2.0 PHYSICAL / BIOLOGICAL SETTING, INCLUDING COVERED SPECIES

2.1 SIGNIFICANT HYDROLOGIC FEATURES

2.1.1 Matadero Creek Watershed

The Matadero Creek watershed is entirely within Santa Clara County (Figure 2-1). Matadero Creek begins in Palo Alto's hills. The creek flows under Highway 280, through Stanford agricultural lands south of Foothill Expressway, and through the developed commercial and residential areas of the Stanford Research Park and Palo Alto. One major tributary, Deer Creek, joins Matadero Creek just upstream from Foothill Expressway.

Upstream from Foothill Expressway, Matadero and Deer creeks are generally low gradient, with broad riffle-run zones and pebble- to cobble-sized substrate. Both of the creeks in this area have reaches that dry out during drought conditions, but Deer Creek is much more ephemeral and susceptible to drying than the generally perennial Matadero Creek. The riparian zone is similar to that of San Francisquito Creek, consisting primarily of willow, bay, and oak trees, but is generally not as extensive (less wide) or mature.

Downstream of El Camino Real the creek has been channelized and concrete-lined for flood control by Santa Clara Valley Water District.

A mix of open space, low-density residential housing, and undeveloped private property covers the upland areas of the watershed. The downstream areas of the watershed have been highly modified and are either commercial or high-density residential.

A portion of the Matadero Creek watershed was listed in 1998 by the U.S. Environmental Protection Agency[1] as being pesticide (diazinon) impaired.

2.1.2 San Francisquito Creek Watershed

The San Francisquito Creek watershed encompasses an area of approximately 45 square miles and is located on the eastern flank of the Santa Cruz Mountains, at the base of the San Francisco Peninsula (Figure 2-1). This watershed is located in two counties, San Mateo and Santa Clara, and two of its constituent creeks (Los Trancos and San Francisquito) form part of the boundary between the two counties. The San Francisquito Creek watershed has four major sub-watersheds located at least partially on Stanford lands: Bear Creek (Bear Gulch Creek), Los Trancos Creek, San Francisquito Creek, and streams that flow into Searsville Reservoir (including Corte Madera, Dennis Martin, Sausal, and Alambique creeks).

A USGS gauging station (11164500) is located on San Francisquito Creek near the Stanford golf course, approximately 500 meters south (upstream) of the Junipero Serra Boulevard/Alpine Road intersection. This station has been in operation since the early 1930s. The mean annual flows within San Francisquito Creek have ranged from less than 0.05 cfs (recorded in 1961) to 89.1 cfs (recorded in 1933). During all but the wettest years, significant portions of San Francisquito Creek and its tributaries dry up by mid-summer.

[1] http://oaspub.epa.gov/tmdl/waters_list.tmdl_report?p_tmdl_id=32396

The Stanford-owned mid-section of this watershed is not covered by the HCP, but this portion of the watershed includes San Francisquito Creek between Searsville Reservoir and Junipero Serra Boulevard, Los Trancos Creek from Arastradero Road to its confluence with San Francisquito Creek at Piers Lane, and Bear Creek from Sand Hill Road to its confluence with San Francisquito Creek. Portions of the watershed within Stanford are developed with low-density residential, commercial, recreational (e.g., Stanford golf course and equestrian facilities), scientific (e.g., SLAC National Accelerator Laboratory (SLAC) and Jasper Ridge Biological Reserve), and agricultural (e.g., Webb Ranch and Boething Treeland) land uses, and contain a number of water diversion and water storage facilities.[2] Downstream from Junipero Serra Boulevard, the watershed is dominated by high-density residential and commercial land uses. Upstream from the Stanford-owned reaches, the watershed is mainly low-density residential and open space. Most of the creeks in the Stanford portion of the watershed support riparian vegetation, generally a 75- to 200-foot-wide band of dense willows, bay laurels, redwoods, alders, cottonwoods, dogwoods, valley oaks, and coast live oaks. This riparian zone is currently limited in extent by land use and topography.

Skippers Pond is the largest natural pond located on Stanford lands. It is situated in the riparian thicket adjacent to Family Farm Road, upstream from Jasper Ridge Biological Preserve, in San Mateo County. This pond fills naturally with groundwater and runoff, with comparatively little surface flow connection to the nearby creeks (Sausal and Corte Madera). Skippers Pond holds water year-round in some years, but generally dries up by the end of summer in years of average or below average rainfall.

A portion of the San Francisquito Creek watershed was listed in 1998 by the U.S. Environmental Protection Agency (EPA) as sediment and pesticide (diazinon) impaired. The EPA also listed Corte Madera Creek and the main stem of San Francisquito Creek as impaired. However, the water quality data from the Long Term Monitoring Program (a cooperative program sponsored by the San Francisquito Creek Watershed Council) in the San Francisquito Watershed consistently indicate absence of diazinon.

Hydrogeologic investigations of the groundwater in this area show the presence of thick coarse- and fine-grained alluvial deposits on the San Francisquito Creek alluvial fan where four of Stanford's groundwater wells are located (Sokol 1963, Geomatrix 1992). Geologic cross sections, based on the correlation of electrical resistivity logs, show that sand and gravel layers range between 50 and 200 feet in thickness, defining the most important groundwater zones. Several clay layers, interpreted to be mostly laterally continuous, range between 20 and 80 feet thick and form aquitards above and between the coarse water-bearing units. Stanford's wells are screened below the upper clays, starting at 100 feet below the surface.

[2] Stanford currently operates Searsville Dam, the Los Trancos diversion, and an in-channel pumping station. Another diversion facility, called the Lagunita diversion dam facility, is currently not in service but historically also served as a diversion facility. Stanford-owned water storage facilities within the San Francisquito Creek watershed include Searsville Reservoir, Felt Reservoir, and Lagunita.

2.2 SIGNIFICANT LAND FORMS

2.2.1 Foothills

A wide-band of low, rolling foothills (generally 200 to 400 feet in elevation) are present from the edge of the main campus to the base of the Santa Cruz Mountains. The foothills are located south of Junipero Serra Boulevard and extend across Interstate 280 to Jasper Ridge. They consist of a mix of grassland, woodland, and riparian areas. The foothills are generally undeveloped, but do support a number of existing uses, primarily livestock grazing. A number of academic facilities are scattered across the foothills. These include radio telescopes, including the landmark Dish; a linear accelerator; solar observatory; student observatory complex; several academic think tanks; artist studio; and part of the Stanford golf course. Commercial communications facilities and four water supply-related facilities, including two enclosed reservoir tanks, are located in the Stanford foothills. Residential and commercial facilities also are located in the Stanford foothills.

Stanford allows public access to a limited portion of the foothills, but this recreational use is restricted to designated service roads. Formal public access points are located along Junipero Serra Boulevard and Alpine Road. Public use is monitored by Stanford University security, and dogs and bicycles are not allowed.

2.2.2 Alluvial Plain

Virtually all of the main campus is located on the comparatively flat areas located between the foothills and San Francisco Bay. Most of the alluvial plain area located north of Junipero Serra Boulevard/Foothill Expressway is developed with a relatively high density of housing, academic buildings, and commercial development. The alluvial plain areas south of Junipero Serra Boulevard are primarily agricultural, with crop plants farmed in areas near San Francisquito Creek, a commercial (wholesale) nursery that operates in several areas, and livestock (equestrian) uses scattered across most of the remaining areas. A few academic facilities are in these southern alluvial plain areas (e.g., a plant genetics laboratory and a plant growth facility).

2.2.3 Santa Cruz Mountains (Jasper Ridge)

A portion of the University is located on the lower, eastern flank of the Santa Cruz Mountains. The majority of this land form at Stanford is located in the Jasper Ridge Biological Preserve. The 1,200-acre Preserve is an academic research and teaching facility that is extensively used by students and researchers. The Preserve does provide significant conservation benefit to the region, but it is not operated as a refuge for native plants and animals. The Jasper Ridge Biological Preserve was designated as a research facility by the trustees of Stanford University. Public access is not allowed but docent-led tours are available.

Other land uses in this region include residential development, a vineyard, and equestrian facilities. Searsville Reservoir is located in the Jasper Ridge Biological Preserve and is managed by the University's Utilities Services in coordination with the Preserve.

2.3 BIOLOGICAL SETTING

2.3.1 Annual Grassland

This community/habitat type consists primarily of non-native annual grasses and forbs forming a continuous cover of herbaceous vegetation. Annual grasslands are present in the alluvial plain and lower foothills portions of Stanford. Non-native species dominating these areas include ripgut brome (*Bromus diandrus*), soft chess (*Bromus hordeaceus*), Italian rye *(Lolium multiflorum*), wild oat (*Avena fatua and A. barbata*), wall barley (*Hordeum murinum*), Italian thistle (*Carduus pycnocephalus*), storksbill (*Erodium* species), bristly ox-tongue (*Picris echioides*), purple star thistle (*Centaurea calcitrapa*), yellow star thistle (*Centaurea solstitialis*), common groundsel (*Senecio vulgaris*), geranium (*Geranium* species), and milk thistle (*Silybum marianum*). Several native grasses, most notably purple needlegrass (*Nassella pulchra*), are not uncommon in some areas of the grasslands at Stanford. Native forbs that commonly occur within this community include: California man-root (*Marah fabaceus*), California buttercup (*Ranunculus californicus*), blue-eyed grass (*Sisyrinchium bellum*), terrestrial brodiaea (*Brodiaea terrestris*), blue dicks (*Dichelostemma capitatum*), Ithuriel's spear (*Tritelia laxa*), suncup (*Oenothera ovata*), and mule's ear (*Wyethia* species). Occasional individual oak trees or small, open-canopied groupings of oaks occur within this community type.

Annual grasslands at Stanford provide habitat for a diversity of terrestrial wildlife. Amphibians include western toad (*Bufo boreas*), Pacific treefrog (*Hyla regilla*), and California tiger salamander (*Ambystoma californiense*). Reptiles include the western fence lizard (*Sceloporus occidentalis*), gopher snake (*Pituophis melanoleuca*), and western racer (*Coluber constrictor*).

A variety of bird species are at least seasonally present in the grasslands at Stanford. Avian seedeaters, including western meadowlark (*Sturnella neglecta*), nest in grazed annual grasslands, while other grassland species, such as red-winged blackbirds (*Agelaius phoeniceus*), are more likely to nest in taller, ungrazed vegetation. A variety of other species, including American goldfinch (*Carduelis tristis*), California towhee (*Pipilo crissalis*), loggerhead shrike (*Lanius ludovicianus*), and northern mockingbird (*Mimulus polyglottos*), nest in scattered shrubs throughout annual grasslands. Raptors, including white-tailed kite (*Elanus caeruleus*), red-tailed hawk (*Buteo jamaicensis*), barn owl (*Tyto alba*), and American kestrel (*Falco sparvarius*), nest in nearby trees and forage in grasslands. Burrowing owls (*Athene cunicularia*) have not been observed nesting at Stanford for nearly a century, but overwinter at several locations at Stanford. Aerial foragers, including northern rough-winged swallow (*Stelgidopteryx serripennis*), tree swallow (*Tachycineta bicolor*), violet-green swallow (*Tachycineta thalassina*), cliff swallow (*Petrochelidon pyrrhonota*), barn swallow (*Hirundo rustica*), and white-throated swift (*Aeronautes saxatilis*), also may frequent annual grasslands. Great blue herons (*Ardea herodias***)** and great egrets (*Ardea alba*) frequently are observed foraging in the grasslands of Stanford.

Small mammals that forage on the plants found in this habitat type include deer mice (*Peromyscus* species), western harvest mouse (*Reithrodontomys megalotis*), California vole (*Microtus californicus*), California ground squirrel (*Spermophilus beecheyi),* and Botta's pocket gopher (*Thomomys bottae).* Larger mammals, such as bobcat (*Lynx rufus*), coyote (*Canis latrans*), opossum (*Didelphis virginiana),* raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), black-tailed jackrabbit (*Lepus californicus*), and black-tailed deer *(Odocoileus*

hemionus), also use the annual grasslands at Stanford, though other habitats are generally required for cover. Badgers (*Taxidea taxus*) are apparently absent from Stanford and rarely sighted in the southern San Francisco Peninsula. Mountain lions (*Felis concolor*) are occasionally reported from the grasslands, riparian zones, and woodlands of the lower foothills region.

2.3.2 Oak Woodland/Savanna

This plant community occurs in a number of locations at Stanford. This community is dominated by a mix of coast live oaks (*Quercus agrifolia*), blue oaks (*Quercus douglasii*), valley oaks (*Quercus lobata*), and California buckeye (*Aesculus californica*). Understory species include shrubs such as poison oak (*Toxicodendron diversilobum*), toyon (*Heteromeles arbutifolia*), common snowberry (*Symphoricarpos albus*), blue elderberry (*Sambucus mexicana*), western leatherwood (*Dirca occidentalis*), and occasional dense patches of coyote brush *(Baccharis pilularis*) along the edges of the woodland. Common grass species and herbs found beneath the oak woodland canopy include ripgut brome, bedstraw (*Galium californicum*), wide-leaf filaree (*Erodium botrys*), soft chess, Italian rye, soft geranium (*Geranium dissectum*), Indian lettuce (*Claytonia parviflora*), and goldenback fern (*Pentagramma triangularis*).

The wildlife typically associated with oak woodland at Stanford include: bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), western gray squirrel (*Sciurus griseus*), California ground squirrel, black-tailed deer, deer mice, San Francisco dusky-footed woodrat (*Neotoma fuscipes annectens*), broad-footed mole (*Scapanus latimanus),* acorn woodpecker (*Melanerpes formicivorus*), band-tailed pigeon (*Columba fasciata*), northern flicker (*Colaptes aurantus*), and western scrub jay (*Aphelocoma californica*). Oak trees and other hardwoods in this community provide shelter, shade, and breeding habitat for mammal species such as raccoon, striped skunk, and cottontail rabbits (*Sylvilagus audubonii*).

The abundant insect and plant life present in the oak woodlands provides food for bird species such as white-breasted nuthatch (*Sitta carolinensis*), California thrasher (*Toxostoma redivivum),* bushtit (*Psaltriparus minimus*), oak titmouse (*Baeolophus inornatus*), dark-eyed junco (*Junco hyemalis*), blue-grey gnatcatcher (*Polioptila caeurlea*), Bewick's wren (*Thryomanes bewickii*), spotted towhee (*Pipilo maculatus*), California quail (*Callipepla californica*), mourning dove (*Zenaida macroura*), Anna's hummingbird (*Calypte anna*), and ash-throated flycatcher (*Myiarchus cinerascens*). A wide variety of woodpecker species are primary-cavity nesters in oak trees, while house wren (*Troglodytes aedon),* western bluebird (*Sialia mexicana*), and American kestrel are secondary-cavity nesters (e.g., utilizing abandoned woodpecker cavities). Coastal oak woodland also is important to neotropical migrant songbirds (e.g., warblers, vireos, grosbeaks) providing feeding, resting, and nesting habitats. Raptors that nest and forage in the oak woodland habitat include great horned owl (*Bubo virginianus*), barn owl, western screech-owl (*Otus kennicotti*), red-tailed hawk, and red-shouldered hawk (*Buteo lineatus*). Cooper's hawk (*Accipiter cooperi*), white-tailed kite, and golden eagle (*Aquila chrysaetos*) are additional special-status bird species that have been recorded in woodlands and grasslands of the Stanford foothills.

More than 10 species of bats are common in the Stanford area, and individuals of some species roost in tree cavities. Townsend's big-eared bats (*Corynorhinus townsendii*) are occasionally

recorded at Stanford and probably utilize local woodlands and riparian areas on a regular basis, at least for foraging.

Amphibian and reptile species that are found in the oak woodlands at Stanford include: California tiger salamander, western toad, Pacific treefrog, California slender salamander (*Batrachoseps attenuatus*), arboreal salamander (*Aneides lugubris*), sharp-tailed snake (*Contia tenuis*), ringneck snake (*Diadophis punctatus*), California kingsnake (*Lampropeltis getulus*), gopher snake, western terrestrial gartersnake (*Thamnophis elegans*), western skink (*Eumeces skiltonianus*), western fence lizard, southern alligator lizard (*Elgaria multicarinata*) and northern alligator lizard (*Elgaria coeruleus*). It is likely that California red-legged frogs (*Rana aurora draytonii*) regularly traverse many of the oak woodlands at Stanford.

2.3.3 Riparian Woodland and Creeks

Riparian woodland is well established along Matadero Creek and Deer Creek and along the creeks in the San Francisquito watershed. There also is a substantial riparian forest associated with the Searsville Reservoir. Vegetation along the creeks consists primarily of a moderately closed canopy of valley oak and coast live oak that ranges from approximately 20 to 40 feet in height. Associated species within this community include California buckeye, bay (*Umbellularia californica*), redwood (*Sequoia sempervirens*), willow (*Salix* species), and white alder (*Alnus rhombifolia*). An understory shrub layer occurs beneath much of the riparian canopy, particularly in areas where gaps in the overstory allow direct sunlight. Shrub species present include poison oak, California rose (*Rosa californica*), blackberry (*Rubus ursinus*), common snowberry, blue elderberry, bee plant, and coyote bush. The riparian forest associated with the Searsville Reservoir is dominated by willows, maples (*Acer* species), and dogwoods (*Cornus* species).

Small clumps of native and non-native grasses and forbs are present in the understory of the riparian woodland, including ripgut brome, wild oat, horehound (*Marrubium vulgare*), poison hemlock (*Conium maculatum*), wild radish (*Raphanus sativus*), field mustard (*Brassica rapa*), milk thistle, and California mugwort (*Artemesia douglasiana*). Aquatic vegetation found intermittently along the creek channels includes water cress (*Rorippa nasturtium-aquaticum*), iris-leaved juncus (*Juncus xiphioides*), broad-leaved cattail (*Typha latifolia*), and curly dock (*Rumex crispus*).

Riparian woodland provides abundant food, cover, and breeding habitat for wildlife. These factors and the structural diversity of riparian woodland are largely responsible for the high productivity of this habitat type. Bird species that are characteristic of this habitat at Stanford include California quail, mourning dove, orange-crowned warbler (*Vermivora celata*), Nuttall's woodpecker (*Picoides nuttallii*), black phoebe (*Sayornis nigricans*), black-crowned night heron (*Nycticorax nycticorax*), belted kingfisher (*Ceryle alcyon*), western wood-pewee (*Contopus sordidulus*), California towhee, and song sparrow (*Melospiza melodia*). Many of these species nest or roost in riparian woodlands and feed in adjacent habitat areas, such as annual grasslands. Stellar's jay (*Cyanocitta stelleri*) and western scrub jays are found in abundance in the riparian woodlands at Stanford, as are California thrasher, red-tailed hawk, Cooper's hawk, red-shouldered hawk, and sharp-shinned hawk (*Accipiter striatus*). Riparian woodlands also provide important feeding, resting, and nesting for neotropical songbirds such as warblers, vireos,

grosbeaks, and flycatchers. Salt marsh common yellowthroat (*Geothlypis trichas sinuosa*) is relatively common at the margin of the riparian forest upstream of the Searsville Reservoir.

Common mammals found within this riparian woodland include: deer, opossum, raccoon, deer mice (including *Peromyscus truei* and *P. maniculatus*), Botta's pocket gopher, tree squirrels (*Scirus* species), San Francisco dusky-footed wood rat, California vole, coyote, gray fox, bobcat, striped skunk, and the non-native red fox (*Vulpes vulpes*). Merriam's chipmunk (*Eutamias merriami*) are also occasionally encountered in the riparian woodlands at Stanford, particularly in the large woodland track upstream from Searsville Reservoir. Recent work by a Stanford graduate student (Evelyn et al. 2004) indicates that the riparian areas at Stanford are used extensively by foraging bats. A number of bat species have been recorded including: Townsend's big-eared bat, red bat (*Lasiurus blossevillii*), hoary bat (*Lasiurus cinereus*), California myotis (*Myotis californicus*), Yuma myotis (*Myotis yumanensis*), long-ear myotis (*Myotis evotis*), fringed myotis (*Myotis thysanodes*), long-legged myotis (*Myotis volans*), big brown bat (*Eptesicus fuscus*), and western pipistrelle (*Pipistrellus hesperus*).

Amphibians and reptiles known to occur in this biotic community at Stanford include western toad, Pacific treefrog, California red-legged frog, arboreal salamander, black salamander (*Aneides flavipunctatus*), slender salamander, California newt (*Taricha torosa*), rough-skinned newt (*Taricha granulosa*), Santa Cruz ensatina (*Ensatina eschscholtzi*), California kingsnake, gopher snake, western night snake (*Hypsoglena torquata*), western fence lizard, southern alligator lizard, and western skink.

Western pond turtles (*Clemmys marmorata*) are found scattered throughout San Francisquito Creek, from Searsville Dam to the downstream edge of Stanford's boundary. They have not been documented from Searsville Reservoir for more than 5 years. Recent observations indicate that there are multiple western pond turtles inhabiting Felt Reservoir. They have been reported from Matadero Creek by local residents, but have not been observed during recent surveys. Newts (*T. torosa* and *T. granulosa*) are common in the San Francisquito system, but they have not been observed in Stanford's portion of the Matadero drainage during the recent surveys.

Native fish recorded from the Matadero and San Francisquito systems include three-spined stickleback (*Gasterosteus aculeatus*), roach (*Lavinia symmetricus*), Sacramento blackfish (*Orthodon microlepidotus*), Sacramento suckers (*Catostomus occidentalis*), and sculpin (*Cottus asper* and *C. gulosus*). Steelhead/rainbow trout (*Oncorhynchus mykiss*) are abundant in the San Francisquito system, but have not been recorded in the Matadero system in recent surveys conducted by Stanford (but have been reported as being historically present by numerous long-term local residents). Hitch (*Lavinia exilicauda*) are also present in the San Francisquito system.

San Francisquito Creek contains one of the few remaining steelhead runs in the San Francisco Bay drainage. Steelhead spawn throughout the San Francisquito Creek system, including those portions that flow through Stanford. The number of steelhead present in the watershed range from essentially zero in drought years to several hundred adult fish during wet years. At Stanford, relatively large numbers of parr are typically found in Los Trancos Creek and in a few portions of San Francisquito Creek and Bear Creek, but due to the flashy nature of the system and physical limitations of the creek beds. Searsville Dam is a barrier to upstream fish migration in the system, and isolates suitable spawning habitat from migrating adult steelhead. Resident

rainbow trout are present in the creeks above Searsville Dam (notably Corte Madera Creek and Sausal Creek) and are also found in many locations downstream from major barriers to dispersal.

Native mussels (*Anodonta* species) are found scattered across the San Francisquito Creek system.

Non-native aquatic animals that have been recorded from the creeks at Stanford include bullfrog (*Rana catesbeiana*), green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus)*, red-ear sunfish (*Lepomis microlophus*), mosquito fish (*Gambusia affinis*), largemouth bass *(Micropterus salmoides*), Louisiana red swamp crayfish (*Procambarus clarki*), and signal crayfish (*Pascifasticus leniusculus*)**.** Bullfrogs are occasionally observed in the Stanford portions of Matadero Creek and Deer Creek; generally no more than three or four individuals are observed each year (and fewer than 10 bullfrog tadpoles have been encountered in Matadero and Deer creeks since the mid-1990s). Green sunfish are relatively common throughout the unincorporated Santa Clara County portion of Matadero Creek, but are limited in Deer Creek to reaches immediately upstream from its confluence with Matadero Creek (reaches that do not typically dry out). No young-of-the-year green sunfish have been observed in the Stanford portions of Matadero Creek and Deer Creek during annual surveys since 1997, suggesting that juvenile or adult sunfish may be dispersing into either downstream or upstream reaches. During recent annual surveys, only one largemouth bass was observed in the Stanford portion of the Matadero watershed and Louisiana red swamp crayfish are rarely encountered.

Mitten crabs (*Eriocheir sinensis*) have been observed in the San Francisquito system since at least 1996. The number of these invasive non-native crabs in the Stanford portions of the creeks varies each year. From 1996 to 1998, there were very few observations of crabs upstream of El Camino Real. In 1999 and 2000, hundreds of crabs were seen in San Francisquito Creek. Some individuals reach the confluence with Bear Creek. During 2001 through 2005, very few crabs were observed in the system. At the present time, the extent and impacts of this recent invasion are unclear.

In 2000, a mitten crab was observed in Matadero Creek, just downstream of the Foothill Expressway bridge (there were mid-1990s reports of mitten crabs at Matadero Creek's outflow into San Francisco Bay). Mitten crabs have not been observed in the areas of the creek that support red-legged frogs, but they could colonize the area in the future.

2.3.4 Serpentine Grasslands

There are two main areas of serpentine grassland at Stanford, both located in the Jasper Ridge Biological Preserve. These two areas are of limited extent, and the total acreage of serpentine grassland at Stanford is less than 25 acres. These grasslands have not been managed specifically to promote native biodiversity; a hands-off management policy has been in effect at the Preserve for more than 25 years. This policy was implemented in order to ensure that the inevitable vagaries of multi-year management activities did not unnecessarily affect the long-term research activities at the site. The grasslands do, however, still support an array of native plant and animal species, including California plantain (*Plantago erecta*), goldfields (*Lasthenia chrysostoma*), serpentine linanthus (*Linanthus ambiguus*), common linanthus (*Linanthus androsaceus*), red maids (*Calandrinia ciliata*), purple needlegrass, California man-root,

California buttercup, poison oak, blue-eyed grass, terrestrial brodiaea, blue dicks, Ithuriel's spear, yarrow (*Achillia millifolium*), and common muilla (*Muilla maritima*).

Native insects are common in the serpentine grasslands at Stanford and the Lepidoptera in particular have been the focus of research efforts. The Bay checkerspot butterfly (*Euphydryas editha bayensis*) has been studied annually by Professor Paul Ehrlich's group at Stanford since 1960. This threatened butterfly subspecies formerly had two relatively robust populations at Stanford (a third population has been recorded in the literature [population "G"], but never supported butterflies for more than a few years). The Bay checkerspot butterfly has not been observed at Stanford since 1997 (despite hundreds of hours spent annually looking for them). Opler's longhorn moth (*Adela oplerella*) has not been recorded from Stanford, and is not expected since its obligatory host plant, California creamcups (*Platystemon californicus*), is rarely observed at Stanford. Several other species of *Adela* moths are common in the serpentine grasslands (*A. trigrapha* and *A. flammeusella*). Approximately 330 acres of grasslands at Stanford are designated as critical habitat for the Bay checkerspot butterfly.

A wide range of reptiles, mammals and birds can be found in the serpentine grasslands at Stanford. However, these are, by and large, the same species found in the annual grasslands and oak woodlands in the area. Botta's pocket gophers are typically found in very high densities in the serpentine grasslands at Stanford.

2.3.5 Chaparral and scrub

Chaparral and scrub are present at Stanford in several locations. There is a several-hundred-acre patch of chaparral located in the Jasper Ridge Biological Preserve. This chaparral includes dense stands of chamise (*Adenostoma fasciculatum*), buckbrush (*Ceanothus cuneatus*), yerba-santa (*Eriodictyon californicum*), toyon (*Heteromeles arbutifolia*), scrub oak (*Quercus berberidifolia*), poison oak, and black sage (*Salvia mellifera*). Scrub also is found on Coyote Hill and at Jasper Ridge. These areas are dominated by California sagebrush (*Artemisia californica*), coyotebrush, scrub oak, toyon, sticky monkeyflower, and California bee plant (*Scrophularia californica*).

Chaparral and scrub at Stanford provide habitat for a diversity of terrestrial wildlife. Amphibians include western toad and Pacific treefrog. Reptiles include western fence lizard, gopher snake, western racer, northern Pacific rattlesnake (*Crotalus viridus*), and western whiptails (*Cnemidophorus tigrus mundus*). Coast horned lizards (*Phrynosoma coronatum frontale)* have not been recorded at Stanford for several decades, but are present in chaparral located about 6 miles south of the University.

A wide range of mammals and birds can be found in the chaparral and scrub at Stanford. These are, however, primarily the same species found in the annual grasslands and oak woodlands in the area.

2.3.6 Seasonal Wetlands

The primary seasonal wetlands at Stanford are Lagunita and Skippers Pond. Both of these bodies of water support large numbers of aquatic invertebrates and vegetation. Pacific treefrogs are found in abundance in both bodies of water, and western toads frequently reproduce in large numbers in Lagunita. California newts do not typically use either of these waters. California

tiger salamanders have been documented to reproduce in Lagunita since the early part of the 1900s. Bullfrogs are abundant in Skippers Pond in some years, and particularly when periods of above average rainfall allow the pond to retain water through the summer. A few bullfrogs are encountered in Lagunita every year, but no bullfrog tadpoles have been encountered there in at least 3 decades. Fish are generally not present in either Lagunita or Skippers Pond, but occasionally low densities of mosquito fish and goldfish are encountered. Crayfish also are found with some regularity in Lagunita. The timing of the crayfish's annual appearance always coincides with the annual crayfish cookout by one of the local dorms, so it has been assumed that the crayfish in Lagunita are the result of intentional releases. Pocket gophers are also abundant in the Lagunita area (so much so that the University Grounds Department must take active measures to control the numbers of gophers residing in the earthen dam that forms two-thirds of Lagunita's edge, as required by the California Division of Safety of Dams). Skunks and raccoons also are commonly encountered in the seasonal wetlands. Waterfowl are fairly abundant in Lagunita during the wet season. A number of reptile species occupy the Lagunita lakebed and surrounding grasslands, including western racer, kingsnake, gopher snake, and common garter snake (*Thamnophis sirtalis*).[3] Non-native red-eared slider turtles are also occasionally observed in the seasonal wetlands (presumably released into the sites by pet owners that do not understand the biological implications of releasing them).

2.3.7 Perennial Standing Water

Searsville Reservoir and Felt Reservoir support populations of fishes, most of which are non-native game species such as largemouth bass, black crappie, sunfish, and catfish. Neither Searsville Reservoir nor Felt Reservoir provide habitat for native aquatic species of conservation concern due to the presence of bullfrogs and abundance of non-native fishes. There are some roach, sculpin, hitch, and trout in the reservoirs, but the vast majority of fish in each are non-natives. However, prickly sculpins are common in Felt Reservoir, western toads reproduce well in Felt Reservoir, and both Searsville Reservoir and Felt Reservoir provide a habitat for water fowl and foraging areas for bats. Felt Reservoir and Searsville Reservoir are also used by both migratory and resident birds. Freshwater mussels (likely *Anodonta californiensis* and *A. oregonensis*) are present in Felt Reservoir. Non-native Chinese mystery snails (*Cipangopaludina chinensis*) and Lousiana red swamp crayfish are abundant in Felt Reservoir. Western pond turtles and non-native turtles (red-eared sliders) are also sporadically present in Felt Reservoir.

2.3.8 Urban/Suburban

Urban landscape includes both native and non-native vegetation growing within the main campus and around residential areas of Stanford lands. Vegetation consists of remnant native species, such as oaks, as well as non-native trees (primarily *Eucalyptus*), ruderal annual grasslands, and ornamental landscape plants.

In rare instances the urban/suburban areas can provide habitat elements for wildlife, including cover for nesting and roosting, and foraging sites. Except for the occasional tiger salamander

[3] Studies have shown that the common garter snake found at Stanford appears to be an intergrade form between the San Francisco garter snake (*T. s. tetrataenia*) found to the north and west, and the red-sided garter snake (*T. s. infernalis*) found to the south and east (Barry 1994).

that wanders into the main campus from Lagunita, the central campus and other developed areas do not support individuals of the Covered Species. It should be noted that the tiger salamanders which do find themselves in the main campus have an exceedingly low chance of getting back to either Lagunita or the ponds in the foothills; in addition to the large numbers of buildings, roads, drains, and simple curbs on the main campus, there many retaining walls and stairs located in the main campus. Since Lagunita is uphill from most of the main campus, these retaining walls and stairs form a unidirectional barrier to California tiger salamander dispersal; individuals dispersing from Lagunita can essentially fall down steps or over a retaining wall and reach the main campus, but the reverse trip is virtually impossible because the tiger salamanders have limited climbing abilities.

Native and introduced animals that are tolerant of human activities can thrive in urban landscapes. These species include: western fence lizard, southern alligator lizard, northern mockingbird, barn swallow, raccoon, striped skunk, European starling (*Sturnus vulgaris*), house sparrow (*Passer domesticus*), house finch (*Carpodacus mexicanus*), eastern grey squirrel (*Sciurus caralinensis*), fox squirrel (*Sciurus niger*), house mouse (*Mus musculus*), Norway rat (*Rattus norvegicus*), black rat (*Rahus rattus*), and opossum. Highly urbanized areas such as the Stanford Shopping Center, Stanford University Medical Center, and the Stanford Research Park consist of very intensely developed landscapes that have little value to native wildlife (Blair 1996, Blair and Launer 1997).

2.3.9 Plant Species

More than 650 species of native vascular plants have been recorded from Stanford and vicinity. There are a number of these plant species that are considered by the California Native Plant Society as being of conservation concern. These include: Franciscan onion (*Allium peninsulare franciscanum*, CNPS 1b), western leatherwood (*Dirca occidentalis*, CNPS 1b), woolly-headed lessingia (*Lessingia hololeuca*, CNPS 3), serpentine linanthus (*Linanthus ambiguous*, CNPS 4), chapparal bush mallow (*Malocothamnus fasciculatus*, CNPS 1b [as *M. arcuatus*), Gairdner's yampah (*Perideridia gairdneri gairdneri*, CNPS 4), Michael's piperia (*Piperia michaelii*, CNPS 4), Mt. Diablo cottonseed (*Stylocline amphibola*, CNPS 3), Hickman's popcornflower (*Plagiobothrys chorisianus var. hickmanii*, CNPS 4), coast rock cress (*Arabis blepharophylla*, CNPS 4), fragrant fritillary (*Fritillaria liliacea*, CNPS 1b), mountain lady's slipper (*Cypripedium montanum*, CNPS 4), spring lessingia (*Lessingia tenuis*, CNPS 4), bristly linanthus (*Linanthus acicularis*, CNPS 4), California rockjasmine (*Androsace elongate acuta*, CNPS 4), showy Indian clover (*Trifolium amoenum*, CNPS 1b), and San Francisco blue-eyed marry (*Collinsia multicolor*, CNPS 1b). Most of the species have not been recorded at Stanford for many decades. If present, these species are found predominately on Jasper Ridge, although the western leatherwood is also found scattered through the oak and riparian woodlands of campus. While conservation measures enacted by Stanford during the course of this HCP will undoubtedly benefit several of these species, no plant species are explicitly covered by this HCP.

In addition to the native species of plants, more than 325 species of non-native plants have been found growing outside of landscaped areas at and near Stanford, and new species of non-native plants invade the area on a regular basis. Many of these exotic species are highly invasive and destructive weeds. Control of these species is often extremely difficult, and management efforts are ongoing. Some of the more problematic exotic plant species at Stanford are mustard

(*Brassica* species), ripgut brome, stinkwort (*Dittrichia graveolens*), Italian thistle, yellow star-thistle, purple star-thistle, pampas grass (*Cortaderia selloana*), storkbill (*Erodium* species), fennel (*Foeniculum vulgare*), broom (*Genista maderensis* and *G. monspessulana*), Italian ryegrass, Harding and canary grass (*Phalaris* species), wild radish, and medusa-head (*Taeniatherum caput-medusae*). Ivy (*Hedera helix*) and greater periwinkle (*Vinca major*) are found in high densities in a number of locations scattered along the creeks and in moist forested areas. Giant reed (*Arundo donax*) is present in a few locations at Stanford and has been the target of focused eradication efforts. Parrot's feather (*Myriophyllum aquaticum*) occasionally reaches potentially problematic densities at Searsville Reservoir.

2.3.10 Animal Species

Nearly 240 species of vertebrates, including 150 species of native birds, are found at and near Stanford. In addition to the native bird species, more than 45 species of mammals, 19 species of reptiles, 11 species of amphibians, and 8 species of fishes native to the area have been recorded. In addition, subfossil remains of a host of other vertebrate species have been found at Stanford. Grizzly bear (*Ursus arctos*), pronghorn (*Antilocapra americana*), tule elk (*Cervus elaphus*), and roadrunner (*Geococcyx californianus*) are among the species recently extirpated from the area.

Approximately 30 non-native vertebrate species are present in the area and some pose problems for conservation efforts. The non-native centrarchids (sunfish and largemouth bass), bullfrog, starling, and red fox potentially cause the most difficulties for native wildlife.

In addition to the vertebrate species, a large number of species of invertebrates are found at Stanford, including more than 30 species of butterflies and skippers, and 55 species of odonates.

2.4 COVERED SPECIES

2.4.1 California red-legged frog

Description. California red-legged frogs are the largest frogs native to California, reaching sizes upwards of 4.5 inches in body length. Adult frogs are variable in color but are often characterized by the rich red coloration of the lower sides of their bodies and the under-surfaces of their hind limbs. Upper portions of red-legged frogs are red-pink to green-brown, with irregular black mottling on dorsal surfaces of the back and thighs. There are dorsolateral folds extending from the hips to eyes on both sides of the body.

Red-legged frog tadpoles are brown, often with a pinkish sheen on their undersides, and commonly reach 3 inches in total length. Tadpoles may be mottled with irregular dark spots, but they do not have the pencil-point black dots typical of bullfrog tadpoles. Juveniles are generally less than an inch in body length at metamorphosis, and more brown-green than red.

Eggs are laid in loose clusters, generally in shallow water. These rough egg masses are clear to yellow brown or grey in color, with a dark developing embryo in each individual egg.

Natural History. Red-legged frogs typically live in still freshwater such as ponds, lakes, and marshes, or in slow flowing sections of creeks and streams. Local reproduction generally begins

in late January and lasts through March. Minimum breeding age appears to be 2 years in males and 3 years in females (Jennings and Hayes 1985). Females lay 750-4,000 eggs in clusters attached to aquatic vegetation, 2 to 6 inches below the water surface. Eggs hatch in 2 to 3 weeks. Once hatched, the tadpoles generally take between 11-20 weeks to metamorphose, doing so between May and August. Tadpoles can reach 3 inches total length just prior to metamorphosis. Individual frogs average 1 ¼ inches in snout-vent length at metamorphosis.

Adults feed on a wide range of invertebrates and small vertebrates including aquatic and terrestrial insects, snails, crustaceans, fish, worms, tadpoles, small mammals, and smaller frogs (including members of their own species). The aquatic larvae (tadpoles) are primarily herbivorous. When threatened, adult and juvenile California red-legged frogs generally seek refuge in water; they will dive rapidly to the bottom of deeper pools and seek refuge under cover. *R. a. draytonii* is prey for a number of species, including bullfrogs, largemouth bass, snakes, raccoons, dogs, foxes, coyotes, cats, herons, and egrets. Crayfish are also thought to prey upon red-legged frog eggs and tadpoles. Newts may eat red-legged frog eggs. Late season heavy rains also wash away egg masses and young tadpoles.

The maximum longevity of red-legged frogs is not known, but an individual of a closely related subspecies (*Rana aurora aurora*) was known to live in captivity for 13-15 years (Cowan 1941).

Some scientists believe that California red-legged frogs are relatively inactive during dry periods of the year or during droughts. California red-legged frogs are known to occasionally disperse widely during autumn, winter, and spring rains. Juveniles use the wet periods to disperse outward from their pond or stream of origin, and some adults have been found to move considerable distances, often well away from aquatic resources. Frogs disperse through many types of upland vegetation and use a broader range of habitats outside of breeding season.

Habitat and Range. Populations of California red-legged frogs are thought to require permanent or nearly permanent bodies of water for persistence. Red-legged frogs are known to occur, at least temporarily, in grassland, riparian woodland, oak woodland, and coniferous forest, but prefer quiet pools, slow-flowing streams, and marshes with heavily vegetated shores for reproduction. California red-legged frogs are frequently encountered in areas of relatively unfiltered sunlight. Seasonal bodies of water are frequently occupied by red-legged frogs, and in some areas these water bodies may be critical for persistence.

While typically associated with bodies of water, individual California red-legged frogs occasionally traverse many miles of non-wetlands during rainy periods. It is also thought that members of some California red-legged frog populations spend most of their lives well away from the wetlands where they reproduce, either in other wetlands or simply in moist, vegetation-covered areas. Historically, California red-legged frogs were found throughout California from Mendocino County in the north to Baja California in the south. The range is considerably reduced, particularly in southern and eastern areas of California, where the California red-legged frog has all but disappeared. A related subspecies (*Rana aurora aurora*) persists in northern California, and ranges north into British Columbia.

Threats. Natural threats to the California red-legged frog include predation by fishes, snakes, birds, mammals, and other frogs. However, loss of habitat and the introduction of non-native

species that compete with or prey upon both adult and larval red-legged frogs are much more significant to the fate of the red-legged frog. Disruption or destruction of suitable habitat has been a major cause of the decline in California red-legged frogs over much of their former range (Davidson et al. 2001). Development of land for agricultural or urban uses has significantly reduced frog populations. Introduced species, such as bullfrogs, crayfish, sunfishes (*Lepomis* species), and largemouth bass, also pose challenges to red-legged frogs, competing for resources and often preying directly upon larval and adult frogs (Alvarez et al. 2003, Doubledee et al. 2003). The introduction of non-native species is also thought to play a role in the spread of disease, particularly chytridiomycosis. A chytrid fungus, very likely *Batrachochytrium dendrobatidis*, is the cause of chytridiomycosis and has been linked to numerous amphibian declines across the world. Given the vulnerability of the remaining populations of California red-legged frogs, this pathogen is considered a major threat.

California red-legged frogs at Stanford. California red-legged frogs have been monitored annually on Stanford lands since 1997. These surveys have documented two distinct frog populations, one along Matadero and Deer creeks, and one along San Francisquito Creek. The population along Matadero and Deer creeks, which will be subject to this HCP, is shown on Figure 2-2. Prior to the construction of Highway 280 and the general suburban buildup of the area, it is likely that these two populations were part of a single, more widespread population.

Annual surveys conducted since 1997 have documented red-legged frog reproduction in Deer Creek and Matadero Creek and in a pool associated with the "Upper Quarry." California red-legged frog reproduction in Matadero Creek appears to be very limited, with only a few tadpoles surviving to metamorphosis each year. In some years, Deer Creek is more productive, with large numbers of mature tadpoles (hundreds) and metamorphs (tens) observed in comparatively wet years. However, it appears that no successful red-legged frog reproduction occurs in Deer Creek during conditions of moderate to severe drought. Reproduction in the quarry pool is fairly consistent, but the pool is somewhat unusual because California red-legged frog tadpoles are present in the pool year-round. (Fellers et al. 2001).

California red-legged frogs have also been found along the Stanford portions of San Francisquito Creek, in the reaches located downstream from the confluence with Bear Creek (in the Jasper Ridge Biological Preserve) to within 2 miles (along the creek) upstream from the Interstate 280 bridge. Red-legged frog reproduction in this area has been variable, with few tadpoles (~20) seen most years since 1997, but with 50+ seen in some years (particularly when weather conditions have caused side-pools to form). California red-legged frogs have been found in Los Trancos Creek well upstream of Stanford, but only one red-legged frog has been found along Stanford's portion of the creek since the early-1990s (a single frog was repeatedly observed in the roots of a large bay tree located just downstream of the Los Trancos Diversion facility). Los Trancos Creek provides cool, clear water that is not typically red-legged frog habitat, but the creek corridor could serve as a dispersal corridor.

There have been other sporadic records of California red-legged frogs in the San Francisquito watershed. There are unsubstantiated records from the 1970s of red-legged frogs in San Francisquito Creek immediately south of the golf course, near the non-Stanford residences along Bishop Lane (a reach some 1.5 to 3 miles downstream from the frog's current distribution). Recent verified observations have been lacking.

While recent observations of red-legged frogs away from the creeks have been few, some individuals disperse far from the riparian zone. A large red-legged frog was found in January 2000 as a road-kill along Junipero Serra Boulevard, opposite Frenchman's Road (approximately 1 mile from the nearest creek site known to support frogs). In 2006, two red-legged frogs were reported from an area between SLAC and Sand Hill Road. Multiple subsequent surveys at the site failed to observe any California red-legged frogs, but, given the location, transient individuals are not unexpected. Other historic records of California red-legged frogs at Stanford indicate that in the early- and mid-part of the last century, they were occasionally found in Lagunita and in the goldfish pond of the Kingscote apartment building on campus. No California red-legged frogs have been observed at these central campus locations for many decades.

At Stanford, several factors threaten California red-legged frogs, including loss of habitat, predation and competition by non-native species, disruption of dispersal routes, and direct interaction with people and domestic animals. Historic reductions of riparian forests, loss of side pools, and degradation of seasonal tributaries have undoubtedly also impacted local frog populations.

The local populations of red-legged frogs have declined considerably during the last 50 years. Anecdotal accounts and specimen locations indicate that red-legged frogs were more widespread and probably abundant in many locations where the frog is now absent. Most likely, no single major reason for this decline exists, but rather the decline is the result of long-term changes to the area that have occurred with increased urbanization.

Notes. There is a sizable concentration of red-legged frogs located on the Lawler Ranch, which is adjacent to Stanford, west of Sand Hill Road. It is presumed that frogs reproducing in the ponds and creeks present in the Lawler Ranch occasionally occupy adjacent upland areas owned by Stanford. The Lawler Ranch population is separated from the red-legged frogs present in San Francisquito Creek by Sand Hill Road and SLAC.

Rana aurora draytonii was first listed as a threatened species by the Service in 1996.

The California red-legged frog, *R. a. draytonii*, is different from the northern red-legged frog, *R. a. aurora*, having larger size, rugose skin, distinct spots with light centers along its dorsal line, and prominent dorsolateral folds. Behavioral and genetic differences are discussed by Hayes and Miyamoto (1984). Recent genetic analyses (Shaffer et al. 2004a) have further documented these differences, and many consider the California red-legged frog and the northern red-legged frog to be two distinct species (*Rana draytonii* and *Rana aurora* respectively)

2.4.2 California tiger salamander

Description. California tiger salamanders are large salamanders, with adults frequently reaching 7.5 inches or more in total length. These are thick-bodied salamanders with broad heads and blunt snouts. Adults are black or dark grey, with oval to bar-shaped spots ranging in color from white to yellow. Juveniles are dark olive green in color and do not generally have any lighter markings.

Larval tiger salamanders have external gills and are olive green in color, generally with very fine dark markings (stippling).

Natural History. Adult tiger salamanders are rarely seen, even during the breeding season when they are most active above ground. For most of the year, they live in the burrows of ground squirrels, gophers, and other rodents in open wooded or grassy areas. Occasionally, tiger salamanders are found in various man-made structures including buildings and drainage pipes. They are found on the surface during periods of damp weather, almost exclusively at night.

Breeding occurs during the winter rainy season. The breeding season begins with a migration of adults to seasonal wetlands where breeding occurs. This migration typically begins with the second or third heavy rain of the season, and may consist of moves in excess of 0.5 miles, though most movements are less than 500 yards (Loredo et al. 1996, Trenham et al. 2001, Trenham et al. 2000). Movement occurs on the surface, and possibly underground through rodent burrows as well. Most male tiger salamanders at Stanford are ready to start breeding when they are 3 years old; most females require an additional year to reach sexual maturity.

Eggs are laid underwater singularly or in small groups, on subsurface portions of emergent vegetation or other debris. Young are aquatic and prefer the cover of vegetation to open water. Larvae feed on anuran tadpoles and various aquatic invertebrates such as crustaceans, zooplankton, snails, and insect larvae. These salamanders metamorphose into land-dwelling juveniles by May or June. After metamorphosis, the juvenile salamanders eat a wide variety of insects and other invertebrates. Juveniles generally remain near the breeding site until autumn rains, at which time they disperse to upland areas.

Habitat and Range. California tiger salamanders require a complex mixture of habitats, consisting of seasonally filled pools located in or near grasslands or oak woodlands (Trenham 2001, Trenham and Shaffer 2005). Semi-permanent ponds and reservoirs, and portions of slow-moving, seasonal creeks, also may be used. Safe and easy access between these habitats is vital, as migration between them is a vulnerable part of the salamanders' life cycle. Seasonal water is important because it usually has fewer predators than permanent bodies of water. Fish in particular are known to have a "significant negative impact on the survival of [salamander] eggs and larvae" (Shaffer et al. 2004b).

The California tiger salamander ranges from west of the Sierra Nevada crest, from Sonoma and Yolo Counties in the north to Santa Barbara County in the south, and west to the outer coast range. It is believed that the salamander population on the Stanford University campus represents the only population remaining on the San Francisco Peninsula. These salamanders apparently live in the grassland and foothills surrounding Lagunita and migrate to Lagunita to breed.

Threats. California tiger salamander populations have declined significantly in California. The main cause is fragmentation and destruction of habitat by agricultural and urban development. Introduced species, such as other species of salamanders that hybridize with native tiger salamanders, may be a problem in some locations (Fitzpatrick and Shaffer 2004, Riley et al. 2003). Natural predators of tiger salamanders include herons, waterfowl, raccoons, snakes, and small mammals such as skunks. Weather is a very important determinant of salamander

reproductive success. In seasons with heavy early rain, which will trigger migration and reproduction, but little or no mid- to late-season rain, many salamander larvae will not grow enough for successful metamorphosis and survival. Likewise, un-seasonally heavy rains can trigger salamander migrations that result in high levels of mortality (Holland et al. 1990).

California tiger salamanders at Stanford. Scientists have studied the California tiger salamander at Stanford and vicinity for more than 70 years (Twitty 1941). Early work focused on local distribution and factors associated with migrations. Recent work has been centered on conservation planning for the salamanders. This work, which started in the early 1990s, has involved many Stanford-affiliated workers and researchers, including undergraduates (two of whom conducted honors work on the local salamanders), graduate students, post-doctoral fellows, research associates, and hired consultants and other experts. Work by non-Stanford scientists on the Lagunita population has also been conducted on a sporadic basis (Barry and Shaffer 1994).

At the present time, California tiger salamanders are concentrated around Lagunita, with the density of salamanders decreasing significantly as the distance from Lagunita exceeds 0.75 miles. The distribution of salamanders is not random, and in the heavily developed area of campus very close to Lagunita, few, if any salamanders are present. Much of the main campus is a population sink for salamanders, which means that any individual unlucky enough to get into the main campus will find it virtually impossible to migrate back to Lagunita. Most of the main campus is downhill from Lagunita, and a myriad of curbs, steps, buildings, drains, and retaining walls block migrating salamanders from reaching Lagunita. Therefore, salamanders found in the main campus are essentially lost from the breeding population, because they have virtually no chance of reproducing successfully.

Much of the recent work was conducted to implement the California Tiger Salamander Management Agreement. This agreement is between Stanford, Santa Clara County, California Department of Fish and Game (CDFG), and the Service and was signed in June 1998. One of its key elements was the designation of a California Tiger Salamander Management Zone. Another important element of the California Tiger Salamander Management Agreement was the construction in the late 1990s of five small seasonal wetlands (ponds) south of Junipero Serra Boulevard. These ponds were classified as experimental and were expected to be modified as their performance was evaluated. The goal of these wetlands is to provide supplemental breeding locations for California tiger salamanders, reduce the reliance of the local population on Lagunita, and extend their effective range farther into the foothills. By 2001, Stanford determined that two of the ponds were essentially non-functional and a third lost capacity during the floods of 1998. The two remaining ponds worked as designed, but were considered too small to contribute significantly to the persistence of the local California tiger salamander population. The constructed wetlands, however, supported large numbers of Pacific treefrogs and western toads, an array of invertebrates, and were used by a wide variety of mammal and bird species. In Fall 2003, following 2 years of consultation and permitting by the Service, CDFG, California Regional Water Quality Control Board, U.S. Army Corps of Engineers, and Santa Clara County, the two remaining ponds were reconstructed and enlarged, and six additional ponds were built. By 2011, California tiger salamanders had reproduced in three of the ponds (Launer 2011). Two of the ponds have successfully supported California tiger salamander reproduction during multiple years (California tiger salamanders have reproduced in Pond #1 during five seasons and

have reproduced in Pond #5 in two seasons). California tiger salamanders have reproduced in Pond #2 during two seasons. Four additional ponds have held water long enough to support California tiger salamander larval development during multiple years, but were not utilized by California tiger salamanders. The population of tiger salamanders, which will be subject to this HCP, is shown on Figure 2-3.

In addition, Stanford installed three amphibian tunnels under Junipero Serra Boulevard to help reduce traffic-caused mortality of salamanders during their migration between Lagunita and the lower foothills.

Non-native tiger salamanders are occasionally found at Stanford. During the last decade, intensive annual fieldwork has turned up three individuals that were clearly not California tiger salamanders (out of more than 1,000 observations of adult and juvenile tiger salamanders). Researchers at UC Davis found that the tiger salamanders at Stanford are native salamanders, of distinct genetic stock, and have not been compromised by introgression with non-native species (Shaffer et al. 2004b). At the present time, non-native tiger salamanders are not considered a huge threat to the local salamander population. But, the threat from non-native salamanders remains a concern because virtually every pet store in the vicinity regularly sells a number of non-native tiger salamander species, and hybridization is a big problem elsewhere in the state.

Mortality due to traffic is quite high, a finding first noted by Victor Twitty at Stanford more than 50 years ago (Twitty 1941). This finding has been confirmed by more recent data from ongoing work by Stanford and by a study by the Coyote Creek Riparian Station (Rigney et al. 1993).

Old records indicate that California tiger salamanders were more widespread in northern Santa Clara and southern San Mateo counties. At Stanford, it is unclear whether the population is declining or remaining steady. It is quite possible, however, that the local California tiger salamander population increased dramatically 100 years ago with the construction of Lagunita.

The Service listed the California tiger salamander as threatened in 2004. The California tiger salamander was listed as threatened in 2010 under the California Endangered Species Act (CESA).

Notes. For a period during the late 1970s and 1980s, the population of tiger salamanders at Stanford was believed by some to be extinct. This was apparently due to a conspicuous lack of suitable observers. The salamanders "publicly" appeared during the winter of 1991-1992 and have been monitored annually since their reappearance.

At least two other "populations" of tiger salamanders once existed in the Stanford area, and there were reports of California tiger salamanders at the Jasper Ridge Biological Preserve in the early 1980s. All attempts to locate these populations (indicated in Twitty 1941) indicate that these populations are no longer in existence.

2.4.3 San Francisco garter snake

Description. The San Francisco garter snake (*T.s. tetrataenia*) and red-sided garter snake (*T.s. infernalis*) are two distinct subspecies of the common garter snake (*Thamnophis sirtalis*). The

San Francisco garter snake is listed as endangered under the ESA. The red-sided garter snake is not a federally listed species. Both subspecies are found on the San Francisco Peninsula.

On the San Francisco Peninsula there is a fairly well documented intergrade zone between the San Francisco garter snake and red-sided garter snake. This intergrade zone is located on the eastern flank of the Santa Cruz Mountains (Barry 1994, Fox 1951). Stanford is within this intergrade zone. The intergrade populations are not considered either the red-sided garter snake subspecies or the San Francisco garter snake subspecies. In this HCP, the San Francisco garter snake, red-sided garter snake, and integrade populations are referred to collectively as "local subspecies" or "garter snakes."

San Francisco garter snakes have a bright turquoise blue to yellow dorsal stripe, which is bordered on both sides by black stripes. Below the black stripes, there are solid red to orange stripes that are bordered by another pair of black stripes. Below the second black stripes and on the underside, the color is generally the same as the dorsal stripe (turquoise to yellow), but is typically slightly darker. There are often some minor dark or red markings below the second dark stripe. In some individuals the red/orange stripe is partially interrupted by black markings. The interruption of the red/orange stripe is particularly evident at the anterior end of some individuals. The dorsal surface of the head is red to orange. In summary, while there is considerable individual and population-level variation, the basic color pattern of this subspecies is a series of four stripes along each side (a turquoise to yellow dorsal stripe, which is bordered by a black stripe, then a red stripe, which is followed ventrally by a black stripe, with a bluish lower body and underside).

Red-sided garter snakes have a light turquoise blue to yellow dorsal stripe, which is bordered on both sides by black stripes. Below the black stripes, there are areas of alternating red/orange and black markings, forming red/orange checkered stripes. The red/orange markings are generally square to slightly rounded in shape and slightly larger in width than the black markings. Below these checkered stripes, there is typically no black stripe, and the body color is similar to that of the dorsal stripe, occasionally with darker markings. In some individuals the red markings dominate and nearly form a more-or-less solid red stripe (with minor black markings), particularly along the posterior part of the body. The dorsal surface of the head is red to orange. In summary, the basic color pattern is a series of three stripes along each side of the body (a light turquoise blue to yellow dorsal stripe, which is bordered by a black stripe, which is then bordered ventrally by a red and black checkered stripe, with the lower body and underside bluish in color). There is individual and population-level variation in color pattern.

The color pattern of individuals from intergrade populations can be quite variable, but individuals from these populations generally exhibit at least some characteristics of both the San Francisco garter snake and red-sided garter snake. Individuals from intergrade populations can, however, look very similar to either of the two subspecies. The color patterns of intergrade individuals are also often asymmetrical. Populations classified as intergrade do not necessarily include individuals with color patterns that are typically characteristic of either of the two subspecies. Intergradation only implies some mixing of two slightly different gene pools. The mixing could be of recent origin or could be the result of events that happened many generations previously.

In general, populations in the northern portion of the intergrade zone have more individuals that are partially or completely striped, which is more similar to the patterns that are diagnostic of San Francisco garter snakes (Barry 1994). In the southern portion of this zone, which includes Stanford, most of the individuals exhibit the alternating red and black markings that are characteristic of red-sided garter snakes.[4]

Natural History. The local subspecies feed on a wide range of animals, including frogs, salamanders, small fishes, and invertebrates. Small rodents and birds may also be consumed. The San Francisco garter snake is often considered a specialist on ranid frogs, and California red-legged frogs are a major component of the diet of adult snakes in many locations. Juvenile San Francisco garter snakes will prey heavily on Pacific treefrog metamorphs. Prey is usually captured in wetlands, either in the emergent vegetation or in areas of shallow water.

The local subspecies are prey for a number of species, including bullfrogs, large red-legged frogs, snakes, raccoons, dogs, foxes, coyotes, cats, fishes, raptors, herons, and egrets. They can reach 4 feet in length, but most individuals are less than 3 feet in length.

The local subspecies mate in the late winter to early spring, and the young are born in summer to early fall. They are livebearing at birth and generally range from 5 to 8 inches in length. Clutch size varies with size of female and year, but generally ranges from eight to 20 young. Females typically bear their young in secluded areas, either hidden in dense vegetation or under some type of cover. In the Bay Area, the local subspecies are generally dormant during the coldest part of winter and may also have a dormancy period during prolonged periods of exceptionally hot and dry weather. The local subspecies generally "hibernate" individually, or in small groups, and not in large numbers, which is typical of other common garter snake subspecies in more northern areas. Their maximum life expectancy is unknown, but it is unlikely that many individuals survive a decade in the wild.

Habitat and Range. The common garter snake is one of the most widely distributed snake species in North America. It is found from coast to coast, from mid-Canada to the Mexican border, being absent from only the most extreme dry and cold areas.

The lack of consensus over the taxonomic status of common garter snake subspecies makes it difficult to identify the range of a particular subspecies. The current view is that San Francisco garter snakes are found on the west-side of the crest of the Santa Cruz Mountains, along virtually the entire coast of San Mateo County, north to San Francisco County. On the coastside, the San Francisco garter snake may stray south into extreme northern Santa Cruz County. East of the crest of the Santa Cruz Mountains, the San Francisco garter snake is found from the City of South San Francisco and the San Francisco airport, south to Crystal Springs Reservoir (all San Mateo County).

[4] It is difficult to determine whether a specific population within an intergrade zone is more closely related to one or the other of the parental subspecies. In the case of the San Francisco/red-sided garter snake intergrade zone this is made more difficult since traditional taxonomic treatments of these snakes rely heavily on color pattern and scale counts – both of which are known to vary within subspecies.

Red-sided garter snakes are currently recognized as having a disjunct distribution, with populations being found from coastal Humboldt County south to coastal Monterey County (surrounding the distribution of San Francisco garter snakes). The garter snakes that have been found in Santa Clara County have been identified as red-sided garter snakes.

The red-sided/San Francisco garter snake intergrade zone that includes Stanford is located on the eastern flank of the Santa Cruz Mountains, extending approximately 12 miles from the vicinity of Boronda Lake in Palo Alto (Foothills Park) to Upper Crystal Springs Reservoir (Barry 1994, Fox 1951).

Populations of the local subspecies are typically associated with permanent or nearly permanent bodies of water, usually areas of shallow water and heavily vegetated shores. However, they are known to occur, at least temporarily, in grassland, riparian woodland, oak woodland, and coniferous forest. Sag ponds in the San Andreas Fault rift zone and freshwater coastal marshes are considered prime habitat for the San Francisco subspecies.

Threats. Natural threats include predation by fishes, snakes, birds, and mammals. However, loss of habitat and the subsequent isolation of formerly interacting populations are the most problematic factors on the San Francisco Peninsula. Urbanization of the eastern flank and bay shore portions of the Peninsula, in particular, has been pervasive and many snake populations have been lost. Those surviving individuals and populations face an array of human-related threats, including being killed on roads, trapped in drains/sewers, poisoned by biocides or pollutants, or any of a myriad of other factors associated with the built environment.

Overcollecting may also be a threat, particularly for the San Francisco garter snake. Garter snakes are relatively easy to maintain in captivity and are very popular as pets. Given the vibrant color of the San Francisco garter snake and the allure of keeping a rare specimen, these snakes have been collected, illegally since 1967, for the pet trade for decades.

The large number of captive specimens also presents another problem for the conservation of the subspecies. The release of specimens from captive bred lineages could be problematic for several reasons, including having a genetic make-up not typical of wild stocks (captive breeding invariably introduces an element of artificial selection or genetic drift) or by transmitting disease.

Garter snakes at Stanford. Stanford is within the southern portion of the red-sided/San Francisco garter snake intergrade zone. As such, the intergrade populations found at Stanford exhibit color patterns that are generally more characteristic of red-sided garter snakes.

The intergrade populations have been studied at Stanford and the vicinity sporadically for nearly 100 years. At the present time, the common garter snake is infrequently encountered at Stanford. A few individuals are encountered at Lagunita every year, but specimens from other locations at Stanford are only very infrequently observed. Given the number of museum records and mentions in the scientific literature, it is likely that historically the intergrade populations were more common in the area.

A 1994 study of 47 snakes found in the Palo Alto area, which included Lagunita and areas near San Francisquito Creek, found that approximately 20 percent of the 47 snakes exhibited a red-sided garter snake color pattern and the remaining, approximately 80 percent, exhibited an intergrade color pattern (Barry 1994). An additional 12 snakes that the study observed just south of Stanford, at Boronda Lake in Foothills Park in Palo Alto, all exhibited a red-sided garter snake color pattern (Barry 1994). The results of this study, therefore, indicate that based on color patterns, the integrade population (or populations) at Stanford have a color pattern that is more similar to the red-sided garter snake than to the San Francisco garter snake.

This conclusion is further supported by California Academy of Science specimens as noted in a 1981 study of 35 individual snakes collected at and near Stanford (Seib and Papenfuss 1981). The museum records classified 18 as red-sided garter snakes, 16 as having an intergrade color pattern, and one as a San Francisco garter snake.

On Stanford lands in southern San Mateo County the taxonomic status of the local subspecies is less clear. Stanford and other researchers have repeatedly surveyed areas near Sand Hill Road and Highway 280 for red-legged frogs and San Francisco garter snakes. These surveys were done at SLAC and the nearby former Christmas tree farm (Barry 1976, Balgooyen 1981, Seib and Papenfuss 1981, Westphal et al. 1998, Launer 2006). With the exception of one intergrade individual captured in 1981 in a drainage near the main SLAC accelerator building, no snakes were observed during any of these surveys.

Garter snakes have not been observed in the vicinity of San Francisquito Creek or Searsville Reservoir, although those areas provide potential habitat. Garter snakes have not been found at Los Trancos Creek, which provides cool, clear, flowing water that is not typically garter snake habitat. Additionally, extensive environmental work on property immediately north of Stanford did not find any local subspecies (H.T. Harvey and Associates 2001, Wagstaff and Associates 2002). In 2007, however, two intergrade individuals were found in Woodside, at a site less than a mile north of Stanford (Swaim Biological 2007).[5]

Notes. Populations found in an intergrade zone generally include individuals exhibiting a range of color patterns and frequently, but not always, include individuals with physical characteristics of one or both of the two subspecies. To assign a population with variation to one of the two subspecies, the variation needs to be quantified, which requires an adequate sample size and knowledge of the genetic basis and linkage of the traits being used for the analysis. Since there is considerable variation in populations, such an analysis would also require a known non-intergrade population. Subspecies determinations based on a single or few specimens are scientifically invalid. Genetic analyses may be helpful in determining the "relatedness" of a series of populations and might aid in the clarification of subspecies determinations.

Thus, one of the key problems to answering questions concerning whether the intergrade populations are more closely related to the red-sided garter snake or San Francisco garter snake is that at the present time neither of the two subspecies are commonly found in most locations.

[5] From the photographs provided, the two specimens from the Woodside site appear to be an intergrade form of red-sided and San Francisco garter snakes. Further specimens were reportedly captured at this site in 2008, but no information about these specimens is available.

This is problematic because a large sample size is necessary to determine the precise genetic make-up of the local population (Amadon 1949, Cicero and Johnson 2006, Mayr 1942, Rand 1948). Additionally, while molecular-level analyses with small sample sizes may be able to address some questions pertaining to population-level relationships, if significant variation is present, they too will need to have a sufficient number of specimens in order to resolve many taxonomic ambiguities.

Moreover, the legal status of the intergrade form currently is not clear. The San Francisco garter snake was listed as endangered by the Service in 1967.[6] However, the ESA listing does not specifically include the intergrade form as a protected form of the San Francisco garter snake subspecies, and the Service has not adopted final regulations clarifying the status of the intergrade populations.

Because of the uncertain legal status of the intergrade populations, difficulties in discerning whether a specific population within the intergrade zone is more closely related to the federally listed San Francisco subspecies or the non-listed red-sided subspecies, and the lack of definitive genetic information, the San Francisco garter snake has been included in this HCP. *Thamnophis sirtalis*, regardless of their ultimate taxonomic or legal classification, will be subject to this HCP.

[6] It is also a Fully Protected species under CESA. Under the CESA, the CDFG cannot authorize the lethal take of a Fully Protected species. To avoid any inconsistencies with State law, Stanford is not seeking a federal incidental take permit that would allow lethal take of the San Francisco garter snake.