INNER COAST RANGE NATURAL COMMUNITY ACCOUNT

The Inner Coast Range lies in the western margin of the County, and includes the Sky Valley and Sulphur Springs Mountain area (Tri-City/County Planning Area), the area west of Green Valley (e.g. West Hills), the volcanic hills of the Rockville area, and the Vaca Mountains/Blue Ridge. This community association is distinguished from the lowland, valley floor or vernal pool grassland association by geographic location, elevation and soils. Consisting of ridges and valleys that trend in a northwestern direction, this natural community is better characterized as a geographical region because it combines a number of plant communities, including grassland, oak woodland, oak savanna, and mixed chaparral/scrub that form a continuum/mosaic over the entire Inner Coast Range. This mosaic of different plant communities at various successional stages and ecotones provide a diverse array of habitat types for plants and wildlife. Conserving, maintaining and managing for the continued existence of this mosaic is critical for preserving the highest levels of biodiversity within the region.

This section identifies the covered species associated with this natural community, defines the specific habitat types covered within the natural community and the distribution of these specific habitat types within the Plan Area. A preliminary narrative conceptual model is presented for the purpose of outlining and discussing the essential ecological processes, habitat variables and significant pressures affecting the natural community.

Associated Covered Species

Two Covered Species from the Solano HCP are primarily associated with the Inner Coast Range Natural Community, the red-legged frog and the callippe silverspot butterfly (Table 4-1). Three additional Covered Species and three Special Management Species are secondarily associated with the Inner Coast Range Natural Community. The Covered Species include Valley elderberry longhorn beetle, burrowing owl, and Swainson's hawk; the Special Management Species include foothill yellow-legged frog, Western pond turtle, and yellow-breasted chat. However, there are very few occurrences of burrowing owls and Swainson's hawks in this area of the County.

Background

The Inner Coast Range Communities vary widely in elevation, bedrock composition and climate (Noss et al. 2002). Elevations range from ~300 to 3,000 feet, and precipitation (which varies with elevation) ranges from 20 to 40 inches per year. Bedrock is dominated by Cretaceous marine sedimentary units, with smaller inclusions of Tertiary sedimentary and basic igneous rocks (Wagner et al. 1981 and Wagner and Bortugno 1982). These units form ridges with intervening narrow valleys that trend in a northwestern direction. Vegetation, which varies with precipitation, contains grassland, oak savannah, oak woodland, and mixed chaparral/scrubland (Noss et al. 2002). These four plant communities were mapped for this HCP using aerial photograph interpretation (Figure 3-4) and described in more detail below. The Fire and Resource Assessment (FRAP) multi-source land cover

map developed by the California Department of Forestry and Fire Protection (CDF) was also reviewed for information about oak woodland classifications within the County that are more refined than the habitat mapping conducted for the HCP, which is based on aerial photograph interpretation only (FRAP 2002. Figure 4-9). FRAP utilizes various sources for vegetation mapping that have been cross-checked to the California Wildlife Habitat Relationship (CWHR) system.

Oak Woodlands. The absolute tree canopy-cover in oak woodland communities ranges from 30 to 100 percent depending on the aspect of the woodland; on moist, north to east facing slopes the cover is greater than on dryer, south to west facing areas. Species composition will also vary according to aspect and water availability. Coast live oak (*Quercus agrifolia*), a broad-crowned, evergreen tree up to 75 feet tall, and blue oak (*Q. douglasii*), a deciduous oak up 60 feet tall, are commonly dominant trees in oak woodlands of Solano County. Other broad-leaved, evergreen or deciduous trees, including interior live oak (*Q. wislezenii*), black oak (*Q. kelloggii*), California bay (*Umbellularia californica*), California buckeye *(Aesculus californica*), and walnut (*Juglans* spp.), are common associates in or at the edges of the woodlands.

Where the canopy cover is less dense and sunlight reaches the forest floor, a diverse flora of mostly native shrubs and herbaceous species may be present. Shrubs in the understory may include current/gooseberry (*Ribes* spp.), woodland rose (*Rosa gymnocarpa*), poison oak (*Toxicodendron diversilobum*), and California hazelnut (*Corylus cornuta* var. *californica*). Grasses, forbs and ferns that are present may include a variety of native species, including California fescue *(Festuca californica*), blue wildrye (*Elymus glaucus*), hound's-tongue (*Cynoglossum grande*), Dutchman's pipe (*Aristolochia californica*), Pacific pea (*Lathyrus vestitus*), California polypody (*Polypodium californicum*), goldback fern (*Pentagramma triangularis*), and woodfern (*Dryopteris arguta*).

The following additional types of oak woodland/oak savannah were mapped by FRAP in the Inner Coast Range area of the County (FRAP 2002; Figure 4-9). Blue oak woodland, which is dominated by blue oak and commonly associated with coast live oak in the Coast Range, is the most common oak woodland community mapped in the Inner Coast Range in the County by FRAP. The Blue oak-foothill pine (*Pinus sabiniana*) community, which is usually dominated by blue oak, also occurs in the northern and central portion of the Inner Coast Range in the County in relatively small patches that are often adjacent to blue oak woodland. Montane hardwood, which often forms pure stands of canyon live oak (*Quercus chrysolepis*) on steep canyon slopes and rocky ridge tops, is also mapped throughout the Inner Coast Range area of the County in patches. Valley oak woodland ranges from savanna-like to more dense woodlands and is the least common type of oak woodland mapped by FRAP in the Inner Coast Range area of the County (Figure 4-9).

Oak savannah. The canopy-cover in oak savanna typically ranges from 10 to 30 percent. Dominant oak species in this plant community in Solano County are valley oak (*Quercus lobata*), growing on deep, alluvial soils on the Central Valley floor, and blue oak (*Q. douglasii*) and Oregon oak *(Q. garryana*), occurring in shallower soils and in other more xeric areas at higher elevations. Blue oak savanna commonly grades into blue oak woodland. In areas grazed by livestock, the shrubby understory in oak savanna is poorly developed, if present at all. In such

areas, the herbaceous understory consists of mostly non-native grasses and forbs, however, native wildflowers and grasses may be abundant in less disturbed areas.

Grassland. The grassland plant community within the Inner Coast Range region is similar to the grassland matrix and grassland associated with the low hills (Montezuma Hills and Potrero Hills) of the Valley Floor Grassland and Vernal Pool Natural Community. The characteristic species in both areas are introduced annual grasses and forbs. This plant community, which may also be found along levees within marsh communities and in agricultural and developed areas (mapped as Ruderal Disturbed; Figure 3-4), corresponds with Holland's "Non-native Grassland", element code 42200 (Holland 1986).

Common non-native grassland/ruderal species in Solano County include: wild oats (*Avena* spp.), bromes (*Bromus diandrus, B. hordeaceus*), hare barley (*Hordeum murinum* ssp. *leporinum*), Italian wildrye (*Lolium multiflorum*), filarees (*Erodium* spp.), mustards (*Brassica rapa, B. nigra, Hirschfeldia incana*), wild radish (*Raphanus sativus*), mallows (*Malva* spp.), vetches (*Vicia* spp.), starthistles (*Centaurea* spp.), and others. Native species that commonly occur with non-native plants in disturbed situations include small-flowered lupine (*Lupinus bicolor*), fiddleneck (*Amsinckia* spp.), California goldfields (*Lasthenia californica*), California poppy (*Eschscholzia californica*), and owl's-clovers (*Castilleja* spp., *Triphysaria* spp.).

In spite of the large-scale introduction and spread of non-native grasses and forbs, some native, perennial grasses are still present in small patches or intermixed stands with the non-native grasses. The size of these patches usually depends on various environmental factors and the severity of disturbance. The common native grassland in Solano County is Valley Needlegrass Grassland. This vegetation type corresponds to Holland's community of the same name and element code 42110 (Holland 1986).

Common native grass species that dominate native grassland areas are purple needlegrass *(Nassella pulchra*), one-sided blue-grass (*Poa secunda*), California fescue (*Festuca californica*), and creeping wildrye (*Leymus triticoides*). Other grasses that occur in lesser densities include blue wild-rye (*Elymus glaucus*) in shady areas, such as in the understory of oak woodland/oak savanna and melic grasses (*Melica* spp.) and nodding needlegrass (*Nassella cernua*), which commonly grow in dry, often rocky grasslands. Wildflowers (forbs) often found in grasslands with a native component include yarrow (*Achillea millefolium*), sanicles/snakeroots (*Sanicula* spp.), California dandelion (*Agoseris grandiflora*), California goldfields (*Lasthenia californica*), brodiaeas (*Brodiaea* spp., *Triteleia* spp. *Dichelostemma* spp.), and mariposa lilies (*Calochortus* spp.).

Mixed Chaparral/Scrub. Mixed chaparral/scrub communities are often characterized by dense low-growing shrubs. Two basic mixed chaparral/scrub communities are present in the County:

> **Northern Mixed Chaparral.** Mixed chaparral is generally a structurally homogenous plant community dominated by dense, fire- adapted shrubs. Shrub height and canopy cover each vary with age since the last burn, precipitation regime, species, aspect, and soil type. Mixed chaparral typically grows as a dense, nearly impenetrable thicket with greater than 80 percent canopy cover and up to four meters in height. On poor soil sites, including serpentine soils,

the canopy cover may be less and the shrubs may be shorter. This community corresponds to Holland's Northern Mixed Chaparral, element code 37110 (Holland 1986).

Species present include scrub oak (*Quercus berberidifolia*), manzanita (*Arctostaphylos* spp.), chaparral pea (*Pickeringia montana*), and chamise (*Adenostoma fasciculatum*). Herbaceous species may include needlegrass (*Nassella lepida*), California cudweed (*Gnaphalium californicum*), vinegar weed (*Trichostema lanceolatum*), woolly sunflower (*Eriophyllum lanatum*), and goldwire *(Hypericum concinnum*).

Scrub. Scrub, in contrast to chaparral, grows in sites that are slightly moister. Species composition will depend on the geographic location, soil, and climate, but there is typically one or a few shrub species dominant and there may be herbaceous plants and grasses in the understory. Scrub habitat is common in ecotones between woodland and grassland and the herbaceous species present will be those that are in the adjacent grassland.

Scrub communities in Solano County are often dominated by coyote brush (*Baccharis pilularis*) in relatively moist sites and California sagebrush (*Artemesia californica*) and sticky monkey flower (*Mimulus aurantiacus*) in dry sites.

Distribution within the County

This natural community, or geographic region, is located along the western boundary of Solano County and is part of the eastern edge of the Inner Coast Ranges (Figure 4-2). The primary areas within Solano County occur in the Sky Valley and Sulphur Springs Mountain area (Tri-City/County Planning Area) including an area west of Green Valley, in the volcanic hills of the Rockville area, and in the Vaca Mountains/Blue Ridge.

As mentioned above, the Inner Coast Range Natural Community comprises several plant communities and habitats. These include oak woodland, oak savanna, grassland and mixed chaparral/scrub (Figure 3-4 and Figure 4-2). A number of factors affect the type of vegetation that occurs in the Inner Coast Range region of Solano County. These factors are discussed in the model section below. A general overview of the distribution of each plant community type is discussed below.

Oak Woodlands. Oak woodland is one of the dominant plant communities in Vaca Mountains, at the eastern edge of the North Coast Ranges.

Historic Extent of Oak Woodlands. Historically, this vegetation has changed greatly from the activities of the European settlers. Many of the areas of the County that are currently dominated by a nonnative annual grassland community are likely deforested savanna and woodland communities. The lack of current woodland and scrub cover appears to have been brought about by historic, post Gold Rush, tree harvest and livestock grazing (Swiecki and Bernhardt 1998a,b,c). The potential natural communities in these Inner Coast Range areas pre-European Settlement throughout much of the western portions of the County (as identified by Kuchler 1977) were blue oak and foothill pine woodlands with smaller areas of mixed hardwoods composed of oaks, madrone, and other species in the moister fog-belt zone in the hills east of Vallejo (Kuchler 1977). The only area identified as grassland, within the

Inner Coast Range Community, is a grassland and scrub mosaic that occurs west of the mixed hardwood zone in the western portion of the Tri-City County area that is north and east of the City of Vallejo (Kuchler 1977).

Oak Savanna. Oak savanna occurs on the eastern, lower slopes of Vaca Mountains where it generally grades into oak woodland at higher elevations.

Grassland. Grassland dominates the southwestern portion of Solano County, but also occurs intermixed within the oak woodland/oak savanna areas.

Mixed Chaparral/Scrub. The habitat mapping conducted for the HCP was not refined enough to distinguish northern mixed chaparral from scrub (Figure 3-4). However, based on subsequent observations by LSA Associates, in Solano County, northern mixed chaparral is the dominant community at higher elevations in the Vaca Mountains, along the Napa County border; whereas, scrub habitat is common in the ecotone habitat between oak woodland and grassland in the lower West Hills/Green Valley region.

Narrative Conceptual Model

Understanding the essential ecological processes that structure natural communities is critical for conservation planning (Margules and Pressey 2000). This section provides a preliminary narrative conceptual model for the Inner Coast Range Natural Community. This model will be used to guide the conservation approach, goals, objectives and measures and the adaptive management and monitoring program. Following concepts developed by Atkinson et al. (2004), the essential ecological processes, habitat variables and anthropogenic threats, described in the model, are considered pressures. Pressures are agents that either promote or inhibit change in the state of the environment (Atkinson et al. 2004). Similar to the Valley Floor Grassland and Vernal Pool model, the pressures affecting the Inner Coast Range Natural Community are divided into three categories, essential ecological processes and habitat variables, land use practices and the consequences of land use practices. All pressures affecting the Inner Coast Range communities are discussed in sections below, starting with the essential ecological processes and habitat variables, then moving into the land use practices, followed by the consequences of these practices.

Essential Ecological Processes and Habitat Variables. The essential ecological processes and habitat variables that structure the Inner Coast Range Natural Communities are:

Slope Aspect. Slope aspect can affect the type of plant community on a slope and the species composition. The relatively cooler north-facing slopes tend to support oak woodland or coyote bush scrub while the south-facing slopes tend to support grassland, California sagebrush scrub, or chaparral. Aspect can also affect the species composition, canopy cover and tree density in oak woodlands. Absolute canopy cover of oak woodlands ranges from approximately 30 to 100 percent and tend to be higher on the moister north to east-facing slopes and lower on the drier south to west-facing slopes. Oak woodlands with a lower canopy cover tend to support a more established and diverse understory of shrubs and herbs.

Soil. Soils are types that are typically associated with upland or hillsides. Common soils in the include: Dibble-Los Osos clay loams, Hambright loam, Maymen-Los Gatos loams,

Millsholm loam and Toomes stony loam. These soils generally occur on slopes above the alluvial terrace lands that are typically associated with the historic extent of vernal pool grassland habitats.

Soil type is considered a natural pressure because it can promote or inhibit the establishment of particular plants species and plant communities. Soil type and depth can also affect the type of vegetation that occurs on a site. In general, shallow soils are droughty and support vegetation that is adapted to xeric conditions. Grassland, Scrub, and Chaparral often grow in areas of shallow soil. The trees of the woodland and savanna tend to grow in the deeper soils. Nevertheless, trees will eventually colonize areas of shallow soil given adequate conditions that occur during an occasional year.

Oak savanna occurs on the eastern, lower slopes of Vaca Mountains where it generally grades into oak woodland at higher elevations. In the oak savanna community, valley oak tend to be more dominant on deeper, alluvial soils and blue oak and Oregon oak tend to be more dominant in shallower soils and in other more xeric areas at higher elevations. The canopy cover of chaparral may be less and the shrubs shorter on poor soils, including serpentinite. In grasslands, shrub encroachment is higher on more productive soils, particularly near existing stands of scrub (Ford and Huntsinger 2003)

Many rare Inner Coast Range plant species, including Brewer's western flax and re-curved larkspur, are associated with certain edaphic conditions such as alkaline soils and/or serpentine soils and shallow volcanic rock-derived soils and outcrops that are nutrient poor or have the presence of other conditions which limit competition with other common plants and introduced grasses.

Climate. Precipitation within the Inner Coast Range community ranges from 20 to 40 inches a year and varies with elevation. Precipitation and water availability generally affects the plant species composition and type of plant community. East to north-facing slopes create microclimates in which water in more available than on west to south-facing slopes. In general, oak recruitment is higher in areas where more soil moisture is available, such as cooler slopes. In grasslands, shrub encroachment is higher during years with above-normal precipitation, particularly near existing stands of scrub (Ford and Huntsinger 2003). The effects of moister on the plant community mosaic were previously described above under Slope Aspect.

Wildlife Habitat and Resources. Oak woodland usually abuts other vegetation types at distinct, natural boundaries or edges creating a landscape-level mosaic of woodland, chaparral, and grassland (Vreeland and Tietje 2004). This mosaic of plant communities, characteristic of the Inner Coast Range within Solano County, provides important habitat for several wildlife species. Oak woodlands in particular provide important resources to wildlife. Approximately, 331 species depend on oak woodlands to varying degrees throughout their lifecycle (Verner 1980; Barrett 1980; Block and Morrison 1998).

> **Effects of the Habitat Mosaic on Species Composition.** Several studies, primarily focusing on birds, have studied the effect of this habitat matrix on species composition. For example, Sisk et al. (1997) examined the effects of matrix habitats

on bird species in oak woodland patches and found that the type of habitat surrounding oak woodland patches influences the composition and structure of the bird assemblage it supports. Specifically, 20 out of 34 bird species showed significant differences in mean abundance between oak woodland patches surrounded by chaparral vs. grassland. 1189 individuals, representing 44 species, with an average of 32 species per patch, were detected in oak woodland patches surrounded by grassland. On the contrary oak woodland patches surrounded by chaparral contained 439 individuals, representing 26 species, with an average of 20 species per patch. Half of the species (22/44) present in the oak woodland patches surrounded by grassland were not observed in the patches surrounded by chaparral, including three of the seven most abundant species: European starling, northern mockingbird, and red-winged blackbird (Sisk et al. 1997). Preserving a diversity of habitat types including multiple wooded patches surrounded by different types of vegetation will likely support the highest species diversity.

In addition to the habitat surrounding oak woodland patches, the amount of canopy cover within a given patch can, to some extant, influence avian community composition. Some species prefer stands with high canopy cover while others prefer more open areas or occur in both open and closed patches (e.g., western scrub-jay). For example, oak titmice prefer woodlands with a canopy cover between 40–70 percent, while western bluebirds prefer fairly open areas (CPIF 2002). Oak woodland stands with less canopy cover will have more shrubs in the understory, creating habitat for Bewick's wren, blue-gray gnatcatcher, California towhee and California thrasher. Western scrub-jays, on the other hand, occur in both closed-canopy and more open oak woodlands (LSA obs.). Unlike the effects of the habitat matrix, potential community-level effects of canopy cover on oak woodland birds have received little study. The degree to which canopy cover influences avian community composition may depend on individual species' habitat preferences rather than community-level processes, although this requires further study.

As mentioned above wooded patches typically occur on north-facing and east-facing slopes, riparian corridors, and canyons, where precipitation is concentrated and moisture is lost less rapidly to evaporation (Block and Morrison 1998). Corresponding to these microclimate conditions, salamanders are also typically found in denser oak woodlands on moister north-facing slopes; whereas, lizards use more xeric and open habitats (Block and Morrison 1998). In a habitat model developed by Block and Morrison (1998), litter depth, development of grasses and forbs, cover by downed woody debris, presence of rocky outcrops and slope aspect were key variables in predicting the herpetofauna of an area. Even a slight change in slope or aspect can result in a measurable difference in the microclimate and soil regime changing the suitability of a site to a particular species of amphibian, reptile or small mammal (Block and Morrison 1991).

Variation in soil and vegetation also influences the distribution of mammals within the Inner Coast Range Natural Community. For example, burrowing mammals, such as, the Broad-footed mole (*Scapanus latimanus*) and the Botta's pocket gopher (*Thomomys bottae*) prefer friable soils over more rocky soils. Trowbridge's shrew

(*Sorex trowdridgii*) is closely associated with well developed litter layers and ground cover of shrubs (Zeiner et al. 1990). Dusky-footed woodrats (*neotoma fuscipes*) prefer forested habitats with moderate canopy, year round greenery and a brushy understory (Zeiner et al.1990). Western gray squirrels (*Sciurus griseus*) are dependent upon mature stands of mixed conifer and oak habitats requiring large trees, mast and snags. Conversely, Botta's pocket gopher requires early stages of forest habitats, meadows and grasslands. Black-tailed hares (*Lepus californicus*) prefer intermediate canopy stages of shrub habitats whereas the brush rabbit (*Sylvilagus bachmani*) and desert cottontail (*S. audubonii*) prefer small scattered patches of dense shrub cover (Zeiner et al. 1990). Habitat for the Sonoma chipmunk (*Tamaia sonomae*) consists of tree/shrub ecotones, chaparral, small brushy clearings in forests and riparian thickets (Zeiner et al. 1990). Suitable habitat for mule deer (*Odocoileus hemionus*) is a mosaic of vegetation, providing an interspersion of herbaceous openings, dense brush or tree thickets (Zeiner et al. 1990). Similar to birds, reptiles and amphibians, preserving a mosaic of vegetation types will likely benefit the maximum number of mammal species within the Inner Coast Range.

Acorn Production. Acorns represent an important food source for several wildlife species that use oak woodlands, including acorn woodpecker, Lewis' woodpecker, Nuttall's woodpecker, western scrub-jay, yellow-billed magpie, oak titmouse, and white-breasted nuthatch, western gray squirrels, Sonoma chipmunk and several other small mammals (CPIF 2002; Zeiner et al. 1990). Verner (1980) names 30 bird species as consumers of acorns, six of which have diets that are more than 25 percent acorns. Acorn woodpeckers and western scrub-jays cache many thousands of acorns every year. Western scrub-jay individuals may store as many as 5,000 acorns annually (Vander Wall 1990), whereas a population of acorn woodpeckers may store up to 43,000 in a year (Koenig 1990, Vander Wall 1990). Acorn production varies in time and space between and among species and can significantly influence vertebrate populations (Sork and Bramble 1993; Koenig et al. 1994). Years of high acorn production, "'mast" years, trigger pulses in vertebrate populations and reproduction. For example, long-term population studies of acorn woodpeckers at the Hastings Reservation in Monterey County indicate that reproductive success and juvenile survivorship are strongly dependent on the size of the acorn crop (Koenig and Haydock 1999). A reduction in acorn availability may endanger local populations of this species, and groups are often forced to emigrate from an area during years of poor acorn production (Hannon et al. 1987). Although other acorn-consuming species have not been studied as extensively, it is likely that they are also heavily dependent on acorn crop size. Thus, a reduction in oak woodlands, corresponding to a reduction of acorn availability, may endanger local populations of several wildlife species dependent on acorns for food.

Cavities. Cavity-nesting birds make up a large proportion of the bird species and a majority of the individual birds breeding in oak woodlands (Wilson et al. 1991). Cavity-nesting species are classified as either excavators (excavate their own nest cavity) or secondary cavity nesters (use cavities previously excavated by another species). Excavator species include acorn woodpecker, Lewis' woodpecker, and Nuttall's woodpecker. Secondary cavity nesters include ash-throated flycatcher, oak

titmouse, white-breasted nuthatch, Bewick's wren, western bluebird, and European starling. Cavities are most often associated with dead and decaying limbs on otherwise living trees or dead snags. Allowing dead limbs to remain on living trees may provide entry points for decay-enhancing organisms, which in turn allow birds to excavate cavities in the rotting wood (CPIF 2002).

Recent studies on the ecology of cavity nesters have focused on community-level interactions among various excavators and secondary cavity nesters, developing the concept of a "nest web": a hierarchical community structure that is similar to a food web but maps the interdependence of members of a cavity-nesting community (Martin and Eadie 1999, Martin et al. 2004). A nest web describing a cavity-nesting community in interior British Columbia showed that most cavity resource use flowed up through the community though aspen trees and cavities excavated by northern flickers (Martin et al. 2004). Thus, the authors concluded that aspen was the critical nesting tree and northern flickers were the keystone excavators in this community (Martin et al. 2004). This pattern, that nest webs and the resulting community diversity and myriad ecological interactions among secondary cavity nesters in a given forest ecosystem may be founded on one or two principal keystone species, has also been documented in other forest systems (Bednarz et al. 2004). No such studies have been conducted in California oak woodlands. Such a study would prove immensely valuable in defining keystone species (i.e., those that exhibit disproportionate influence over the structure and function of their community due to some life-history trait or interactions with other species [Paine 1969]) in California oak woodlands, which support a variety of both excavators and secondary cavity nesters (see above).

Links between the Riparian, Stream and Freshwater Marsh Natural Communities and the Inner Coast Range Natural Community. The Inner Coast Range Natural Community consists of the watershed area of the Riparian, Stream and Fresh Water Marsh Natural Community (Figure 3-5). As such, there are important links between these two communities. The development and alteration of a surrounding watershed can significantly alter the function and value of streams and wetlands. The wetland functions most threatened by loss of upland habitats are water quantity and quality, energy and nutrient systems and wildlife habitat (Taylor et al. 2002). Most of the focus of preserving watershed land is for the benefit of maintaining water quality and wetland functions. Similarly, ecologists have often assumed that material exchange between rivers and watersheds is highly asymmetric, with terrestrial watersheds, feeding rivers. However, tremendous secondary production of aquatic insects can be sustained by lotic algae (Power and Rainey 2000). The aquatic insects flourish on lotic algae then emerge from the aquatic environments and transport biomass upslope into the watershed. Such a backflow was documented in Sycamore Creek, Arizona, where Jackson and Fisher estimated that 97 percent of the aquatic insect emergence (22.4 grams carbon m-2y-1) was exported to the watersheds where it fed consumers including ants, birds and bats. Aquatic insect emergence provided 25% of the annual energy budget for birds around a headwater forest stream in Hokkaido (Nakano and Murakami (2001). Along the South Fork Eel River in Mendocino County, bats, tracking emergent insect fluxes, foraged extensively over the river, then deposited aquatic nutrients into the uplands via defecation (Power and Rainey 2000). Wetlands provide habitat for many species of birds, mammals and reptiles that

are primarily associated with the Inner Coast Range Natural Community. These species feed and/or breed in wetlands, then spend time in adjacent upland habitats where they defecate, die, and become food for upland animals, adding both energy and organic matter to the upland community (Taylor et al. 2002).

Similarly, amphibians, particularly California red-legged frogs and foothill yellow legged frogs two species primarily associated with the Riparian, Stream and Freshwater Marsh Natural Community, are also dependent on and use the watershed land of the Inner Coast Range Natural Community. Adult red-legged frogs are highly aquatic but if water is no longer available during the summer, they have been observed using boulders, rocks, downed trees, logs, moist leaf litter or small mammal burrows in the upland areas as refuge (USFWS 2002). The Inner Coast Range Natural Community also provides critical dispersal habitat for these frogs. California red-legged frog populations persist and flourish where suitable breeding and foraging habitats (Riparian, Stream and Freshwater Marsh habitat) are interspersed throughout the landscape and are interconnected by contiguous dispersal habitat (Inner Coast Range habitat).

Fire. Some plant communities, such as some types of chaparral, are dependent on fire. Fire burns the decadent above ground stems and branches and returns the ash to the soil as nutrients. The chaparral species replace themselves from sprouts from the root crown or from seeds. The seeds are adapted to withstand the heat from fires and, in some cases, require fire to germinate.

Pulses in oak regeneration have sometimes been attributed to fire (Ford and Huntsinger 2003). Some researchers believe that fire suppression has contributed to the lack of oak regeneration by eliminating competition, improving seed bed conditions for acorn germination, reducing habitat for wildlife that eat acorns, and increasing stump sprouting; however, most researchers believe poor oak regeneration is primarily caused by factors other than fire suppression (McCreary 2004). Valley oak and blue oak, which are species that are important components of Solano County oak woodlands, are two of the three species of oaks in California that have regeneration problems. Fire affects the structure of some oak woodlands by clearing shrubs from the understory and maintaining an understory of herbs. Typically in California oak woodlands, fire suppression has created fuel loads and ladders that are hazardous and can lead to severe fires. Severe fires can also remove the overstory of Oak Woodland. When this happens, the resulting vegetation is most often grassland and scrub prior to the reestablishment of the oak savanna or oak woodland.

Natural or anthropogenic, fires affect grasslands in the Inner Coast Range community in a similar way that it affects valley floor grassland community as described in the preceding section on the Valley Floor Grassland and Vernal Pool Natural Community Conceptual model. The largest benefit of fire on this ecosystem is the reduction of thatch build-up and a decrease in nonnative annual grasses in the following year. Reduction of thatch and non-native plants reduces competition for native plants and improves their seed production and cover.

Fire can have a beneficial or detrimental impact on native plants, depending on the season and intensity of the burn. Fires that burn plants prior to seed set can decrease the abundance

of those species. Native perennial grasses have also been shown to respond favorably to appropriately timed burns. Prescribed burning has also been used to control invasive exotic species. At the Jepson Prairie a series a prescribed burns were implemented in the vernal pool grassland complex in the late-spring and fall and results indicated that late-spring burning reduced thatch density and the cover of nonnative exotic grasses such as medusahead (*Taeniatherum caput-medusae*), while increasing the cover of native grasses and forbs (Pollak and Kan 1998). The late-spring burn also increased the cover of some early spring forbs, especially filaree (*Erodium* spp.). Fall burns also reduced thatch and killed some exotic plant seedlings, but some native plants were also vulnerable.

The *Report of Science Advisors: Supplement on Rangeland Management* that was prepared for this HCP reviewed scientific literature on the effects of rangeland management activities such as prescribed burning on the special-status species and their habitats covered by this HCP (Ford and Huntsinger 2004). They point out that prescribed burning research, especially for special-status species covered by this HCP, is limited and sometimes conflicting. Prescribed fire is currently being used in California to enhance native grasses and forbs in grasslands, but the effects are complex, context specific conditions, vary with edaphic and climatic factors and effect different species differently (Ford and Huntsinger 2004). Climate, especially precipitation, has a major impact on the response of perennial grasses and forbs to fire; therefore, long-term research is required to assess the changes caused by manipulating burning treatment verses changes caused by weather (Ford and Huntsinger 2004). Although the effects of fire are complex and species specific research is sparse, speculations about the affects of fire can be made based on more general research and assumptions about a species' habitat requirements (Ford and Huntsinger 2004).

> **The effect of fire on wildlife.** The affect of fire on wildlife is dependent on the fire type. Different fire types, dictated by fuel loads, fuel moisture, and weather conditions, produce a wide range of post-burn results (McCreary 2004). Low- to moderate-intensity fires in oak woodland habitat can actually have a net positive effect on wildlife habitat. Vreeland and Tietje (2002) observed no change in the relative abundance of small mammals, breeding birds, amphibians, or reptiles in response to a light-intensity prescribed fire in mixed blue oak-coast live-oak woodlands in coastal-central California; even though the prescribed fire significantly reduced the density of grass and shrub cover, coarse woody debris and woodrat houses. From their results, they concluded that light- to moderate-intensity prescribed fire in California oak woodlands probably benefits wildlife by stimulating shrub and tree vigor by reducing resource competition from exotic annual grasses, and increasing overall habitat rejuvenation (Vreeland and Tietje 2002). Fire conflagrations, on the other hand, can seriously impact habitats and require years for recovery. Bigger, hotter fires destroy more of the seed base and cause a greater loss of topsoil, both of which make habitat recovery slower and more difficult (McCreary 2004).

Sudden Oak Death. Sudden Oak Death (SOD) is caused by the recently described fungus-like pathogen called *Phytophthora ramorum*. The name Sudden Oak Death refers to the rapid die back of the crown of infected trees. When a tree is infected, is can becomes susceptible to invasions by insects and fungi which can further weaken the tree. *Phytophthora ramorum*

spreads via rainwater, soil, infected plants and wood, and via the air from the foliage of host plants. The pathogen thrives in moist coastal environments in California and the presence of SOD has been confirmed in the western portion of Solano County by the California Oak Mortality Task Force (COMTF 2004). *Phytophthora ramorum* infects oak trees in the sections Lobatae (red oaks) and Protobalanus (intermediate oaks) oak trees (*Quercus* spp.), but not white oaks in the section Quercus (white oaks) (Garbelotto 2004). In California, tanoak (*Lithocarpus densiflorus*) and coast live oak have suffered the highest SOD mortalities compared to other host tree species. Tanoak and oak (*Quercus* spp.) tree infections are considered bark canker hosts. In Solano County, coast live oak and black oak trees are vulnerable to *Phytophthora ramorum* infections, but blue oak and valley oak, which are white oaks, are not considered susceptible to the pathogen. Bark cankers in trees often cause tree mortality, but infected foliar hosts only occasionally die (UC Extension 2003). Some plant species that occur in Solano County that are known *Phytophthora ramorum* foliar hosts include California bay laurel, California buckeye, big leaf maple, and poison oak (Rizzo and Garbelotto 2003). California bay laurel in particular is believed to be one of the hosts most responsible for spreading the pathogen; with a single exception, all known infected California sites support either California bay laurel and/or tanoak (Garbelotto 2004).

Land Use Practices. The land use practices or primary pressures that directly affect the Inner Coast Range community and its associated plant communities in Solano County are:

Urbanization. Urbanization results in increased fragmentation of Inner Coast Range habitat and decreased watershed area. In the last approximately 50 years, the conversion of oak woodlands in California for residential development and the fragmentation of large parcels into smaller rural residential parcels have increased (Giusti et al. 2004). This fragmentation of large oak woodland parcels into smaller parcels is sometimes a necessity when land is inherited from deceased family members because of the financial burden of estate taxes (Giusti 2004). Each year, over 30,000 acres of oak woodlands in California are cleared for residential and commercial development (Standiford and Scott 2001 as referenced in Giusti et al. 2004). Pressure from urbanization in the Inner Coast Range community is more pronounced in the Vallejo area and along the eastern boundary of the community. Urbanization is also associated with the establishment and spread of exotic plant and animal species. See consequences of land use practices for more specific information.

The effect of urbanization on wildlife. The impact of encroaching urbanization affects wildlife species in different ways, with some species being more tolerant than others. The effect of urbanization on California's oak woodlands does not always result in distinct edges. Unlike the abrupt edges created by development and agriculture in eastern-deciduous, boreal, and tropical forests, encroaching urban development, particularly rural residential and estate residential developments, retain a certain degree of canopy cover. For example, Merenlander and Heise (1999) did not find a statistical difference between percent hardwood cover, calculated using thematic mapper satellite data, between residential sites and preserve sites; however they did find substantial differences in bird populations between various land uses. They surveyed plots in (1) relatively undisturbed hardwood rangeland in private parcels greater than 300 acres; (2) ranchettes on 10- to 40-acre lots; and (3) suburban areas with single-family homes on 0.5- to 2.5-acre lots. They found that tree density

decreased with increasing housing density and suburban areas had a marked increase in exotic plants because of residential gardens. The number of plant, bird, and butterfly species was also similar among land-use types. Conversely, bird species composition significantly differed among land-use types, illustrating that subdividing private land can have a substantial affect on species composition. Specifically, they found that the percent of neotropical migrant birds, species that winter in Central and South America, was significantly higher at undeveloped sites than at ranchettes and small suburban lots. The results of Merenlender and Heise's (1999) study suggest that smaller property sizes and associated disturbances (e.g., increased road density, impact of house cats, and human activity) likely reduce the diversity and abundance of rarer bird species, particularly neotropical migrants.

Another study on the effects of rural residential development and landscape composition on breeding birds in Placer County's oak woodlands, found that many species were sensitive to development density or landscape composition (Stralberg and Williams 2002). The species most sensitive to urban edge proximity or development density were lark sparrows, rufous-crowned sparrows and western meadowlark. Using the results from a generalized linear regression model they predict that lark sparrow densities would be greatly reduced at development densities greater than 5 acres per parcel and would be virtually non existent at one acre per parcel density (Stralberg and Williams 2002). A few species appeared to be positively affected by urban edge proximity or development density; these included the house finch, western crowned sparrow, black phoebe and western scrub jay. In a similar study in Palo Alto, California, Blair (1996) found that the composition of the bird community shifted from predominantly native species to more invasive and exotic species along a gradient of increasing urbanization. Blair (1999) also found that butterfly abundance was highest at preserve sites and decreased as sites became more urbanized, bird abundance, however, peaked at a site of intermediate development.

Intensive Agriculture (Croplands). Inner Coast Range habitats have also been directly lost from conversion to agricultural crops. In the last approximately 50 years, the conversion of oak woodlands in California for intensive, water-demanding agriculture has increased (Giusti et al. 2004). Intensive agriculture or croplands result in increased fragmentation of existing habitat and decreased watershed area. See consequences of land use practices for more specific information.

Cultivated Grassland/Dry-land Farming. Cultivated grassland/dry-land farming does occur in a few limited areas within the Inner Coast Range where irrigation water is not readily available and/or topography is not suitable for irrigation; however, the majority of this land use type is restricted to the Montezuma Hills in the south-eastern portion of the County within the Valley Floor Grassland and Vernal Pool Natural Community. Cultivated grassland and dry-farmed areas are largely similar to the non-native annual grasslands and provides very similar wildlife habitat. The direct affects include reduction of native plant species, reduced biodiversity and the periodic disking or tilling of the land.

Livestock Grazing. In the last approximately 50 years, oak woodlands in California that have been traditionally used for livestock grazing are increasingly being converted for residential development and intensive agriculture (Giusti et al. 2004).

The *Report of Science Advisors: Supplement on Rangeland Management* that was prepared for this HCP focuses on the effects of grazing on the special-status species and their habitats covered by this HCP (Ford and Huntsinger 2004). They point out that grazing management research, especially for special-status species covered by this HCP, is limited and sometimes conflicting. Furthermore, they state that literature often describes moderate grazing as neutral or beneficial, but little applicable information is available to guide the development of a prescribed grazing plan to benefit specific species or to minimize specific negative effects. Conflicting results on the effects of grazing can sometimes be due to site specific conditions or weather patterns (Ford and Huntsinger 2004). In California annual grasslands and oak woodlands, weather can have a major affect on vegetation changes and the rate of oak recruitment; therefore, long-term research is required to assess the changes caused by manipulating the management regime verses changes caused by weather variables (Ford and Huntsinger 2004). Although the effects of grazing are complex and species specific grazing management research is sparse, speculations about the effects of grazing can be made based on more general research and assumptions about a species' habitat requirements (Ford and Huntsinger 2004).

The following sections describe the negative and beneficial affects of livestock grazing on Upland plant communities. The affects on Inner Coast Range grasslands is similar to the affects on Valley Floor Grasslands that were described in the preceding section on the Valley Floor Grasslands and Vernal Pool Natural Community Conceptual Model.

Negative Effects of Livestock Grazing. In Inner Coast Range areas, if livestock are allowed to graze at inappropriate times, they can disturb the habitat of sensitive species, or directly consume or trampling them. Grasslands are an understory component in many of the plant communities in the Inner Coast Range Natural Community. In grasslands, inappropriate grazing regimes such as overgrazing or undergrazing or the removal of grazing can reduce the cover of native plants and increase the cover of non-native plants or cause the introduction or spread of invasive non-native species. The heavy grazing of the European settlement period of California is considered one of the reasons for the conversion of grasslands dominated by native species to those dominated by non-native species. In chaparral and scrub communities, grazing can reduce the cover of shrubs and potentially lead to a conversion to a grassland community. In oak woodlands, grazing generally has the effect of restricting oak performance to a narrower range of abiotic conditions (Anderson et al. 2002; Anderson S. personal communication).

The authors of the *Report of Science Advisors: Supplement on Rangeland Management* that reviewed grazing impacts for this HCP, sited grazing as one of the many causes of the lack of oak recruitment in California oak woodlands/oak savannas (Ford and Huntsinger 2003). Valley oak and blue oak, which are species that are important components of Solano County oak woodlands, are two of the three species of oaks in California that have regeneration problems. Grazing causes oak

seedlings mortality through trampling, soil compaction, and selective herbivory, especially in the summer and fall when the quality of forage grasses declines (Ford and Huntsinger 2003). The shift in native grasslands to non-native annual grasslands, which is caused by disturbances such as grazing, is also considered one of the causes for poor oak recruitment in California (Allen-Diaz et al. 1999 as referenced in Ford and Huntsinger 2003). Ford and Huntsinger (2003) also point out that sometimes other factors such as weather, deer, insects, rodents, and soils play a larger role than livestock grazing in the lack of oak recruitment. Oak recruitment, for example, can be higher on specific soil types and in moister areas such as cooler slope aspects.

Beneficial Effects of Livestock Grazing. Appropriate levels and timed grazing can be a successful management tool in Inner Coast Range plant communities. In grasslands, grazing can reduce biomass of annual non-native plants and decrease the build up of thatch that may inhibit successful germination of native plants. Reducing annual grasses also improves moisture levels for native perennial grasses and oak saplings and decreases habitat for rodents that cause herbivory on oak seedlings (Ford and Huntsinger 2003). Grassland communities can also be maintained be reducing the cover of shrubs and the conversion to a chaparral, scrub or oak savanna community. In oak woodlands/savannas, if spring grazing is implemented as a management tool, it causes less damage to oak seedlings compared to prescribed burning. Creating a diversity of grazing regimes can also increase small-scale plant species richness (Ford and Huntsinger 2003).

Oak Tree Harvesting. Many of the non-native grasslands in the Inner Coast Range community are likely deforested oak savanna and oak woodland communities resulting from grazing and oak tree harvesting. Oak tree harvesting in California for fuel and charcoal production was extensive after the 1848 Gold Rush until about 1898 (Bernhardt and Swiecki 2001). California's hardwood rangelands, have been harvested for wood products since the late 1700s. This practice continues today, especially in the Sacramento Valley, where more than 50% of California's firewood is harvested blue oak woodlands (Vreeland et al. 2000). Furthermore, oak tree harvesting and oak woodland conversion is not regulated by the California Department of Forestry and Fire Protection and the Board of Forestry like harvesting other commercial tree species is regulated, but oak woodlands receive protection under CEQA through the Senate Bill 1334: Oak Woodlands Conservation: Environmental Quality and local county regulations (Giusti et al. 2004). Harvesting trees can potentially cause problems such as soil erosion, reduction in water quality and a subsequent decline in aquatic habitat, and fire hazards.

Recreation. The inappropriate use of designated open spaces, for example off-road vehicle use and vandalism, by recreation enthusiasts can threaten the ecological functions of Inner Coast Range communities. Off-road vehicle use, bicycling and even hiking in inappropriate areas can lead to direct mortality, trampling, soil erosion soil compaction. Site visitors may also facilitate the spread of invasive species via seeds transport.

Consequences of Land Use Practices. The consequences of the above land use practices (i.e. secondary pressures) on Inner Coast Range communities in Solano County are:

Habitat Loss and Fragmentation. Habitat loss and fragmentation is one of the largest threats to the survival and recovery of the covered species in the Inner Coast Range Natural Communities. The processes contributing to oak woodland fragmentation in California can be grouped into three categories: (1) large-scale conversion of woodlands, which may isolate a number of habitat islands within a short time; (2) patchwork conversion of woodlands, which has the cumulative effect of isolating progressively smaller patches of woodlands over longer periods; and (3) rural development, which alters the integrity of habitat areas without actually converting large acreages (as identified by Scott 1991). Rural residential (2.5 acre minimum) and estate residential (1/4 acre minimum) developments are one of the main causes of habitat loss within Inner Coast Range Natural Communities and the major force fragmenting existing oak woodland habitat. There are several different aspects to wildlife habitat, including breeding locations, sufficient home range areas to maintain population demographics and social structure, and avenues for dispersion, migration and gene flow. If the fragmentation of habitat interferes with movements, this may also disrupt the ratio of males to females or patterns of mate selection. This interference can lead to inbreeding and the loss of genetic material. The loss of genetic variability may leave species with less ability to adapt to future changes, thereby hastening extinction.

Edge Effect. Rural development often creates qualitative changes to woodlands which alter landscape dynamics in a fashion similar to the quantitative changes brought by patchwork development. However, habitat characteristics are often altered without major changes in vegetation. Habitat quality may be corrupted for some distance around rural developments because these areas act as innoculates of exotic and feral wildlife. The 'corruption' of wildlife habitat in areas surrounding development is often called the edge effect. Meffe and Carroll (1997) define edge effect as the negative influence of a habitat edge on interior conditions of a habitat, or on species that use interior habitat. The term edge effect is also used when describing the effect on species diversity of adjoining habitat types. As mentioned under urbanization, natural communities abutting developed areas are more susceptible to negative impacts of increased human occupancy such as increased road density, introduced species, and human activity (i.e. recreation).

Soil Compaction, Erosion and Sedimentation. The north-west corner of the Inner Coast Range Community consists of steep hillsides. Removal of vegetation from these plant communities for other uses such as development, tree harvesting and intensive agriculture is likely to create soil erosion and compaction, especially on steep slopes. This can also lead to increased sedimentation into downstream watercourses. In deeper soil areas in the Tri-City/County planning Area and hills surrounding the Suisun and Green Valley areas, hillsides are often prone to large landslides. Removal of vegetation or even limited grading activity can trigger mass soil movements and sedimentation into local waterways.

Disking or Tilling. In areas of dry-land farming fall tillage and seeding is employed to plant and grow various crops, including oats (*Avena* sp.), barley (*Hordeum* sp.), and wheat (*Triticum* sp.). Disking or tilling can potentially decrease the abundance of native plants by directly removing these species prior to seed set. Because non-native seeds are planted regularly, competition with non-natives is exacerbated and in these areas few native plant species are present. Disking is also employed to create fire breaks within this fire prone habitat. These fire breaks create corridors for annual grasses and other noxious weeds.

Introduced annual plants. California grasslands are dominated by non-native plants species that can either directly out-compete native species or indirectly affect native species via the development of thatch that inhibits establishment of native plants. Competition from invasive annuals may cause native plant species to set fewer seed, or add fewer seeds to the seedbanks then were removed through germination or other factors. The encroachment by non-native plants often follows surface-disturbing activities, such as disking, grading, filling, ditch construction, and off-road vehicle use. Grass thatch inhibits the germination of native annuals, but has little if any retarding effect on the germination and growth of exotic grasses. Results from an on-going California Department of Fish and Game study show that thatch depth is negatively correlated with frequency and percent cover of native forb species (Mary Ann McCrary, pers. comm. 2004 as references in USFWS 2004). In the absence of control and eradication programs, invasive plants may eliminate the remaining native plants, including the host plants of the Callippe silverspot butterfly, Johnny jump-up, a wild violet in the genus *Viola*. Adequate levels of *Viola* species are especially critical for the long term survival of populations of silverspot butterflies. Thatch build-up from annual plants can be reduced through managed grazing and prescribed burning. In addition, areas currently dominated by invasive annual plants may be restored to a more natural vegetation type, probably a mix between native forbs, perennial grasses and oak woodland.

A study conducted in Sonoma County showed that dividing large undeveloped oak woodlands parcels into smaller 10 to 40 acre rural residential lots increased the number of exotic plants and eliminated the presence of certain bird species (Merenlender 1998 as referenced in Giusti et al. 2004).

Non-Native Species. The presence of non-native wildlife species, such as European starlings, turkeys, feral cats, and pigs, may be harmful to native birds within oak woodlands. Non-natives may compete with or prey upon native birds, or may impact the suitability of oak woodlands (CPIF 2002). Brown-headed cowbirds parasitize songbird nests and European starlings compete for nest sites with native cavity nesters. Recent studies suggest that European starling populations may be increasing in oak woodlands and may be more likely to forage in or near grazed oak woodlands or pastures than in the center of ungrazed areas (Verner et al. 1997). Comparing Christmas Bird Count and Breeding Bird Survey data before and after invasion of sites by European starlings, Koenig (2003) was unable to find any evidence that starlings had a severe impact on populations of native birds. He went on to surmise that native hole-nesting birds have thus far "held their own" against the starling invasion, despite the latter's abundance and aggressive usurpation of often limited cavities (Koenig 2003). For example, acorn woodpeckers are able to reproduce successfully at sites where starlings are present because they are able to nest successfully later in the breeding season when competition with starlings declines (Troetschler 1976). Parasitism of songbird nests by brown-headed cowbirds is a well-known cause of lowered productivity in many sensitive songbird species (e.g., least Bell's vireo), and has been documented in several oak woodland open-cup nesters (i.e., lark sparrow and blue-gray gnatcatcher [CPIF 2002]). However, the extent to which cowbirds impact songbird populations relative to other pressures (e.g., habitat loss, predation, etc.) is relatively uncertain.

Chemical Contaminants. Contaminants such as pesticides, heavy metals, and other air pollutants can affect wildlife within the Inner Coast Range Natural Community. For the Callippe silverspot butterfly chemical contaminants can affect larval development, potentially leading to malformations, increased susceptibility to disease and death. Silverspot butterfly larvae are extremely sensitive to pesticides, and even the accumulation of runoff in the soil after spraying has proven lethal to the larvae of members of the genus *Speyeria* (Mattoon *et al.* 1971). Other invertebrates may also be affected by chemical contaminants which could potentially have trophic affects higher up the food chain, affecting birds, salamanders and lizards. 485,810 feet of the Inner Coast Range Habitat abuts agricultural areas. Drift or runoff from vineyards adjacent to habitat is therefore a concern for the callippe silverspot butterfly.

Data Gaps, Uncertainties and Assumptions

While many threats to the Inner Coast Range Natural Community are well known, exactly how they affect the community and ways to ameliorate or eliminate these threats are not. For the conceptual model described in Appendix B, most of the effects of land use practices on the Natural Community are purely speculation and are based on our current understanding of the essential ecological processes and habitat variables that drive the system.

Several pressures on the Natural Community and Covered Species that current management practices do not address or adequately address are: fire, weather, and soil. The effects of natural and prescribed fire on the Natural Community and on special-status species and their habitat is often not studied in detail or implemented as a management tool because of the limited resources or logistics. Fire is an important management tool and additional efforts should be taken by resource managers to explore the implementation of prescribed burns and to establish sound vegetation monitoring protocols after natural fires to explore relationships between fire and vegetation. The conclusion that has been drawn from limited fire studies is that light- to moderate-intensity prescribed fire in California oak woodlands probably benefits wildlife by stimulating shrub and tree vigor by reducing resource competition from exotic annual grasses, and increasing overall habitat rejuvenation (Vreeland and Tietje 2002). Fire conflagrations, on the other hand, can seriously impact habitats and require years for recovery. Weather and how it affects annual trends of special-status species and their habitats, and how it interacts with management actions such as grazing, mowing and prescribed fire is an important pressure that requires long-term studies to better understand. Some special-status plants are restricted to certain soil types, such as serpentine or highly alkaline soils, and while some of this information is currently available, more details on these specific associations are needed. Determining the specific soil series that Covered Species are associated with would be important information for understanding species' habitat requirements and potential limitations in population expansions.

For wildlife, the habitat mosaic or matrix of vegetation types (i.e. oak woodland, oak savanna, grassland and chaparral/scrub) as well as canopy cover affect species composition, but little is known about how species composition is influenced by these variables. For example, the degree to which canopy cover influences avian community composition may depend on individual species' habitat preferences rather than community-level processes. Oak woodlands also provide an important food source for several wildlife species, acorns; but it is poorly understood how wildlife populations are affected by fluctuations in acorn production. As oak woodland habitat and the overall habitat matrix

characteristic of the Inner Coast Range becomes increasingly fragmented by development, how will species composition be affected?

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