as western burrowing owl. During winter, this type of agricultural land also provides important foraging and roosting habitat for wintering waterfowl.

Pastures support a variety of wildlife, particularly ground-nesting birds such as western meadowlarks (*Sturnella neglecta*). Irrigated pasture, particularly alfalfa, can provide a variety of wildlife benefits due to its relatively high production of small rodents. Several birds that forage in open grasslands, such as white-tailed kites and great blue herons, may also use this land cover type.

Irrigated Agriculture Land Cover Types

Orchard

Orchards are those areas planted in fruit-bearing trees. Orchard was distinguished on the basis of its tree cover, canopy characteristics, and distinctive production rows. In Santa Clara County, orchards mostly include apricots, cherries, prunes, and walnuts (County of Santa Clara, Department of Agriculture 2004).

Orchards comprise an estimated 2,697 acres (0.06%) of the study area (**Table 3-7** and **Figure 3-10**). Orchards are scattered in relatively small patches throughout the Santa Clara Valley floor from the southern point of San José south to the county line. The largest patch of orchard is found in Coyote Valley in the area designated as the Coyote Greenbelt. Small orchards are also present south of Highway 130 in the Diablo Range foothills.

Some covered species may be found in orchards. For example, where natural open spaces abut, some individuals of San Joaquin kit fox may forage in and disperse through orchards. Western burrowing owl may forage in and move through orchards. Tricolored blackbirds may move through and/ or forage in and over orchards. Bay checkerspot butterfly, California red-legged frog and California tiger salamander may migrate through orchards between areas of suitable habitat. Western pond turtle may nest along the open margins of orchards, particularly if situated adjacent to suitable aquatic habitat (**Table 3-5**).

Vineyard

Vineyard was identified on the basis of its row production pattern and canopy characteristics. Vineyards appeared similar to orchards on the aerial photographs but were characterized by more closely spaced rows with a smaller, less dense vegetation canopy.

Vineyards occupy 1,393 acres (0.3%) of the study area (**Table 3-7** and **Figure 3-10**).Vineyards are mostly located in the southern portion of the county, in the foothills west of San Martin, along Uvas Creek and its tributary Little Arthur Creek, and along SR 152 east of Gilroy. Similar covered species are expected to be found in vineyards as in orchards, with the exception of burrowing owl (**Table 3-5**).

Agriculture Developed

Agriculture developed was identified by the presence of large agricultural buildings such as greenhouses, shadehouses, nurseries, corrals, or dairies. These intensive uses were found within agricultural areas rather than urban settings. Air photo signatures were generally distinctive because of their large agricultural structures or high densities of livestock.

This land cover type occupies 1,935 acres (0.4%) of the study area in small patches scattered throughout the Santa Clara Valley from Coyote Valley to the county line (**Table 3-7** and **Figure 3-10**). Covered species that may be found in this land cover type include western burrowing owl (e.g., in some of the larger corrals that may be less intensively used), tricolored blackbird, and migrating Bay checkerspot butterfly and San Joaquin kit fox (**Table 3-5**).

Grain, Row-Crop, Hay and Pasture, Disked/Short-Term Fallowed

Tilled land not appearing in the aerial photographs to support orchard or vineyard was mapped as grain, row-crop, hay and pasture, disked/short-term fallowed. *Grain, row-crop, hay and pasture, disked/short-term fallowed* is the most common of the agriculture land cover types in the low-lying areas of the study area, occupying 33,648 acres (7.3%) of the study area (**Table 3-7** and **Figure 3-10**). These lands are abundant throughout the Santa Clara Valley south of San José, and are most dense just north of the southern county border.

Row-crops are those areas tilled and cultivated for agricultural crops such as corn, lettuce, peppers, and pumpkins. *Fallow fields* include fields that were not in production at the time aerial photos and/or site visits were conducted, but may be utilized for grain, row-crops, and hay and pasture in subsequent years. This land cover type includes ruderal areas that had been left fallow for several growing seasons. Ruderal sites may be dominated by weeds such as black mustard or thistles.

Hay and *pasture* include both dryland settings and irrigated areas. The key difference between hay production and pasture is that crops are harvested on site and consumed off site, whereas pasture is consumed by livestock on site (hay is also cut, bailed, and trucked off site). In addition to production for consumption, hay is also produced in Santa Clara Valley for grain. The pasture land cover type consists of fast-growing annual and perennial grasses mixed with irrigated forage crops in the legume family. Pastures typically function as onsite sources of forage for livestock. These areas are distinguished from other cultivated land types by the presence of livestock and livestock fencing (paddocks). Pastures tend to occur in lowland areas adjacent to cropland. Pasture was mapped on aerial photographs based on its location and smooth texture on the photographs, indicating land that is covered by vegetation and not currently tilled for cropland.

Common vegetation includes fast-growing forage grasses, such as wild oats and Italian ryegrass, as well as irrigated legumes such as alfalfa (*Medicago sativa*), sweet clover (*Melilotus* spp.), and true clover (*Trifolium* spp.). In some areas, nonnative weedy vegetation, such as thistles, mustards, and a variety of other weedy forbs, are also common.

Covered species expected to be found in this land cover type are tricolored blackbird, and western burrowing owl all of which forage in grain crops and pastures (**Table 3-5**). Tricolored blackbird and western burrowing owls may also breed in agricultural settings. San Joaquin kit fox may move through this land cover type if it occurs near suitable grassland areas. California tiger salamander, California red-legged frog, and western pond turtle move through croplands to reach suitable breeding and aestivation habitat. Bay checkerspot butterfly migrate through these habitats between patches of serpentine grassland.

Ecosystem Functions

Function and Integrity

This land cover type has relatively low value for native plants and wildlife in terms of habitat that supports full lifecycle needs. Nonetheless, agriculture does provide some benefit, although species composition depends heavily on the planting cycle. For example, cropland has a higher value for terrestrial mammals (e.g., black-tailed jackrabbit) and herbivorous birds (e.g., red-winged blackbird) near harvest time, when the standing crop is mature and produces a quantity of food (e.g., fruit, seeds), than it does after the harvest when the cropland is fallow. Agricultural production methods can also have an impact on wildlife use. For example, production practices such as *clean farming*, where farm edges are maintained as vegetation-free areas, reduce cover and movement opportunities for wildlife; on the other hand, *wildlife friendly farming*, where native cover crops and hedge rows are used between crops and on farm edges, can increase opportunities for wildlife use in croplands.

In addition, agricultural lands often play a key role in providing connectivity between larger open space areas, especially in urbanizing areas such as the Santa Clara Valley. Maintaining connectivity between open space patches that provide habitat supports a diversified genetic pool due to the ability of populations to disperse and co-mingle. Agriculture also often is associated with streams, canals, and ditches used for irrigation that may support riparian vegetation, trees (planted as windbreaks), and shrubs. These areas may provide habitat to songbirds, raptors, amphibians and reptiles, as well as provide a movement corridor for other species.

Natural Disturbance

Disturbances common to cropland, orchards, and vineyards relate to the standard operations of farming practices. Seasonal tilling, planting, and harvesting prevent the long-term establishment of plants or animal burrows on this land. Management practices also usually include the application of pesticides, discouraging the establishment of plants or presence of wildlife. Furthermore, offsite drift may harm wildlife or plants in adjacent open space areas.

Threats

Orchards, vineyards, and row-crops are often found in areas of low to moderate topographical variation—areas such as valley floors or foothills. In these areas, the major threat to irrigated agriculture is land conversion to urban uses, often as residential housing.

Developed

Developed land cover types were mapped and described for the study area in order to describe the extent and distribution of modified lands. Developed areas were classified into the land cover types listed below.

- Urban-suburban.
- Rural-residential.
- Barren.
- Landfill.
- Golf courses/urban parks.
- Ornamental woodland.

Developed land cover types were mapped on the basis of their distinct signatures on aerial photographs and are readily distinguishable from naturally occurring signatures in any terrain. The minimum mapping unit for all developed land cover types was 10 acres.

Common Wildlife Associations

Developed, or urban, areas tend to support a low diversity of wildlife (Dickman 1987; Gilbert 1989). However, what species do exist in urban areas tend to be present at greater concentrations than is typical of other habitat types (Gilbert 1989). A limited number of mostly nonnative species such as dogs, cats, house mice, Norway brown rats, pigeons, European starlings, and opossums thrive in urbanized habitats in the study area (Santa Clara Basin Watershed Management Initiative 2003).

Several species are common to urban areas, including a variety of bird species that adapt well to urban landscapes. Typical bird species found in the urban landscape include the American robin (*Turdus migratorius*), mockingbird (*Mimus polyglottos*), American crow (*Corvus brachyrhynchos*), and European house sparrow (*Passer domesticus*). These species are typically generalized opportunistic foragers that are highly tolerant of human activity. Few special-status avian species occur in urban areas, however, there are some notable exceptions. As discussed below, western burrowing owl, covered in this Plan, may be found in ruderal or barren remnant patches in urban areas. Peregrine falcons (*Falco peregrinus*) are found even in downtown San José, where one pair nested in 2006. In 2006 a colony of approximately 200 red-winged blackbirds and tricolored blackbirds was documented during field work for this project using the southern fringe of a pond located adjacent to U.S. 101 in a vacant lot in Morgan Hill.

Some wildlife species are abundant in the ruderal areas of agricultural sites where there is no disturbance from tilling and pest control measures. This is especially true for burrowing mammals such as California ground squirrels. Western fence lizards and gopher snakes, which often use mammal burrows for cover, are also more common in these urban areas. Other common wildlife found in urban areas include rodents, grey squirrel, opossum, raccoon, and skunk. Other wildlife, once less common in urban areas but now on the rise across the country, include deer, coyote, and wild turkeys.

Ornamental woodlands, including eucalyptus stands, are occasionally planted as wood lots or shelter belts. The overall wildlife value of ornamental woodlands is highly variable and depends on the species planted. For example, eucalyptus trees provide night roosts, foraging perches, and nest sites for a few bird species, particularly raptors. Eucalyptus bark peels can create microhabitats for some small vertebrate species, such as alligator lizards and woodrats (Santa Clara Basin Watershed Management Initiative 2003).

Developed Land Cover Types

Developed areas comprise all types of development for residential, commercial, industrial, transportation, landfill, landscaping, and recreational uses (e.g., sites with structures, paved surfaces, horticultural plantings, golf courses, and irrigated lawns). Developed sites were mapped on the basis of their distinct signatures on aerial photographs. Developed areas are often characterized by geometric or regular shapes, and are readily distinguished from naturally occurring signatures in any terrain. This category was separated into six land cover types: urban-suburban, rural residential, barren, landfill, golf courses/urban parks, and ornamental woodland.

Urban-Suburban

The *urban-suburban* land cover comprises areas where the native vegetation has been cleared for residential, commercial, industrial, transportation, or recreational structures, and is defined as one or more structures per 2.5 acres. These include areas that have structures, paved and impermeable surfaces, horticultural plantings, and lawns smaller than 10 acres (irrigated lawns larger than 10 acres were mapped as urban parks). Many small, rural residential areas were observed in the inventory area. Such areas were mapped as urban if they exhibited at least 10 acres of buildings, turf, and pavement. Rural residential areas of less than 10 acres that were adjacent to or surrounded by agriculture and/or natural land cover types were mapped as the adjacent land cover type. Parcels of non-urban land cover types within the study area on which development projects were already approved were mapped as urban-suburban.

Vegetation found in the urban-suburban land cover type is usually in the form of landscaped residences, planted street trees (i.e., elm, ash, liquidambar, pine, palm), and parklands. Most of the vegetation is composed of nonnative or cultivated plant species. One invasive nonnative tree, the tree-of-heaven, has become established in yards and vacant lots in the City of San José area (Santa Clara Basin Watershed Management Initiative 2003).

The major urban-suburban area in the study area is San José, located in the northern portion of the Santa Clara Valley. Other urban-suburban areas include areas within Morgan Hill and Gilroy. Urban-suburban areas comprise 89,438 acres (19.4%) of the study area (**Table 3-7** and **Figure 3-10**).

It is unlikely that any covered species would be found in urban-suburban areas; however, Bay checkerspot butterfly may migrate across urban-suburban areas (i.e., parking lots) between patches of serpentine grassland. Still, this land cover type is largely characterized by impermeable surfaces and extreme hazards to wildlife that provide no habitat value.

Rural Residential

The *rural residential* land cover type is similar to the urban-suburban type except that it is typically much less dense (defined as less than 1 structure per 2.5 acres) and usually contains extensive landscaping and/or irrigated lands (including small areas of pasture).

Rural residential areas are mainly located in the foothills along the eastern edge of San José, at the southern point of San José near Almaden Quicksilver County Park and Santa Teresa County Park, and south of Morgan Hill and north of Gilroy. Rural residential areas comprise 12,414acres (2.7%) of the study area (**Table 3-7** and **Figure 3-10**).

Several covered species may be found in rural residential areas. Species such as California red-legged frog, western pond turtle, western burrowing owl, tricolored blackbird, or San Joaquin kit fox may move through rural residential land cover if it occurs adjacent to or near open space. Bay checkerspot butterfly will move through rural residential areas to disperse between patches of serpentine grassland. Rural residential areas that contain small patches of serpentine soils may be used by dispersing Bay checkerspot butterflies as temporary foraging sites.

Barren

Barren land cover types are non-agricultural areas that have been historically and recently disturbed. Land uses in this type include aggregate facilities and mine tailings. Barren land use types are uncommon throughout the study area. Barren land use types comprise only 211 acres (0.05%) of the study area in 6 locations.

While barren landscapes do not provide high quality for most covered species, this land cover type is often suitable for foraging and breeding western burrowing owls (**Table 3-5**). San Joaquin kit fox and tricolored blackbird may move through and/or forage in barren areas. California tiger salamander, California red-legged frog and Bay checkerspot butterfly may migrate through barren areas between habitat patches.

Landfill

Landfills are those areas where vegetation has been cleared and large amounts of soil have been moved for solid waste disposal. Typically, these areas are excavated pits into which refuse is placed and compacted. After a landfill is closed and capped, it may be returned to natural habitats through planting and management. Only active landfills were mapped in this category.

There are three landfills within the study area: San José's Guadalupe and Kirby Canyon landfills, and a landfill east of Gilroy. The Guadalupe landfill is located on the border of the study area; it has a 411-acre permitted facility boundary and a 115-acre permitted disposal area. Eighty-eight acres of this facility (21%) is inside the study area. The Kirby Canyon landfill has a 760-acre facility boundary and a 311-acre disposal area, all of which is in the study area. The Gilroy landfill is approximately 82 acres.

Landfills were mapped as occurring on 364 acres (0.02%) of the study area (**Table 3-7** and **Figure 3-10**). The difference in mapped acreage and locally-approved boundaries indicates that the landfills are expected to expand in the future.

Landfills are highly disturbed areas while in use. They often attract some wildlife such as gulls, crows, pigeons, and rats. The only covered species that may be found in landfill areas is Bay checkerspot butterfly as it migrates between suitable habitat patches.

Golf Courses/Urban Parks

Urban parks are located within cities in the study area and tend to be smaller in scale than a county or regional park. Many serve as neighborhood or community parks.

Urban parks and *golf courses* are located throughout the urbanized areas of the study area. Urban parks and golf courses comprise 8,673 acres (1.9%) of the study area (**Table 3-7** and **Figure 3-10**).

Golf courses and urban parks provide limited habitat for native wildlife. Urban parks are unlikely to support any covered species. Golf courses on the fringe of urban areas are known to support California tiger salamander, California red-legged frog, western pond turtle, western burrowing owl, San Joaquin kit fox or tricolored blackbird, particularly if ponds are present on or near the golf course (**Table 3-5**). Bay checkerspot butterfly may migrate through this land cover type between habitat patches.

Ornamental Woodland

Ornamental woodlands are those areas where ornamental and other introduced species of trees, including Eucalyptus, have been planted or naturalized and dominate, forming an open to dense canopy.

Ornamental woodland was mapped primarily in areas surrounded by development, where the signatures on aerial photographs and locations did not meet the characteristics of oak or riparian woodlands. Ornamental woodland was included as a separate land cover type because some stands could provide suitable habitat for raptors. The ornamental woodlands land cover type comprises only 95 acres (0.02%) of the study area (**Table 3-7** and **Figure 3-10**).

While ornamental woodland land cover does not provide appropriate habitat for most covered species, this land cover type may support breeding raptors.

Table 3-1. Natural Community Classification and Land Cover Types

Natural Community	Land Cover Type	Sensitive Land Cover Type*
Grassland	California annual grassland	
	Non-serpentine native grassland (not mapped)	✓
	Serpentine bunchgrass grassland	✓
	Serpentine rock outcrop	✓
	Serpentine seep	✓
	Rock outcrop	
Chaparral and Northern Coastal Scrub	Northern mixed chaparral/chamise chaparral	
	Mixed serpentine chaparral	✓
	Northern coastal scrub/Diablan sage scrub	
	Coyote brush scrub	
Oak Woodland	Valley oak woodland	✓
	Mixed oak woodland and forest	
	Blue oak woodland	
	Coast live oak forest and woodland	
	Foothill pine—oak woodland	
	Mixed evergreen forest	
Riparian Forest and Scrub	Willow riparian forest and scrub	
	Central California sycamore alluvial woodland	✓
	Mixed riparian forest and woodland	
	Riverine (also called streams)	
Conifer Woodland	Redwood forest	
	Ponderosa pine woodland	
	Knobcone pine woodland	
Wetland	Coastal and valley freshwater marsh	✓
	Seasonal wetland	✓
Open Water (Aquatic)	Pond	
	Reservoir	
Agriculture	Orchard	
	Vineyard	
	Agriculture developed	
	Grain, row-crop, hay and pasture, disked/ short-term fallowed	
Developed	Urban-Suburban	
	Rural residential (<1 unit per 2.5 acres)	
	Golf courses / Urban parks	
	Landfill	
	Ornamental woodland	
	Barren	

* Equivalent to sensitive natural communities as defined by the California Department of Fish and Game (California Department of Fish and Game 2003a).

Table 3-2. Crosswalk of Land Cover Classification to Other Classification Systems

Habitat Plan Land Cover Type	Manual of California Vegetation and CDFG Vegetation Code [1]	CWHR[2] Habitat Type	Coyote Ridge Vegetation Associations[3]	GAP Map—Santa Clara County	SFPUC Alameda Watershed HCP Land Cover Types[4]
Grassland					
California annual grassland	41.280.00	Annual grassland	*Aegilops triuncialis* alliance, *Lolium multiflorum-Hemizonia congesta* (mixed herb) association, *Avena* spp. alliance, *Bromus hordeaceus* alliance, *Plantago erecta* alliance	Annual grassland	Nonnative grassland
Non-serpentine native grassland (not mapped)	41.150.00	Annual grassland	*Leymus triticoides* alliance, *Melica torreyana* grassland alliance, *Elymus multisetus* alliance, *Vulpia microstachys* grassland alliance, Purple Needlegrass alliance	Annual grassland	Valley needlegrass grassland
Serpentine bunchgrass grassland	41.280.00	Annual grassland	*Plantago erecta* alliance, *Vulpia microstachys* alliance, *Melica torreyana* grassland alliance, *Nasella pulchra* alliance, *Elymus multisetus* alliance, *Lolium multiflorum-Nassella pulchra-Astragalus gambelianus-Lepidium nitidum* association, *Lolium multiflorum-Nassella pulchra-Calystegia collina* (mixed herb) association	Annual grassland	Serpentine bunchgrass grassland
Serpentine rock outcrop	None	None	Not mapped	Barren	not mapped
Serpentine seep	45.56x.00 (in part)	Fresh Emergent Wetland	*Cirsium fontinale* var. *campylon* alliance, *Juncus xiphioides* alliance	Not mapped	Freshwater seep
Rock outcrop	99.900.04/ 99.900.05	None	Not mapped	Barren	Rock outcrop

Habitat Plan Land Cover Type	Manual of California Vegetation and CDFG Vegetation Code[1]	CWHR[2] Habitat Type	Coyote Ridge Vegetation Associations[3]	GAP Map—Santa Clara County	SFPUC Alameda Watershed HCP Land Cover Types[4]
Chaparral and Coastal Scrub					
Northern mixed chaparral/chamise chaparral	37.000.01 / 37.101.00	Mixed chaparral / chamise-redshank	*Prunus illicifolia* alliance, *Arctostaphylos glauca* alliance, *Cercocarpus betuloides* alliance, *Adenostoma facsiculatum-Arctostaphylos glauca-Mimulus aurantiacus*	Mixed chaparral/ chamise-redshank chaparral	Not mapped
Mixed serpentine chaparral	37.000.06	Mixed chaparral	*Rhamnus tomentella* alliance, *Pinus sabiniana/Artemisia californica-Ceanothus ferrisiae-Heteromeles arbutifolia,* *Adenostoma fasciculatum-Heteromeles arbutifolia/Melica torreyana,* *Arctostaphylos glauca* mixed *(Artemisia californica-Salvia mellifera),* *Arctostaphylos glauca/Melica torreyana,* *Artemisia californica-Ceanothus ferrisiae,* *Quercus durata* alliance	Mixed chaparral	Serpentine foothill pine-chaparral woodland?
Northern coastal scrub/Diablan sage scrub	(32.000.00)	Coastal scrub	*Salvia mellifera* alliance, *Artemisia californica/Eschscholzia californica*-Grass, *Artemisia californica-Salvia mellifera*	Coastal scrub	Diablan sage scrub
Coyote brush scrub	32.060.00	Coastal scrub	*Baccharis pilularis* alliance	Coastal scrub	Not mapped
Oak Woodland					
Valley oak woodland	71.040.05	Valley oak woodland	Not mapped	Valley oak woodland	Valley oak woodland, oak savannah
Mixed oak woodland and forest	71.100.00	Coastal oak woodland	Not mapped	Coastal oak woodland	Mixed evergreen forest/oak woodland
Blue oak woodland	72.020.00	Blue oak woodland	Not mapped	Blue oak woodland	Blue oak woodland, oak savannah

Habitat Plan Land Cover Type	Manual of California Vegetation and CDFG Vegetation Code[1]	CWHR[2] Habitat Type	Coyote Ridge Vegetation Associations[3]	GAP Map—Santa Clara County	SFPUC Alameda Watershed HCP Land Cover Types[4]
Coast live oak forest and woodland	71.060.00	Coastal oak woodland	*Quercus agrifolia* alliance	Valley-foothill riparian	Central coast live oak riparian forest, coast live oak riparian forest, mixed evergreen forest/oak woodland
Foothill pine-oak woodland	87.130.05	Blue oak-foothill pine	Not mapped	Blue oak—foothill pine	Not mapped
Mixed evergreen forest	81.100.00	Montane hardwood-conifer	Not mapped	Montane hardwood-conifer	Mixed evergreen forest/oak woodland
Riparian Forest and Scrub					
Willow riparian forest and scrub	61.200.00 & 63.902.00	Valley-foothill riparian	Not mapped	Valley-foothill riparian	Central coast arroyo willow forest
Central California sycamore alluvial woodland	61.311.00	Valley-foothill riparian	*Platanus racemosa* alliance	Valley-foothill riparian	Sycamore alluvial woodland
Riverine	none	Riverine	Not mapped	Not mapped	Streams
Mixed riparian forest and woodland	61.900.00	Valley-Foothill Riparian	Not mapped	Not mapped	Not mapped
Conifer Woodland					
Redwood forest	86.100.00	Redwood	Not mapped	Redwood	Not mapped
Ponderosa pine woodland	87.010.00	Ponderosa pine	Not mapped	Ponderosa pine	Not mapped
Knobcone pine woodland	87.100.00	Closed-cone pine-cypress	Not mapped	Knobcone pine	Not mapped
Wetland					
Coastal and valley freshwater marsh	52.100.01	Fresh emergent wetland	Not mapped	Not mapped	Freshwater marsh
Seasonal wetlands	44.000.00	Fresh emergent wetland	*Juncus xiphioides* alliance (seasonal wetlands), *Phalaris aquatica* alliance (seasonal wetlands)	Not mapped	Not mapped

Habitat Plan Land Cover Type	Manual of California Vegetation and CDFG Vegetation Code [1]	CWHR[2] Habitat Type	Coyote Ridge Vegetation Associations[3]	GAP Map—Santa Clara County	SFPUC Alameda Watershed HCP Land Cover Types[4]
Open Water					
Pond (0.25-20 acres)	None	Lacustrine	Not mapped	Lacustrine	Pond or reservoir
Reservoir (defined by management)	None	Lacustrine	Not mapped	Lacustrine	Pond or reservoir
Agricultural					
Orchard	None	Orchard—vineyard	Not mapped	Orchard and vineyard	Cultivated agriculture
Vineyard	None	Orchard—vineyard	Not mapped	Orchard and vineyard	Cultivated agriculture
Grain, row-crop, hay and pasture, disked/short-term fallowed	None	Cropland	Not mapped	Cropland	Cultivated agriculture
Agriculture developed/Covered Ag	None	Urban	Not mapped	Urban	Not mapped
Developed					
Urban-Suburban	None	Urban	Not mapped	Urban	Developed
Rural—residential (<1 unit per 2.5 acres)	None	Urban	Not mapped	Residential	Developed
Golf courses / urban parks	None	Urban	Not mapped	Urban	Turf
Landfill	None	Urban	Not mapped	Other urban or built-upland	not mapped
Ornamental woodland	None	Eucalyptus, Urban	Not mapped	Groves	Developed
Barren	None	Urban	Not mapped	Barren	Developed

Notes:

[1] Sawyer and Keeler Wolf 1995; California Department of Fish and Game 2003a.

[2] CWHR= California Wildlife Habitat Relationships (Mayer and Laudenslayer 1988, 1999).

[3] Evens and San 2004; plant species nomenclature follows that listed in Evens and San 2004.

[4] This habitat conservation plan (Jones & Stokes 2005) is adjacent to the Santa Clara Valley Habitat Plan study area.

Table 3-3a. Counts of Polygons of Field-Checked Land Cover Types in Valley Floor[a]

	Field-Verified Land Cover Type (Corrected)																											
Mapped Land-Cover Type	California Annual Grassland	Serpentine Bunchgrass Grassland	Serpentine Rock/Outcrop	Rock Outcrop	Mixed Serpentine Chaparral	Northern Coastal Scrub/ Diablan Sage Scrub	Coyote Brush Scrub	Valley Oak Woodland	Mixed Oak Woodland and Forest	Blue Oak Woodland	Coast Live Oak Forest and Woodland	Foothill Pine-Oak Woodland	Willow Riparian Forest and Scrub	Mixed Riparian Forest and Woodland	Coastal and Valley Freshwater Marsh	Pond	Reservoir	Orchard	Vineyard	Grain, Row-Crop, Hay, Fallowed	Agriculture Developed	Urban/ Suburban	Barren	Rural Residential	Golf Courses/ Urban Parks	Landfill	Ornamental Woodland	Grand Total
California Annual Grassland	3																											**3**
Serpentine Bunchgrass Grassland	1	1																										**2**
Serpentine Rock Outcrop			1																									**1**
Rock Outcrop				3																								**3**
Northern Mixed Chaparral/Chamise Chaparral						1			1																			**2**
Mixed Serpentine Chaparral					2																							**2**
Coyote Brush Scrub							1																					**1**
Valley Oak/Grass								3																				**3**
Mixed Oak Woodland and Forest									7																			**7**
Blue Oak Woodland										6		1																**7**
Coast Live Oak Forest and Woodland									2		4																	**6**
Foothill Pine-Oak Woodland												1																**1**
Mixed Evergreen Forest									1		1																	**2**
Willow Riparian Forest and Scrub													1															**1**
Mixed Riparian Forest and Woodland								1	1					12														**14**
Ponderosa Pine Woodland										1																		**1**

Mapped Land-Cover Type	Field-Verified Land Cover Type (Corrected)																											
	California Annual Grassland	Serpentine Bunchgrass Grassland	Serpentine Rock/Outcrop	Rock Outcrop	Mixed Serpentine Chaparral	Northern Coastal Scrub/ Diablan Sage Scrub	Coyote Brush Scrub	Valley Oak Woodland	Mixed Oak Woodland and Forest	Blue Oak Woodland	Coast Live Oak Forest and Woodland	Foothill Pine-Oak Woodland	Willow Riparian Forest and Scrub	Mixed Riparian Forest and Woodland	Coastal and Valley Freshwater Marsh	Pond	Reservoir	Orchard	Vineyard	Grain, Row-Crop, Hay, Fallowed	Agriculture Developed	Urban/ Suburban	Barren	Rural Residential	Golf Courses/ Urban Parks	Landfill	Ornamental Woodland	Grand Total
Coastal and Valley Freshwater Marsh															1													**1**
Pond																1												**1**
Reservoir																	3											**3**
Orchard																		27	1	1			1				1	**31**
Vineyard	2																		18	4	1						1	**26**
Grain, Row-Crop, Hay, Fallowed	11																		1	14			1				3	**30**
Agriculture Developed																					27	8					2	**37**
Urban/Suburban																						28	1					**29**
Rural Residential																					2	1	27					**30**
Golf Courses/Urban Parks	2																					1		18			8	**29**
Landfill																								1	3		1	**5**
Ornamental Woodland											1															8		**9**
Barren																						2		1	2		14	**19**
Grand Total	**19**	**1**	**1**	**3**	**2**	**1**	**1**	**4**	**12**	**7**	**6**	**2**	**1**	**12**	**1**	**1**	**3**	**27**	**20**	**19**	**30**	**40**	**30**	**20**	**5**	**8**	**30**	**306**

[a] Entries in shaded cells in the diagonal indicate a match between the mapped and field-verified land cover type (i.e., a correct identification of land-cover type). Entries outside of the diagonal indicate an incorrect assignment.

Table 3-3b. Amounts of Field-Checked Land Cover Types (Acres) in Valley Floor[a]

	Field-Verified Land Cover Type (Corrected)																											
Mapped Land-Cover Type	California Annual Grassland	Serpentine Bunchgrass Grassland	Serpentine Rock/Outcrop	Rock Outcrop	Mixed Serpentine Chaparral	Northern Coastal Scrub/Diablan Sage Scrub	Coyote Brush Scrub	Valley Oak Woodland	Mixed Oak Woodland and Forest	Blue Oak Woodland	Coast Live Oak Forest and Woodland	Foothill Pine - Oak Woodland	Willow Riparian Forest and Scrub	Mixed Riparian Forest and Woodland	Coastal and Valley Freshwater Marsh	Pond	Reservoir	Orchard	Vineyard	Grain, Row-Crop, Hay, Fallowed	Agriculture Developed	Urban/Suburban	Rural Residential (<1 unit per 2.5 acres)	Golf Courses/Urban Parks	Landfill	Ornamental Woodland	Barren	Grand Total
California Annual Grassland	66																											**66**
Serpentine Bunchgrass Grassland	8	28																										**35**
Serpentine Rock Outcrop			1																									**1**
Rock Outcrop				2																								**2**
Northern Mixed Chaparral/ Chamise Chaparral						35			9																			**44**
Mixed Serpentine Chaparral					41																							**41**
Coyote Brush Scrub							20																					**20**
Valley Oak/Grass								73																				**73**
Mixed Oak Woodland and Forest									513																			**513**
Blue Oak Woodland										305		31																**336**
Coast Live Oak Forest and Woodland									88		151																	**238**
Foothill Pine-Oak Woodland												153																**153**
Mixed Evergreen Forest									314		151																	**466**
Willow Riparian Forest and Scrub													18															**18**
Mixed Riparian Forest and Woodland								11	5					123														**139**

	Field-Verified Land Cover Type (Corrected)																										
Mapped Land-Cover Type	California Annual Grassland	Serpentine Bunchgrass Grassland	Serpentine Rock/Outcrop	Rock Outcrop	Mixed Serpentine Chaparral	Northern Coastal Scrub/Diablan Sage Scrub	Coyote Brush Scrub	Valley Oak Woodland	Mixed Oak Woodland and Forest	Blue Oak Woodland	Coast Live Oak Forest and Woodland	Foothill Pine - Oak Woodland	Willow Riparian Forest and Scrub	Mixed Riparian Forest and Woodland	Coastal and Valley Freshwater Marsh	Pond	Reservoir	Orchard	Vineyard	Grain, Row-Crop, Hay, Fallowed	Agriculture Developed	Urban/Suburban	Rural Residential (<1 unit per 2.5 acres)	Golf Courses/Urban Parks	Landfill	Ornamental Woodland	Barren	Grand Total
Ponderosa Pine Woodland										1																		**1**
Coastal and Valley Freshwater Marsh															1													**1**
Pond																2												**2**
Reservoir																	320											**320**
Orchard																		724	19	19			14				12	**787**
Vineyard	29																		1,044	261	4						14	**1,352**
Grain, Row-Crop, Hay, Fallowed	770																		50	1,524			5				124	**2,473**
Agriculture Developed																					625	95					22	**742**
Urban/Suburban																						20,084	16					**20,099**
Rural Residential (<1 unit per 2.5 acres)																					10	10	1,238					**1,258**
Golf Courses/Urban Parks	76																					11		370			747	**1,204**
Landfill																								14	177		20	**211**
Ornamental Woodland											29															86		**115**
Barren																						42		77	109		318	**546**
Grand Total	**949**	**28**	**1**	**2**	**41**	**35**	**20**	**84**	**930**	**306**	**331**	**184**	**18**	**123**	**1**	**2**	**320**	**724**	**1,113**	**1,803**	**639**	**20,241**	**1,273**	**461**	**286**	**86**	**1,257**	**31,258**

[a] Entries in shaded cells in the diagonal indicate a match between the mapped and field-verified land cover type (i.e., a correct identification of land cover type). Entries outside of the diagonal indicate an incorrect assignment.

Table 3-4. Uncertainties in Land Cover Mapping, by Land Cover Type

Land Cover Type	Comment	General Mapping Confidence[1]
Grassland		
California annual grassland	Almost always has a distinct signature, may be difficult to distinguish from some seasonal wetlands.	High
Serpentine bunchgrass grassland	As for California annual grassland. Uncertainty lies with available serpentine soils and geology mapping, from which this land cover was derived (see text).	High
Serpentine rock outcrop	Likely under-mapped because outcrops are generally small and below the minimum mapping unit of 0.25 acres; outcrops below a chaparral or woodland canopy would be missed.	Low
Serpentine seep	Could be difficult to distinguish if seep is seasonal (i.e., not perennial) and therefore would appear similar to surrounding grasslands on December aerial photograph.	Moderate
Rock outcrop	As for serpentine rock outcrop.	Low
Chaparral and Northern Coastal Scrub		
Northern mixed chaparral /chamise chaparral	Generally quite distinct; the main issue in mapping was the distinction with adjacent mixed oak or foothill pine-oak;- there was often a gradation rather than a distinct difference in signatures among these land cover types. This occurred mainly in the northeast and east portions of the study area where chaparral on south-facing slopes graded into mixed-oak woodland in drainages and on north-facing slopes with intermediate areas of taller chaparral and lower-stature oak. At times it was difficult to judge the height of vegetation on slopes from the photos.	High
Mixed serpentine chaparral	Clear signature, mapped where serpentine soils/rocks intersected with chaparral signature.	High
Northern coastal scrub/Diablan sage scrub	Northern coastal scrub dominated by California sagebrush had a distinctive pale green signature, but coastal scrub dominated by black sage appeared dark green and was similar in hue to chamise and to some of the components of mixed chaparral.	High
Coyote brush scrub	Dark green signature was similar to chamise and black sage; landscape position aided in distinguishing this uncommon type in the plan area.	Moderate
Oak Woodland		
Valley oak woodland	Main issue in mapping was distinguishing valley oak woodland from blue oak woodland. Valley oak trees typically appeared large-crowned, well-spaced, grayish (leafless) on the March 2003 photo, and were located on either broad ridge tops and shoulders or broad valley bottoms. Blue oak trees typically appeared smaller-crowned, closer-spaced, were beginning to leaf out in the March photos (earlier than valley oak), and were located on steeper, south, southwest, or southeast-facing slopes. Trees that appear intermediate in any of those characters were more difficult to classify, so large well-spaced blue oaks, denser stands of small-crowned valley oak, and blue oaks on valley bottoms were more likely to be mis-classified.	Moderate
Mixed oak woodland and forest	This type was characterized by a mix of deciduous and evergreen oaks; the two could be distinguished on the December 2003 or 2005 photographs when the deciduous trees were leafless; on the March 2003 photo, when the deciduous trees were in leaf, Mixed oak appeared similar to Coast live oak woodland. Because this type generally graded into the adjacent types with no clear distinction, the main issue was deciding where to separate the different types. Topography was helpful.	Moderate

Land Cover Type	Comment	General Mapping Confidence[1]
Blue oak woodland	See comments under Valley oak woodland. Blue oak woodland is much more abundant than Valley oak woodland, so errors in attributes would have greater effects on the Valley oak woodland land cover type than blue oak woodland.	High
Coast live oak forest and woodland	See comments under Mixed oak woodland and forest	Moderate
Foothill pine—oak woodland	The signature of foothill pine was usually distinctive. As discussed above, this type could grade into chaparral. December photos were taken at a time of day with pronounced shadows, which made isolated trees such as foothill pine easy to identify.	High
Mixed evergreen forest	Difficult to distinguish from Coast live oak woodland as both types are closed-canopy woodlands with similar dark green signatures. Geographic location was helpful – mixed evergreen occurred on the west side of the valley, while coast live oak woodland occurred throughout the plan area. Topography was somewhat useful – although both types occurred on north-facing slopes, Mixed evergreen was often in mid-slope positions while Coast live oak tended to be on the lower slopes.	Moderate
Riparian Forest and Scrub		
Willow riparian forest and scrub	Distinguished from Mixed riparian woodland by generally smaller stature trees and by the bright yellow appearance of small willows that retained their leaves into December; generally dominated by willow and lacking other species, such as bay and coast live oak, that would appear green in December photo, and alder, cottonwood, and valley oak, that would appear leafless in December. This type graded into Mixed riparian woodland, however, without a distinct boundary	Moderate-High
Central California sycamore alluvial woodland	Mature stands of sycamore had a distinctive signature in the December aerial, with the well-spaced large pale grayish crowns surrounded by a 'halo' of golden-yellow fallen leaves. Main difficulty in mapping was with large well-spaced cottonwood trees, which could appear similar to large sycamores, although the canopy was generally smaller. Land cover mapping for the HCP/NCCP was compared to field-based mapping conducted by CDFG (Keeler-Wolf et al. 1997) and found to be generally consistent (see text for more discussion).	Moderate-High
Mixed riparian forest and woodland	See comments under Willow riparian forest and scrub	Moderate-High
Riverine	Not mapped; using linear data sets provided by SCVWD.	N/A
Conifer Woodland		
Redwood forest	Mature redwood canopies were readily distinguishable; main confusion would be with Douglas-fir, which fieldwork revealed to be relatively uncommon (no large stands were observed); areas with regenerating redwoods could be confused with mixed evergreen forest.	Moderate-High
Ponderosa pine woodland	Very clear signature and restricted geographic distribution in the plan area made this a distinct type: ponderosa pine occurs on just 3 ridges with widely scattered tall trees casting distinctive long shadows on the surrounding grassland. However, small stands of ponderosa pine also occurred in some of the valley below the ridges, where they could be difficult to distinguish from the surrounding evergreen oak crowns.	High
Knobcone pine woodland	Restricted geographic and topographic distribution in the Plan but lacking a distinctive signature, mostly identified on the basis of geographic and topographic location (ridgetops in the extreme west of the plan area).	High

Land Cover Type	Comment	General Mapping Confidence[1]
Wetland		
Coastal and valley freshwater marsh	Generally had a distinct signature. Some freshwater marshes may have been below the minimum mapping unit of 0.25 acres. Photos from three seasons (winter 2003 and 2005, spring 2003) ensured that conditions were favorable to perennial marsh on one or more air photos.	Moderate
Seasonal wetlands	Color differences in seasonal wetlands were difficult to distinguish from a variety of surrounding land cover types, and resulted in a very small acreage of this land cover in the first draft of the maps. Many seasonal wetlands may occur at a scale below the minimum mapping unit of 0.25 acres. Subsequent mapping of seasonal wetlands using additional data sources (e.g., Coyote Valley Specific Plan and National Wetland Inventory data) have resolved some of the mapping uncertainties.	Low (Moderate[2])
Open Water (Aquatic)		
Pond	Distinctive; main issue was visibility because of heavy shadows on the December photo when ponds were full.	High
Reservoir	Large, highly distinctive.	High
Irrigated Agriculture		
Orchard	Distinctive regular pattern of tree crowns; recently planted orchards could be confused with disked or fallow fields if the small trees were too small to be visible.	High[3]
Vineyard	Generally distinctive because of the narrow rows; recently planted vineyards could be confused with disked or fallow fields because the small vines were too small to be visible	High[3]
Agriculture developed	Distinctive	High[3]
Grain, row-crop, hay and pasture, disked/ short-term fallowed	Distinctive; the main issue was more associated with the definition rather than recognition and was related to the separation of annual grassland and short-term fallow	High[3]
Developed		
Urban-Suburban	Distinctive	High[3]
Rural residential (<1 unit per 2.5 acres)	Distinctive	High[3]
Golf courses/Urban parks	Distinctive	High[3]
Landfill	Distinctive	High[3]
Ornamental woodland	Generally distinctive based on location and patterning of the tree crowns; many stands below minimum mapping unit of 10 acres but this is generally not important for the covered species.	Moderate[3]
Barren	Distinctive	High[3]

Notes:

[1] Qualitative confidence in mapping in terms of accuracy of polygon boundaries, polygon attributes, and the extent of the land cover type in the study area (i.e., over- or under-mapped).

[2] With supplemental mapping using additional data sets (see text under *Seasonal Wetlands*).

[3] See text and Tables 3-3a and 3-3b for quantitative error checking of agricultural and urban land-cover types. Quantitative error checking of natural land-cover types was not feasible.

Table 3-5. Covered Wildlife Species and Their Associated Land Cover Types

		Covered Species								
		Invertebrate	Amphibians				Birds			Mammals
Natural Community	Land Cover Type	Bay checkerspot butterfly *Euphydryas editha bayensis*	California tiger salamander *Ambystoma californiense*	California red-legged frog *Rana draytoni*	Foothill yellow-legged frog *Rana boylii*	Western pond turtle *Clemmys marmorata*	Western burrowing owl *Athene cunicularia hypugea*	Least Bell's vireo *Vireo bellii pusillus*	Tricolored blackbird *Agelaius tricolor*	San Joaquin kit fox *Vulpes macrotis mutica*
Grasslands										
	California annual grassland	M	U,M	U,M		M	F,B		Y	M,F
	Non-serpentine native grassland (not mapped)	M	U,M	U,M		M	F,B		Y	M,F
	Serpentine bunchgrass grassland	Y	U,M	U,M		M	F		Y	M,F
	Serpentine rock outcrop/Barren	M	M	M						M,F
	Serpentine seep	M	U,M	M		M				M,F
	Rock outcrop	M								M,F
Chaparral and Coastal Scrub										
	Northern mixed chaparral/ chamise chaparral		U,M	M		M				
	Mixed serpentine chaparral	M	U,M	M		M				
	Northern coastal scrub/ Diablan sage scrub	M	U,M	M		M				
	Coyote brush scrub	M	U,M	M		M				
Oak Woodland										
	Valley oak woodland	M	U,M	M		M	F,M		Y	M,F
	Mixed oak woodland and forest		U,M	M		M				M
	Blue oak woodland	M	U,M	M		M				M
	Coast live oak forest and woodland	M	U,M	M		M				M
	Foothill pine—oak woodland		U,M	M		M				
	Mixed evergreen forest					M				
Riparian Forest and Scrub										
	Willow riparian forests and scrub	M	M	Y	M,F	Y		F, B	B	M
	Central California sycamore alluvial woodland		M	Y	M,F	Y		F, B	Y	M
	Mixed riparian forest and woodland	M	M	Y	M,F	Y		F,B	Y	M
Conifer Woodland										
	Redwood forest			M	M,F	Y				
	Ponderosa pine woodland		M	M		M				
	Knobcone pine woodland			M		M				

Key: U = Upland habitat; B = Breeding habitat; F = Foraging habitat; M = Movement habitat; Y = Year-round habitat (includes breeding)

Natural Community	Land Cover Type	Covered Species								
		Invertebrate	Amphibians				Birds			Mammals
		Bay checkerspot butterfly *Euphydryas editha bayensis*	California tiger salamander *Ambystoma californiense*	California red-legged frog *Rana draytoni*	Foothill yellow-legged frog *Rana boylii*	Western pond turtle *Clemmys marmorata*	Western burrowing owl *Athene cunicularia hypugea*	Least Bell's vireo *Vireo bellii pusillus*	Tricolored blackbird *Agelaius tricolor*	San Joaquin kit fox *Vulpes macrotis mutica*
Wetland										
	Coastal and valley freshwater marsh	M	B,F	Y		Y			F,B	
	Seasonal wetland	M	B,F	B,F		F	M		F,B	M
Open Water										
	Pond	M	B,F	Y		Y			F,B	
	Reservoir					Y			F,B	
	Riverine	M	B,F, M	Y	Y	Y				
Agricultural										
	Orchard	M	M	M			F, M		F	M,F
	Vineyard	M	M	M					F	M
	Grain, row-crop, hay and pasture, disked/short-term fallowed	M	M	M		M	F,B, M		F,B	M,F
	Agriculture developed	M					F,M		F	M
Developed										
	Urban-suburban	M								
	Rural–residential	M		M		M	F, B		F	M
	Golf courses / urban parks	M	M	M		M	F, B		F	M
	Landfill	M								
	Barren	M	M	M		M	F, B		F	M,F

Key: U = Upland habitat; B = Breeding habitat; F = Foraging habitat; M = Movement habitat; Y = Year-round habitat (includes breeding)

Table 3-6. Covered Plant Species and Land Cover Types

Natural Community	Land Cover Type	Tiburon Indian paintbrush *Castilleja affinis* ssp. *neglecta*	Coyote ceanothus *Ceanothus ferrisiae*	Mount Hamilton thistle *Cirsium fontinale* var. *campylon*	Santa Clara Valley dudleya *Dudleya abramsii* ssp. *setchellii*	Fragrant fritillary *Fritillaria liliacea*	Loma Prieta hoita *Hoita strobilina*	Smooth lessingia *Lessingia micradenia* var. *glabrata*	Metcalf Canyon jewelflower *Streptanthus albidus* ssp. *albidus*	Most beautiful jewelflower *Streptanthus albidus* ssp. *peramoenus*
Grasslands										
	California annual grassland					S				
	Non-serpentine native grassland (not mapped)									
	Serpentine bunchgrass grassland	P	P	P[1]	P	P		P	P	P
	Serpentine rock outcrop/Barren	P			P			P	P	P
	Serpentine seep			P						
	Rock outcrop									S
Chaparral and Coastal Scrub										
	Northern mixed chaparral/ chamise chaparral						S			
	Mixed serpentine chaparral		P				S			P
	Northern coastal scrub/ Diablan sage scrub					S				S
	Coyote brush scrub									
Oak Woodland										
	Valley oak woodland				P[2]	S				
	Mixed oak woodland and forest				P[2]	S	P			
	Blue oak woodland					S				
	Coast live oak forest and woodland				P[2]	S	P			
	Foothill pine—oak woodland					S				
	Mixed evergreen forest					S				

Key: P = Primary habitat (most likely to occur); S = Secondary habitat (unlikely but possible to occur); ? = may occur but data from study area is lacking.

Natural Community	Land Cover Type	Tiburon Indian paintbrush *Castilleja affinis* ssp. *neglecta*	Coyote ceanothus *Ceanothus ferrisiae*	Mount Hamilton thistle *Cirsium fontinale* var. *campylon*	Santa Clara Valley dudleya *Dudleya abramsii* ssp. *setchellii*	Fragrant fritillary *Fritillaria liliacea*	Loma Prieta hoita *Hoita strobilina*	Smooth lessingia *Lessingia micradenia* var. *glabrata*	Metcalf Canyon jewelflower *Streptanthus albidus* ssp. *albidus*	Most beautiful jewelflower *Streptanthus albidus* ssp. *peramoenus*
Riparian Forest and Scrub										
	Willow riparian forests and scrub									
	Central California sycamore alluvial woodland									
	Mixed riparian forest and woodland									
Conifer Woodland										
	Redwood forest					?				
	Ponderosa pine woodland									
	Knobcone pine woodland					?				
Wetland										
	Coastal and valley freshwater marsh									
	Seasonal wetland					?				
Open Water										
	Pond									
	Reservoir									
	Riverine									
Agricultural										
	Orchard									
	Vineyard									
	Grain, row-crop, hay and pasture, disked/ short-term fallowed									
	Agriculture developed									

Key: P = Primary habitat (most likely to occur); S = Secondary habitat (unlikely but possible to occur); ? = may occur but data from study area is lacking.

Natural Community	Land Cover Type	Tiburon Indian paintbrush *Castilleja affinis* ssp. *neglecta*	Coyote ceanothus *Ceanothus ferrisiae*	Mount Hamilton thistle *Cirsium fontinale* var. *campylon*	Santa Clara Valley dudleya *Dudleya abramsii* ssp. *setchellii*	Fragrant fritillary *Fritillaria liliacea*	Loma Prieta hoita *Hoita strobilina*	Smooth lessingia *Lessingia micradenia* var. *glabrata*	Metcalf Canyon jewelflower *Streptanthus albidus* ssp. *albidus*	Most beautiful jewelflower *Streptanthus albidus* ssp. *peramoenus*
Developed										
	Urban-suburban									
	Rural–residential									
	Golf courses / urban parks									
	Landfill									
	Barren									

Key: P = Primary habitat (most likely to occur); S = Secondary habitat (unlikely but possible to occur); ? = may occur but data from study area is lacking.

Table 3-7. Land Cover Types and their Extent in the Study Area

Vegetation Type	# of Polygons	Acres	Percent of Study Area
Grasslands			
California annual grassland	937	81,795	18
Non-serpentine native grassland (not mapped)	N/A	N/A	N/A
Serpentine bunchgrass grassland	329	10,308	2.2
Serpentine rock outcrop	136	260	0.05
Serpentine seep	40	34	0.01
Rock outcrop	80	87	0.02
Chaparral and Coastal Scrub			
Northern mixed chaparral / chamise chaparral	400	23,763	5.2
Mixed serpentine chaparral	181	3,712	0.8
Northern coastal scrub / Diablan sage scrub	486	10,306	2.2
Coyote brush scrub	12	180	0.04
Oak Woodland			
Valley oak woodland	393	12,895	2.8
Mixed oak woodland and forest	609	84,488	18.4
Coast live oak woodland and forest	376	31,652	6.9
Blue oak woodland	296	11,160	2.4
Foothill pine - oak woodland	190	10,960	2.4
Mixed evergreen forest	58	5,775	1.3
Riparian Forest and Scrub			
Willow riparian forest, woodland and scrub	293	2,544	0.6
Central California sycamore alluvial woodland	14	373	0.1
Mixed riparian woodland and forest	356	3,766	0.8
Riverine (streams, in miles; see text for data source)	N/A	2,392	N/A
Conifer Woodland			
Redwood forest	23	9,693	2.1
Ponderosa pine woodland	10	419	0.1
Knobcone pine woodland	11	711	0.1
Wetland			
Coastal and valley freshwater marsh	79	381	0.1
Seasonal wetland	135	201	0.04
Open Water (Aquatic)[1]			
Pond	689	1,1105	0.2
Reservoir	16	2,767	0.6
Agricultural			
Orchard	96	2,697	0.6
Vineyard	34	1,393	0.3
Agriculture developed / covered agriculture	1047	1,935	0.4
Grain, row-crop, hay and pasture, disked/short-term fallowed	328	33,648	7.3

Table 3-7. Continued

Vegetation Type	# of Polygons	Acres	Percent of Study Area
Developed			
Urban-suburban	183	89,438	19.4
Rural – residential	362	12,414	2.7
Barren	6	211	0.05
Landfill	4	364	0.02
Golf courses / urban parks	293	8,673	1.9
Ornamental woodland	9	95	0.02
Total	**7,571**	**460,205**	**100.0**

[1] The number of polygons identified for each open water land cover is equal to the total number of open water bodies (e.g., 689 polygons for the pond land cover indicates there are 689 mapped ponds in the study area).

Table 3-8. Native Fish and Amphibian Species in Relation to Fish Communities in Santa Clara County Streams

	Fish Community						
Species	Cold Trout	Cold Steelhead	Warm Potential Trout/ Steelhead	Warm Native	Mixed Salmon	Mixed Native and Introduced	Fish Scarce
Resident trout	X						
Steelhead trout		X	(x)				X (migration)
Chinook salmon		(x)	(x)		X		(x) (migration)
Riffle sculpin	X	X					
Sucker	(x)	X	X	X	X	X	
Lamprey	(x)	X	X	(x)	X	(x)	X (migration)
Roach	(x)	X	X	X	X		
Pikeminnow		(x)	X	X			
Prickly sculpin			X	X	X		
Hitch			(x)	X	X		
Blackfish						X	
Tule perch						(x)	
Nonnatives Common					X	X	
California red-legged frog	X	X	(x)	(x)			
Foothill yellow-legged frog	X	(x)		X			
Western toad				X	(x)	(x)	(x)

Notes:
X = habitats commonly or reliably occupied.
(x) = habitats occupied intermittently or at low densities.
See Chapter 3 for definitions of fish communities and **Figure 3-11** for locations.
Source: Habitat Plan Science Advisors Report (Spencer et al. 2006).

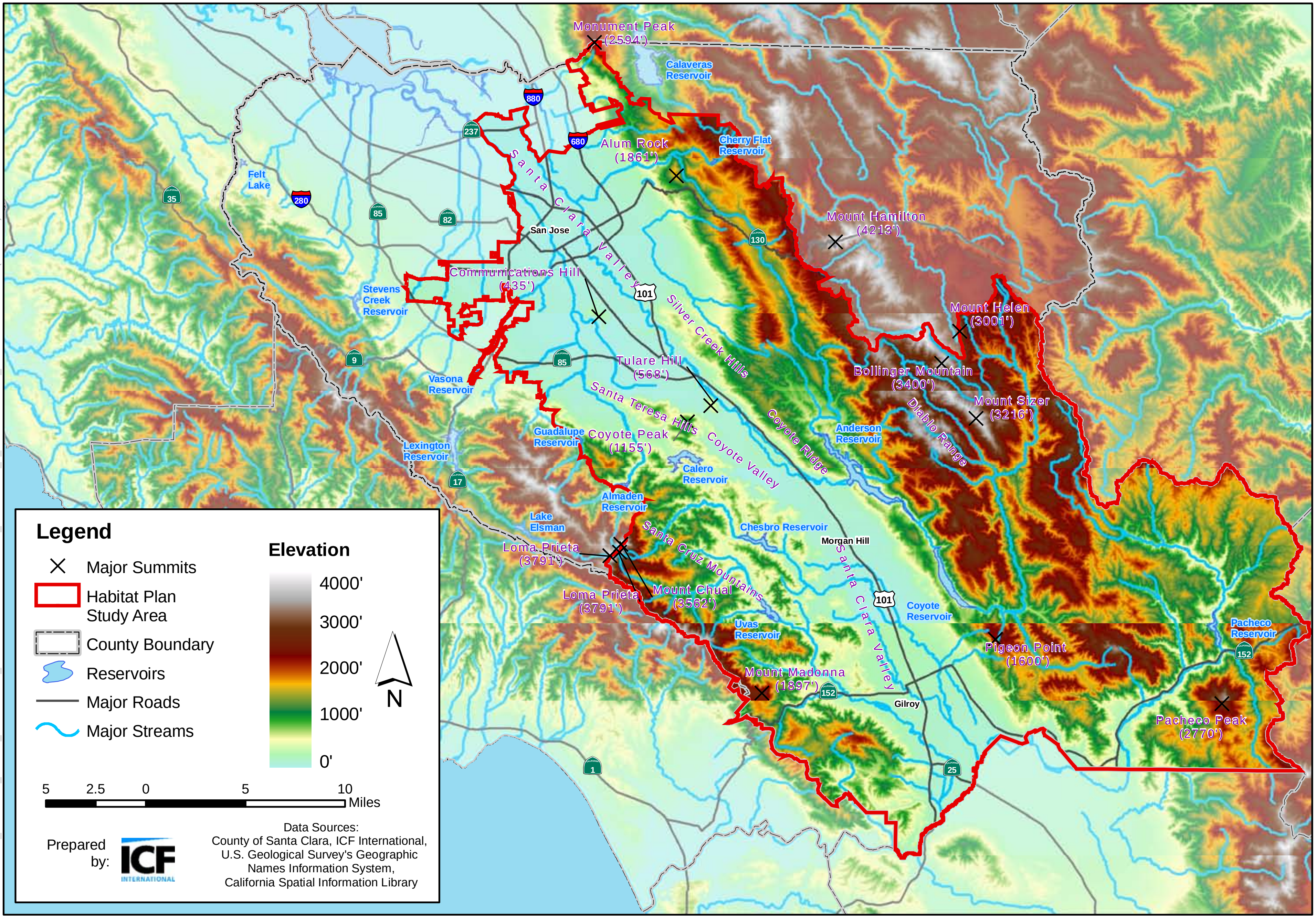

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Figure 3-1
Santa Clara Valley HCP/NCCP Topography

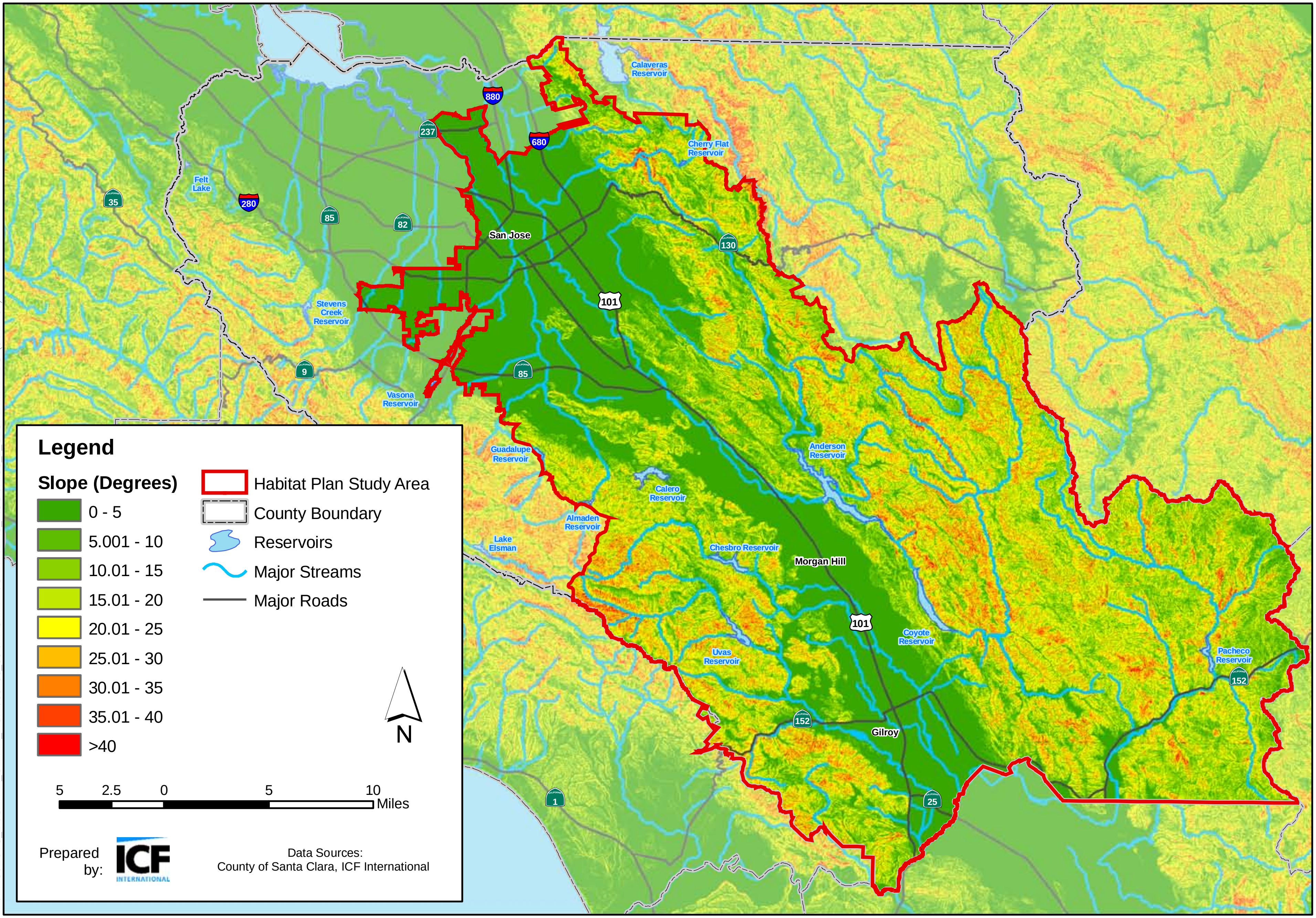


Figure 3-2
Santa Clara Valley HCP/NCCP Slope in Degrees

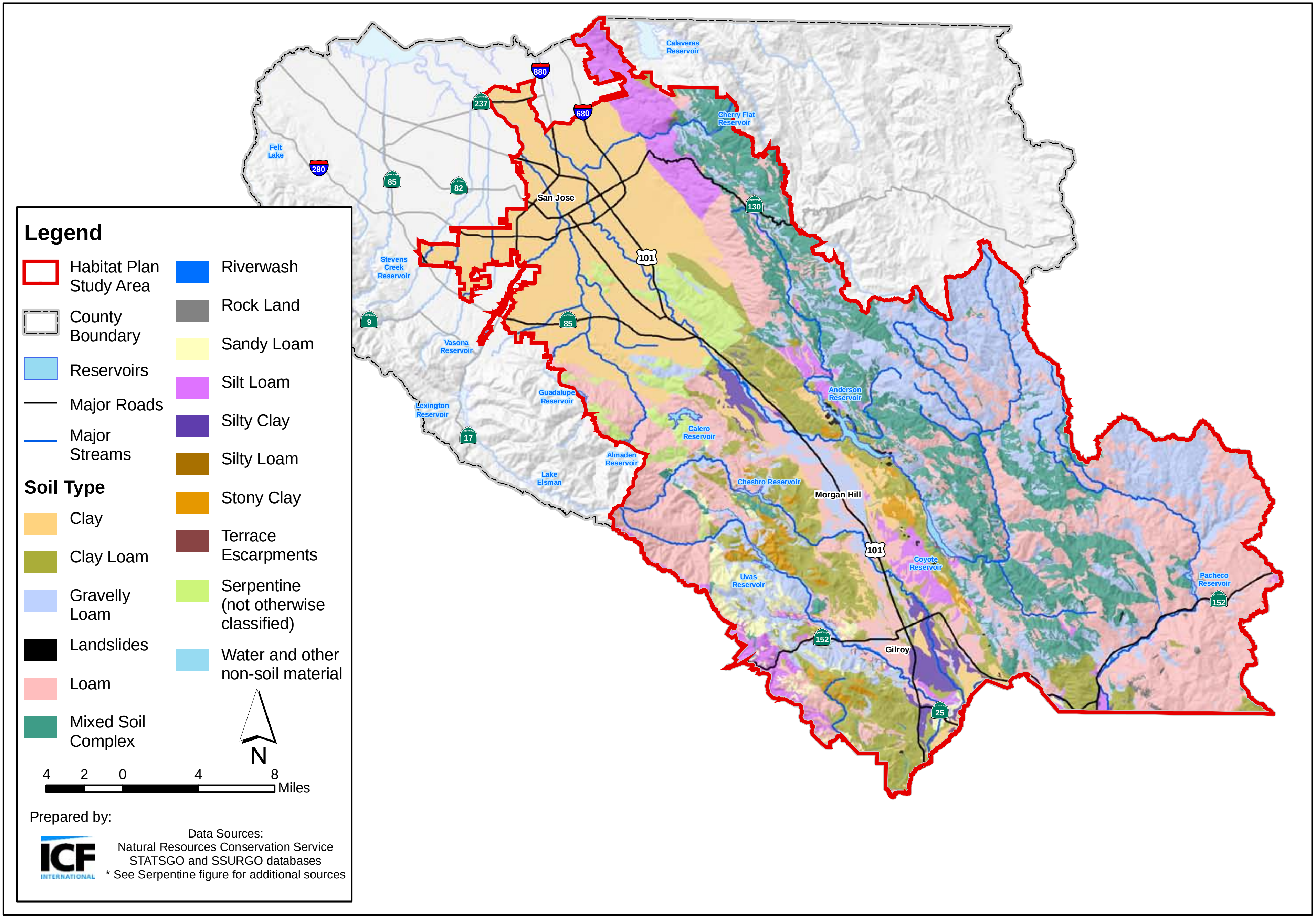


Figure 3-3
Soils in the Santa Clara Valley HCP/NCCP Area

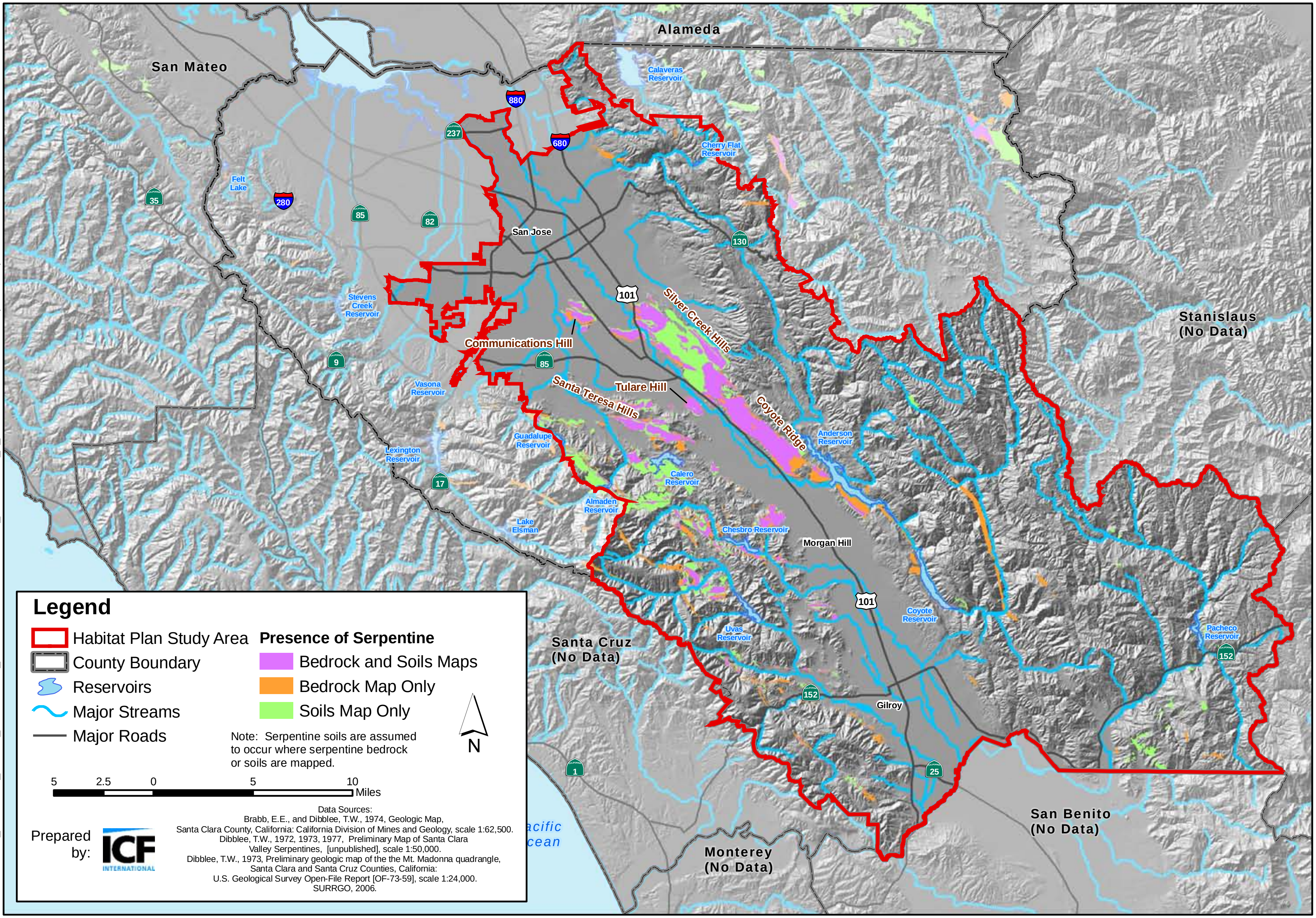


Figure 3-4
Santa Clara Valley HCP/NCCP Serpentine Areas

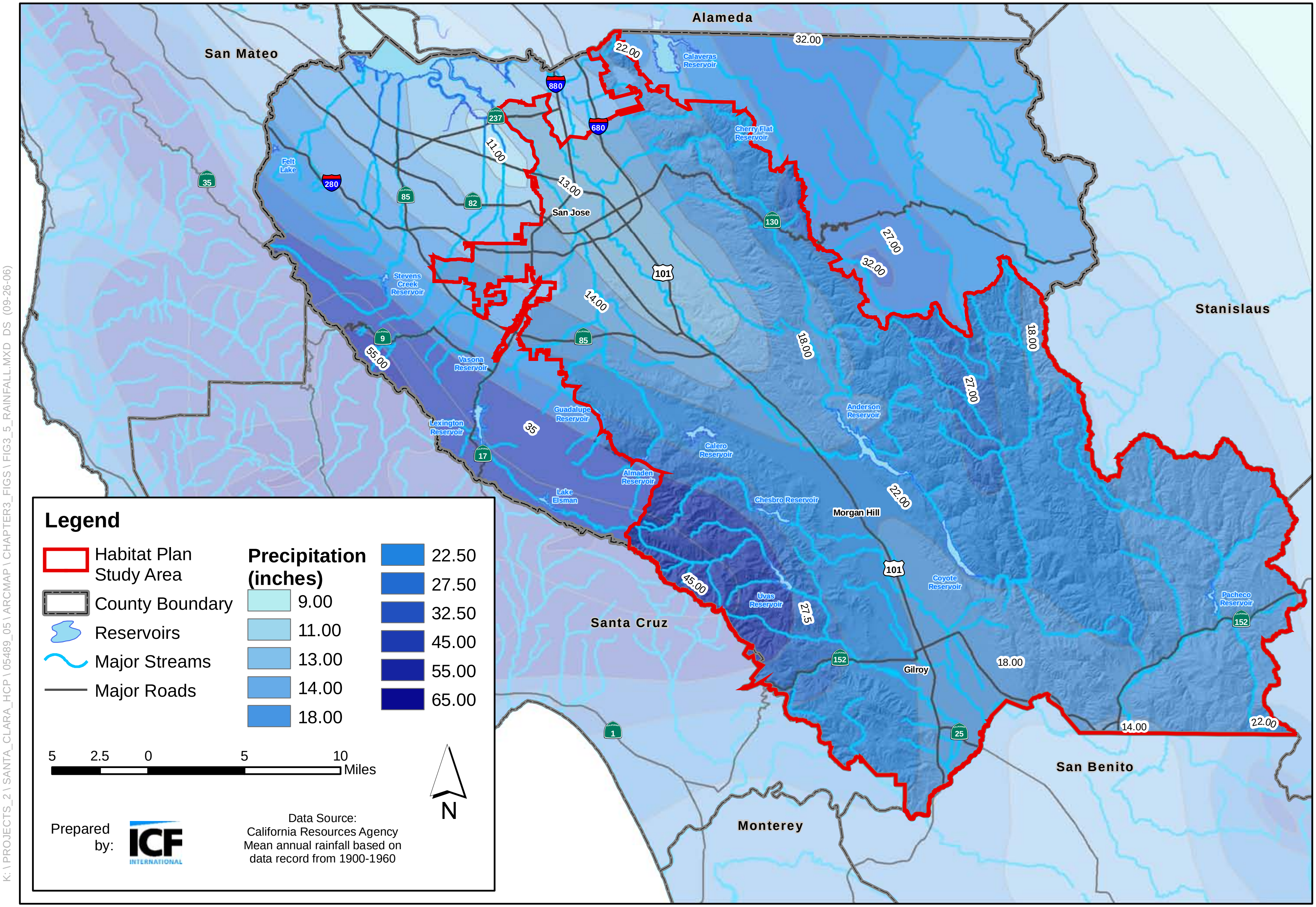


Figure 3-5
Average Annual Rainfall in HCP/NCCP Study Area

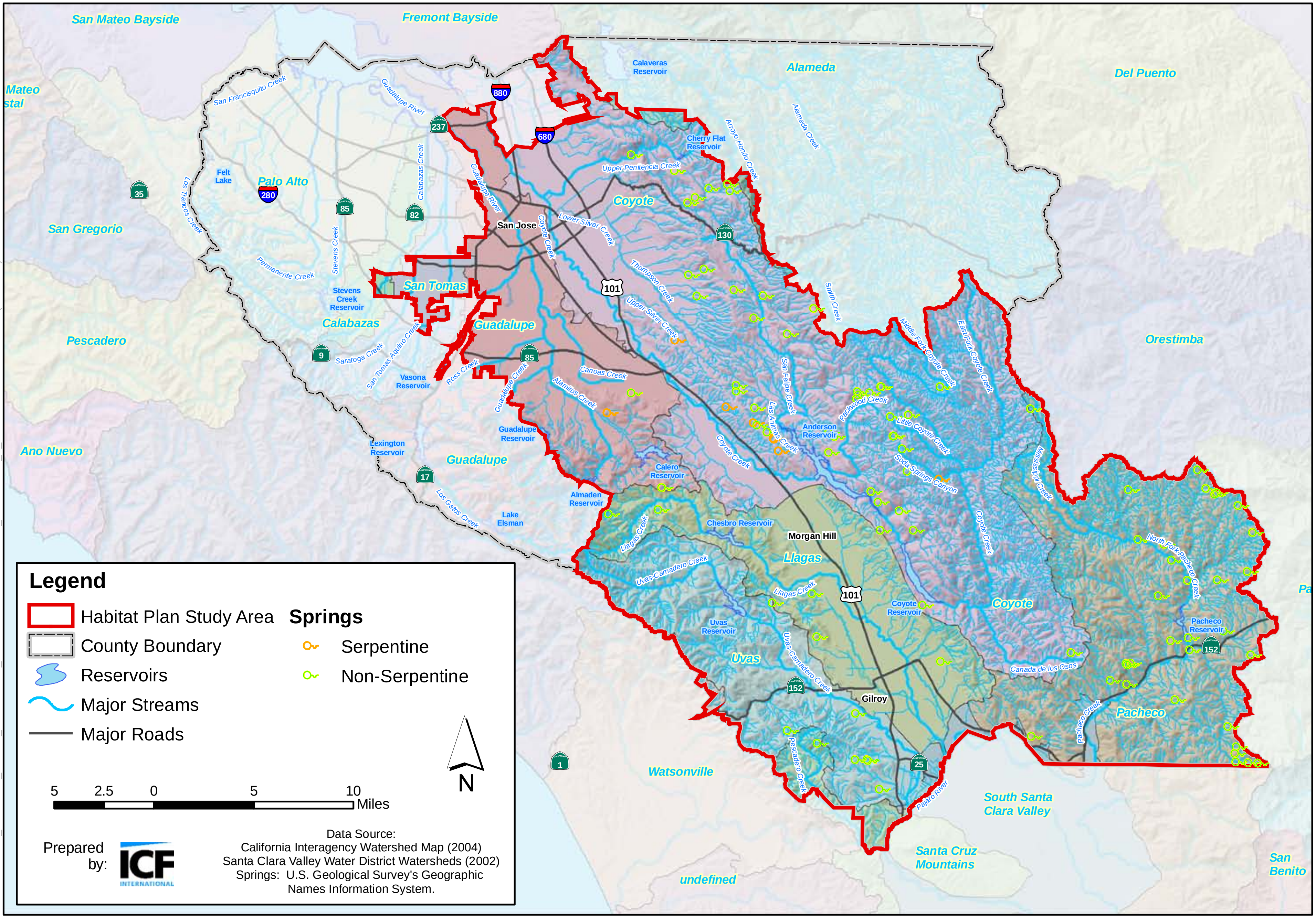
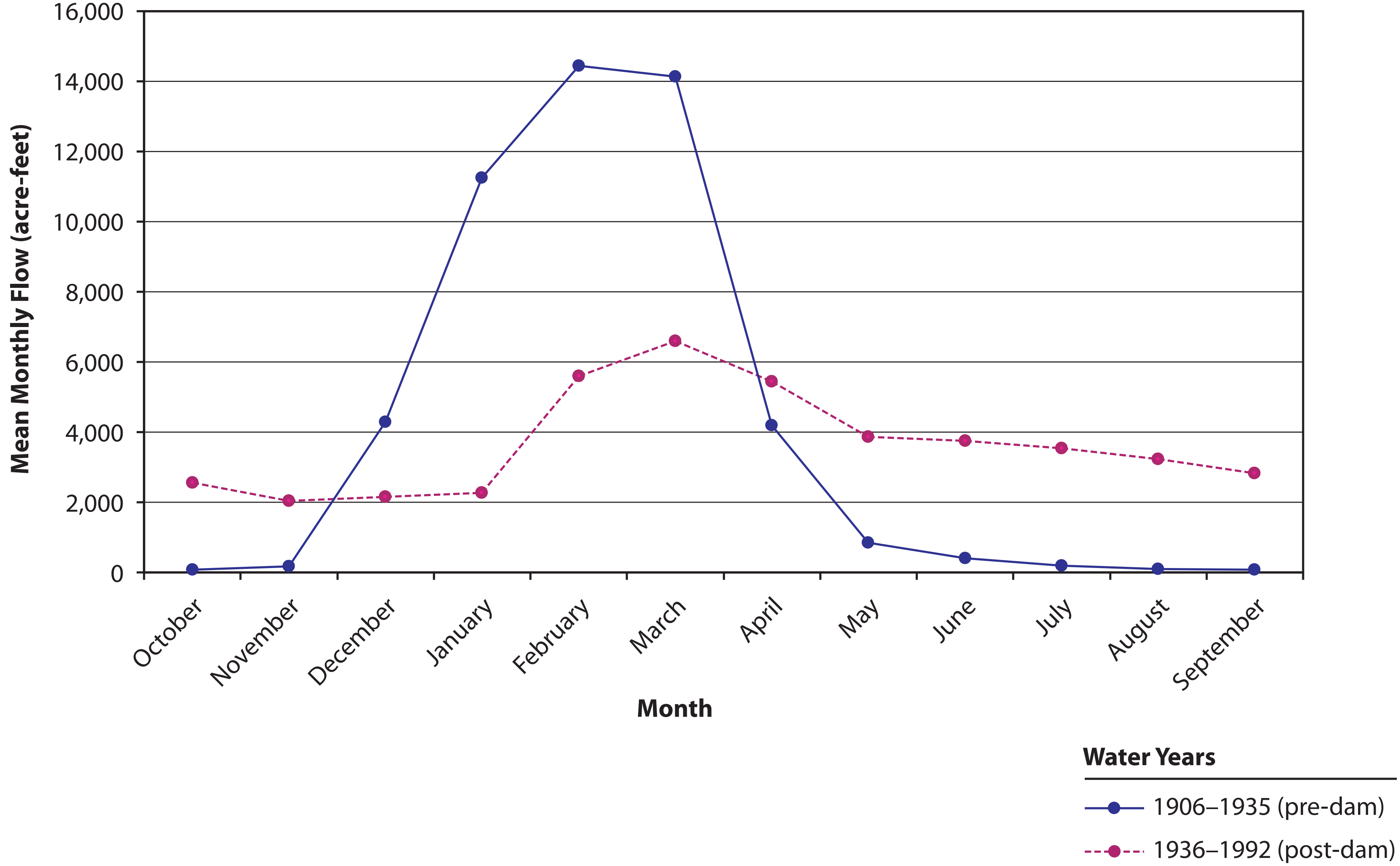


Figure 3-6
Santa Clara Valley HCP/NCCP Watersheds



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Source: California Department of Water Resources 2006.
Available: http://cdec.water.ca.gov/cgi-progs/selectQuery?station_id=cyo&sensor_num=&dur_code=M&start_date=01%2F01%2F1901&end_date=now. Accessed: September 13, 2006.

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Figure 3-7
Coyote Creek Historic and Current Mean Monthly Flows below Anderson Dam

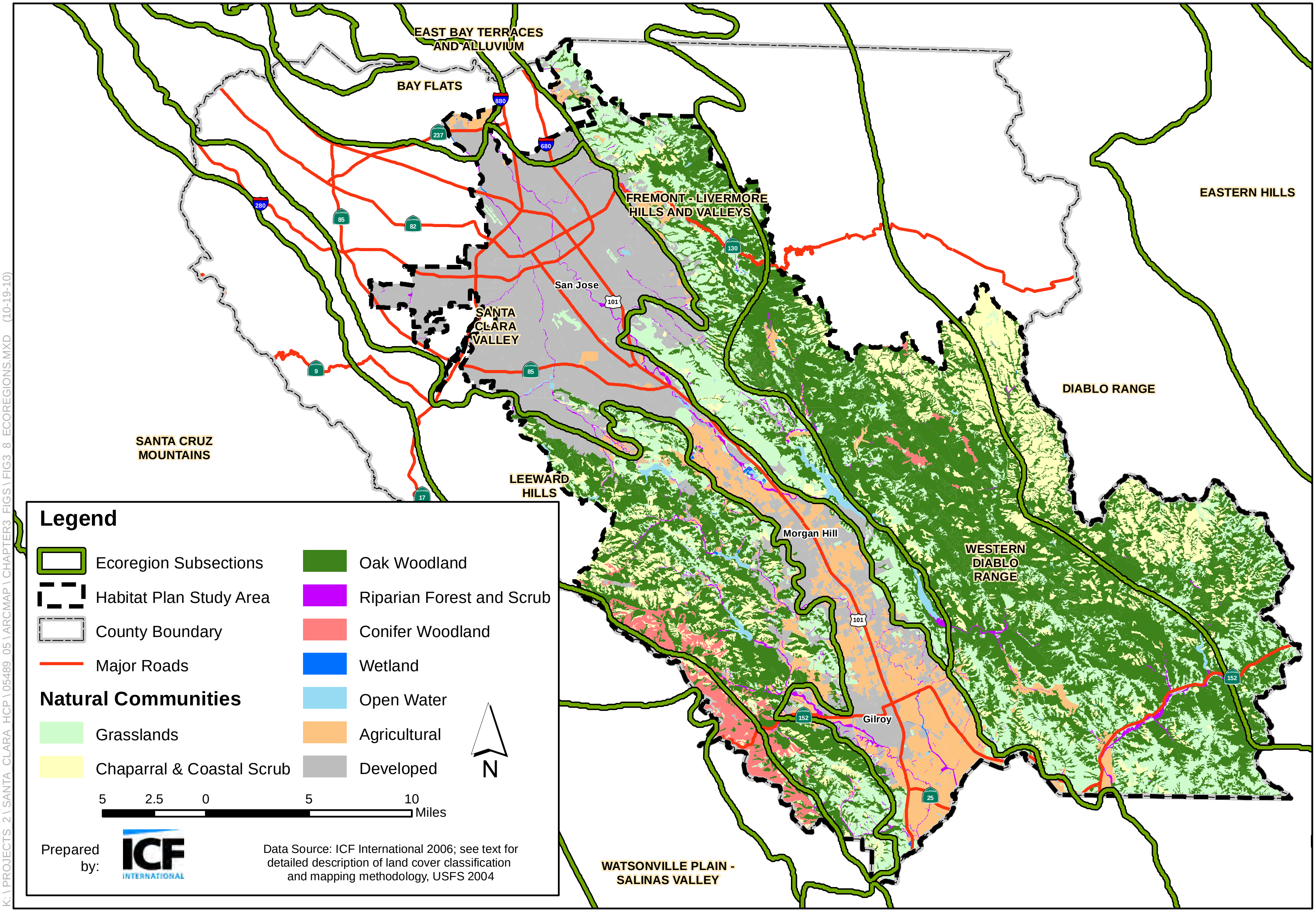

Figure 3-8
Santa Clara Valley Habitat Plan Natural Communities and USDA Ecoregion Subsections

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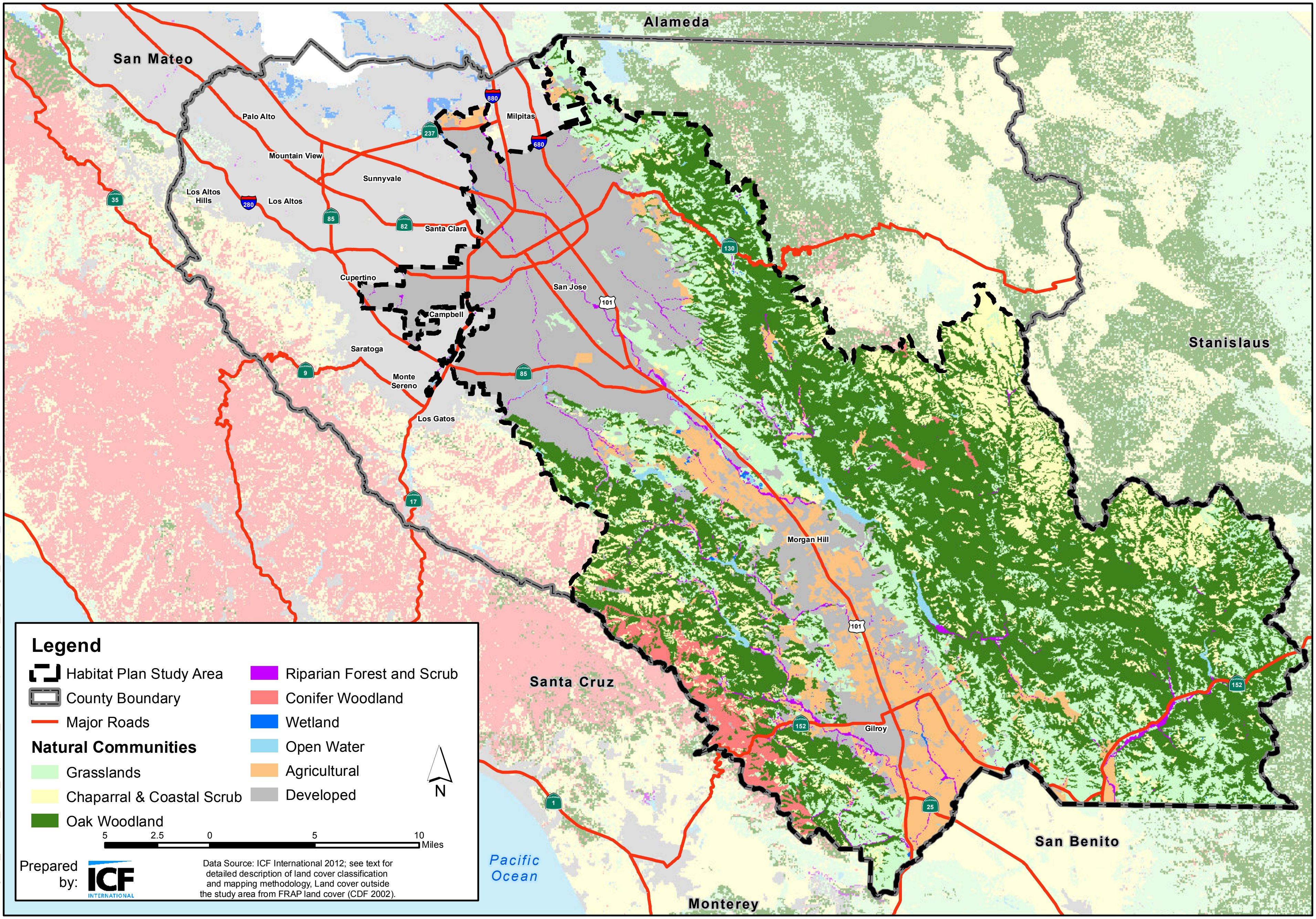

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Figure 3-9
Santa Clara Valley Habitat Plan Natural Communities

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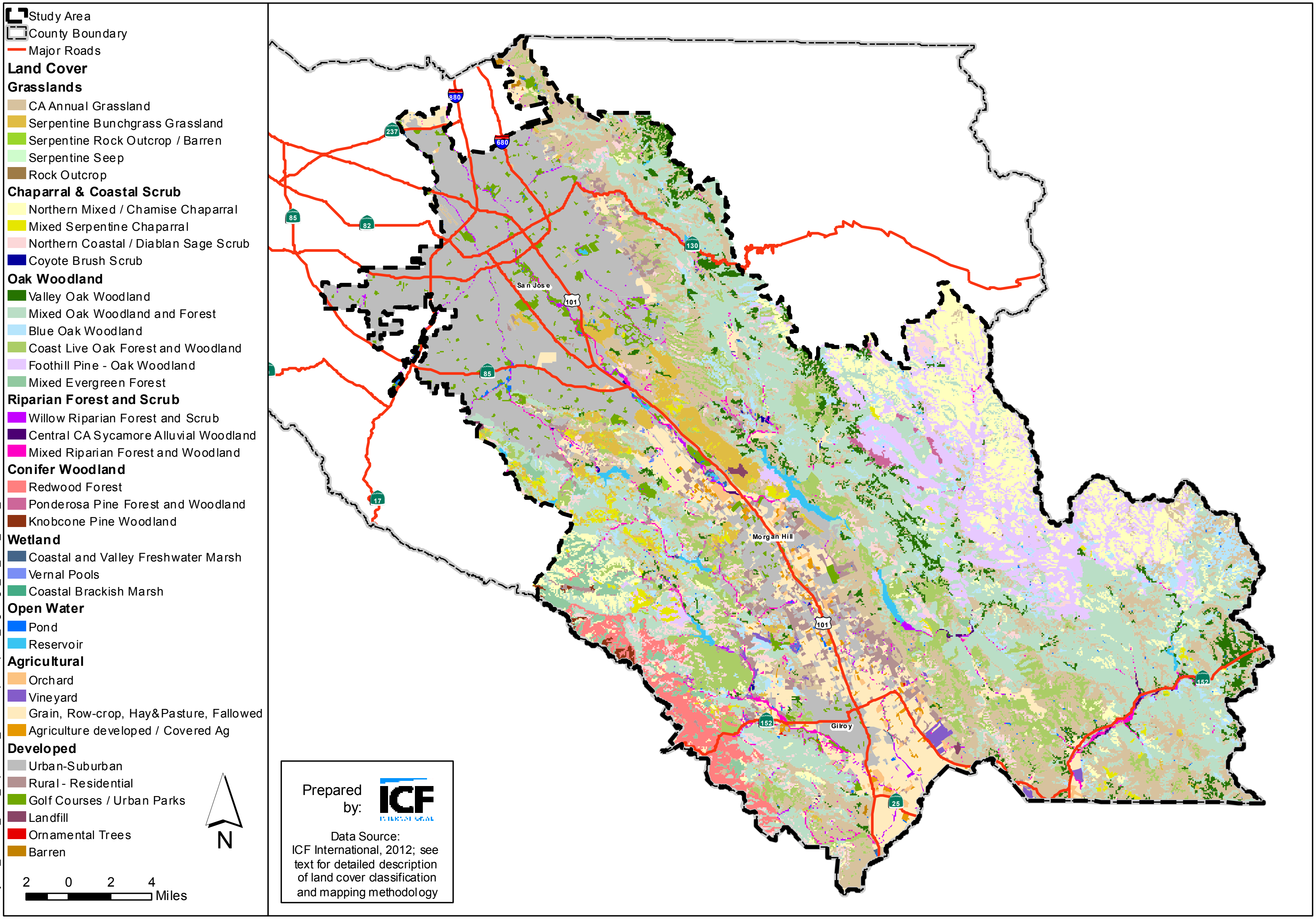

Figure 3-10
Santa Clara Valley Habitat Plan Land Cover

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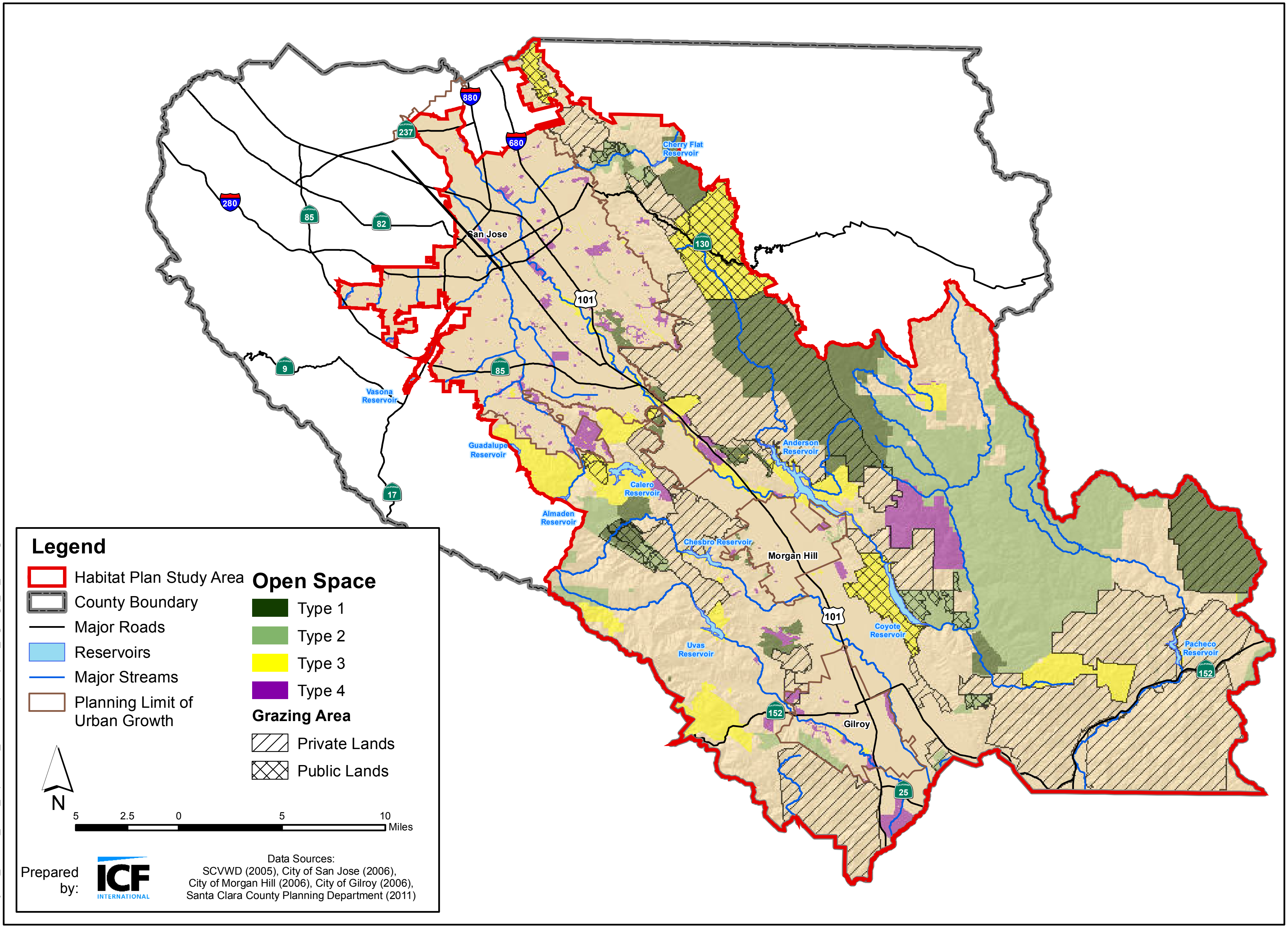

Figure 3-11
Extent of Grazing in the Study Area

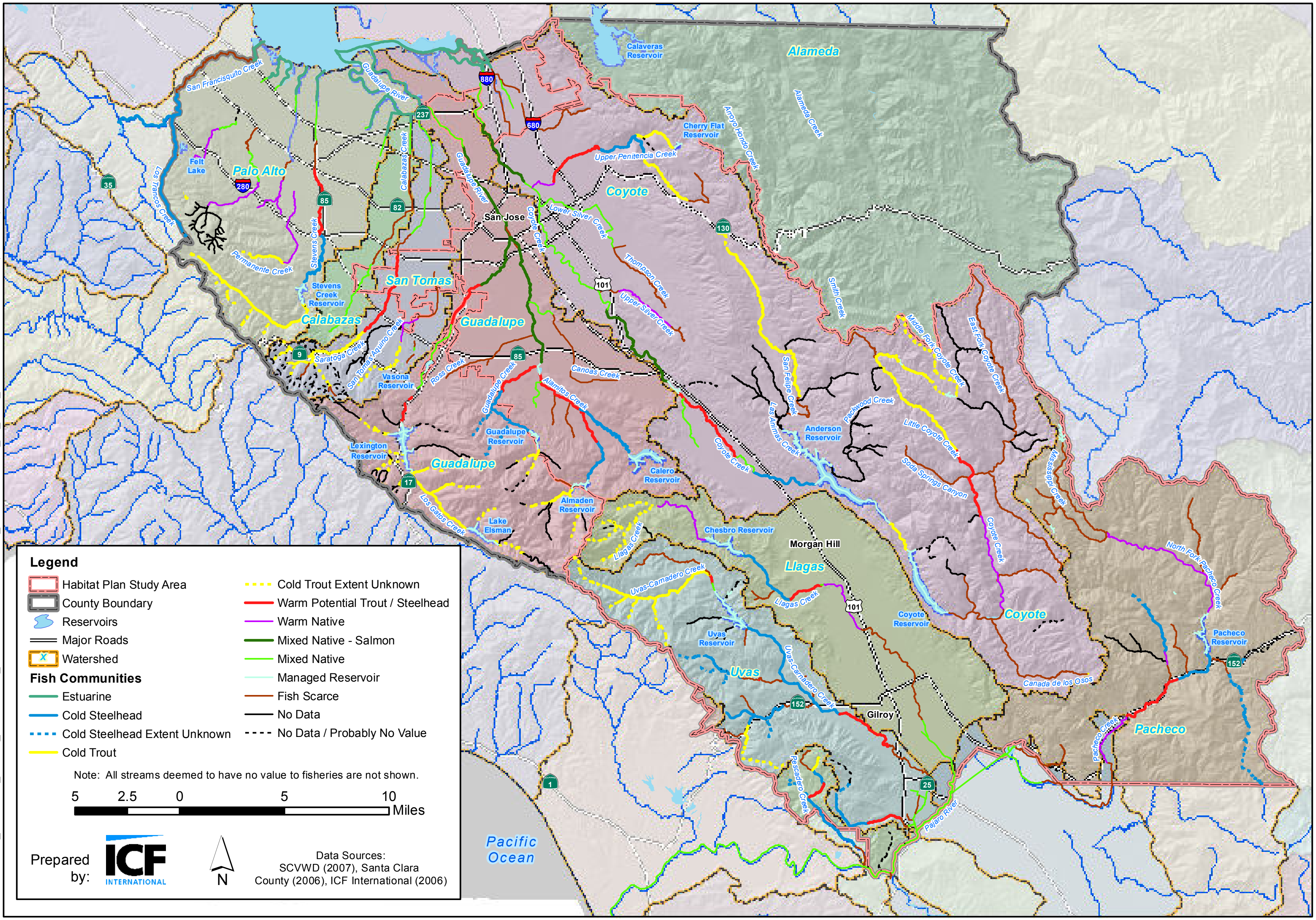

Figure 3-12
Fish Communities in the Study Area

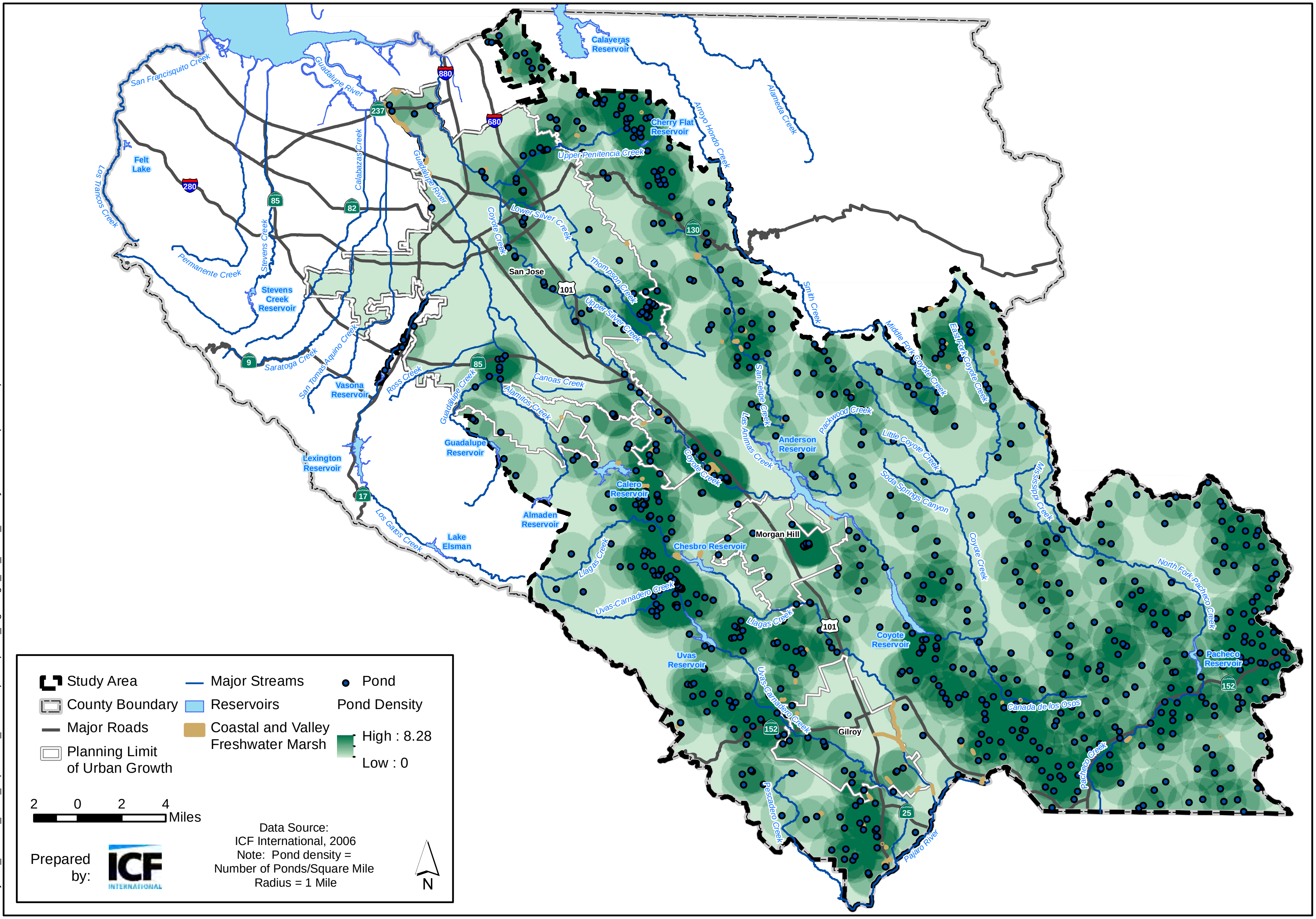

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Figure 3-13
Pond Density in the Study Area