APPENDIX I

PLANT COMMUNITIES OF CAMP PENDLETON

I.1. OAK WOODLANDS

The primary woodland communities on Camp Pendleton are oak woodlands. Though oak woodlands are not the most common vegetation type on Base, they are the most visually striking, and therefore give much of the character to the natural landscape of Camp Pendleton. This was also the case in 1769 when Fray Crespi passed through the area of what would be Camp Pendleton. He mentions oaks several times, observing that in the area upstream from the campsite on the Santa Margarita River: "…there are many live oaks, and the same on the skirts of the mountains." Further north traveling toward Los Christianitos he commented, "we traveled in the mountains… with hills and extensive mesas, covered with a great deal of grass and grown with live oaks and alders, especially in the little valleys and arroyos. …Three mesas covered with large live oaks were encountered." But these oak woodlands could not have been dense or common along the immediate coast, because Font, after traversing present-day Camp Pendleton and camping near the mouth of the San Luis Rey River complained that "during the night we were very cold for want of firewood, which is the thing most lacked in all these lands and hills" (Zedler et al. 1997).

The southern California coastal climate is not, in general, favorable to tree growth, but oaks are particularly well adapted to survival in difficult conditions. Even so, mature tree-sized oaks are common only where some factor ameliorates droughty conditions. Thus, oaks are most abundant on north facing slopes protected from the maximum intensity of the sun, in drainages and below rock faces or bouldery areas where runoff is concentrated, in areas of deep soil that can hold a moisture reserve through the summer, and at the higher elevations where it is cooler and rainfall is generally more abundant. Depending on the circumstances, oaks will occur as scattered individuals in a matrix of shrubs or grasses, or as dense stands with little groundcover beneath them. Oaks usually form the uppermost margin of riparian zones. They are situated above the usual floodplain, thus avoiding prolonged periods of saturated soils while receiving runoff from the slopes above and perhaps being able to tap the fringes of the subsurface moisture available in the drainage.

The two species of tree-sized oak found at Camp Pendleton are drought hardy and tolerant of fire. Both will resprout vigorously from the branches and from the base when the crowns are severely burned or killed. It seems almost impossible to kill an oak tree by fire, other than by burning it out from the inside, a process which can be observed in some of the areas frequently burned on Base.

Oak woodland is important to the training mission of the Base. It provides structural diversity, and is the only upland vegetation tall enough to provide good concealment for vehicles and larger equipment. Oak woodlands are also relatively open, permitting ready movement of personnel. The commonly luxuriant growth of poison-oak (*Toxicodendron diversilobum*) found in oak woodlands is, however, an occupational hazard for Marines

training in this habitat (despite the name, poison-oak is not an oak, rather it is in the same family as mangoes and cashew nuts).

I.1.1. Engelmann Oak Woodlands

Engelmann oak (*Quercus engelmannii*) is a species restricted to southern California and adjacent Baja California. It is considered rare and though it is not in any immediate threat of extinction, its preservation is of special concern to land managers. Camp Pendleton contains one of the largest and healthiest populations in the region, with 2,655 acres mapped as this type.

Engelmann oak rarely occurs in pure stands. On Camp Pendleton, Engelmann oak woodlands average 38% Engelmann oaks with a range of 5% to 95%. Most of the remaining trees are coast live oak (*Quercus agrifolia*). Engelmann oak has a growth form and life history that are broadly similar to the coast live oak, but mature trees are generally smaller and the bark much lighter in color. Leaves are grayish-green rather than dark green, allowing the species to be distinguished even at a great distance. Though the two species are intermingled, on Camp Pendleton the Engelmann oaks tend to be more abundant in the drier and more open landscapes. The understory is generally annual or perennial grasslands or coastal sage scrub (CSS).

I.1.2. Coast Live Oak Woodlands

Coast live oak is the most widely distributed of the evergreen oaks. It is capable of achieving large size and great age (exceeding 250 years), and the widely spreading crowns of old open grown trees are one of the distinctive features of the natural California landscape and especially of Camp Pendleton. Coast live oak occurs at the fringes of riparian woodlands, scattered in grassland or CSS, and as an element of Engelmann oak woodland. Where it occurs in pure stands or as the only tree, it is mapped as coast live oak woodland. The Base supports approximately 2,900 acres of coast live oak woodlands.

Coast live oak is a fire adapted tree with thick bark and a marked ability to resprout. Through the natural or pre-European fire regime is a matter of debate, there is no question that oak woodlands regularly experienced fire in the past. All of the oldest trees with branches near the ground show the typical pattern of a frequently burned tree. There are many branches arising on tops of the low branches, often in clusters, but few or no branches that grow from the bottom, these having been fire pruned in the past. On Camp Pendleton most of the woodlands experience fire regularly. A few have been burned repeatedly at short intervals and may be suffering some damage as a result.

I.2. SHRUBLANDS

Southern California is one of five regions in the world that share a Mediterranean climate characterized by hot, dry summers and cool, rainy winters. In all these areas – the lands around the Mediterranean Sea, central Chile, the Cape region of South Africa, and the coastal regions of southeast and southwest Australia and in California – shrublands are a major component of the vegetation. This fact establishes that there is something about the Mediterranean climate that favors the development of dense shrublands. This point is worth

making because the predominance of shrublands in southern California is a sharp contrast with most of the rest of the country's vegetation.

An important part of the explanation for the predominance of shrublands in the southern Californian climate is the strong contrast between the summer drought and the wet winters during which there is the possibility for growth or at least photosynthesis. This pattern rewards plants that can tap deep moisture over the course of the summer, and that can be active in the winter or very early in the spring. Thus, woody plants have an advantage, but they cannot become too large. High temperatures and drying winds can cause severe moisture stress from time to time, and the size of the plant must not be too great to be supported by the water available, hence shrubs or small trees are favored.

The winter rain/summer drought climate pattern is also ideal for fire. Wet winters favor growth and the creation of dense vegetation. Long summers dry out the vegetation and as a result, fire becomes inevitable. Fire provides a further advantage for shrubs, which lose less aboveground tissue in a fire, and are better equipped to recoup their losses by resprouting or germinating from seeds. Only the seeds of some chaparral species survive fires, and of these, some are dependent upon fire to successfully germinate. Other species persist by resprouting from the burned stumps of the plants. A too frequent occurrence of fires can burn young or resprouting shrubs before they become reproductively mature, thus depleting or exhausting the seed bank. Conversely, sustained fire prevention can result in senescent (extreme aging) plant communities that may not survive the eventual and unpredictable fires to reproduce vegetatively. Within these senescent chaparral communities, high fuel loads of plant material build up in the absence of fire, which often results in unnaturally hot fires that may kill plants and destroy the seed banks of some species. However, these species may potentially repopulate historically occupied areas if a natural fire regime is restored.

Two main types of shrublands are recognized in coastal southern California: those dominated by evergreen species with small, thick, leathery, dark green and sclerophyllous leaves (chaparral types), and those dominated by species that lose all or most of their usually softer, larger, and grayish-green leaves over the summer (CSS types). Chaparral types tend to be most abundant at higher elevations, particularly above 3,000 feet, where temperatures are lower and moisture supplies are more ample. CSS types are more common at lower elevations with higher temperatures, lower rainfall, and a more pronounced summer drought. This pattern makes sense ecologically because leaf loss is the ultimate accommodation of a woody plant to drought. When high temperatures raise the demand for water above the level that can be supplied by the roots of a deciduous tree, the solution during drought conditions is to jettison the transpiring leaves and shutdown operations until a sufficient amount of moisture becomes available again, for a new set of leaves to be produced. An evergreen, in contrast, either must have a deeper and more extensive root system (e.g., laurel sumac [*Malosma laurina*]) or it has to depend on the ability of its thick, tough leaves to survive through the driest days without too much damage (e.g., yucca).

Camp Pendleton has both types of plants and both types of shrublands. Chaparral is relatively tall (5-10 ft, 1.5-3 m) and generally dense. This is significant for training because

old chaparral is impossible to walk through without considerable damage to the plants, and heavy use invariably produces a network of pathways. Several subtypes of this vegetation community are present on Base, based on their dominant species component, including: chamise chaparral (*Adenostoma fasciculatum*), southern mixed chaparral (*Quercus berberidifolia, Adenostoma fasciculatum, Arctostaphylos, and Ceanothus*), *Ceanothus crassifolius* chaparral (*Ceanothus crassifolius* and *Adenostoma fasciculatum*), and scrub oak chaparral (*Quercus berberidifolia*). Several shrub species are characteristic of chaparral communities including: holly-leaf redberry (*Rhamnus ilicifolia*), manzanita (*Arctostaphylos* spp.), sugar bush (*Rhus ovata*), and laurel sumac. Several CSS species are also associated with chaparral vegetation, including: California buckwheat (*Eriogonum fasciculatum*), toyon (*Heteromeles arbutifolia*), deerweed (*Lotus scoparius*), laurel sumac, sages (*Salvia* spp.), poison-oak, and chaparral candle (*Hesperoyucca whipplei*) (Holland 1986). Chaparral plant communities are adapted to nutrient poor soils, cool wet winters, and hot dry summers. Chaparral vegetation accounts for approximately 9,000 acres on Camp Pendleton.

CSS types are shorter (1.5-6.5 ft, 0.5-2 m) and generally more open, often with enough spaces between the shrubs to permit a path to be picked out without much damage to the shrubs. The proportion of herbs and sub-shrubs is correspondingly higher in sage scrub. These semi-woody plants are low growing because higher temperatures and drying winds can cause severe moisture stress, and plant size is relative to the available water supply. Scrub species form a continuous to open canopy, and they occupy gentle to steep slopes, with shallow or heavy soils, generally at elevations below 3,000 feet.

The CSS vegetation on Camp Pendleton is categorized as Diegan CSS, although dominant species may vary by site. The Base supports approximately 57,500 acres of CSS and its subtypes. This vegetation type consists of sparsely to densely spaced, low-growing, drought-deciduous shrubs; it frequently occurs on south-facing slopes and ridges below 3,000 feet where the rainfall, drainage, soil type, and exposure to the sun provide the conditions necessary for the plant community. CSS is thought to be one of the most endangered vegetation types in California. Less than 20% of the original area once covered by CSS probably remains. Scrub communities have suffered severe losses to spreading urbanization, and consequently, several plant and animal species associated with CSS are vulnerable to habitat depletion. Large areas of coastal sage shrublands are occupied by the federally listed threatened coastal California gnatcatcher (*Polioptila californica californica*). Plant species characteristic of CSS include California sagebrush (*Artemisia californica*), California buckwheat, black sage (*Salvia mellifera*), white sage (*Salvia apiana*), bush monkey flower (*Mimulus aurantiacus*), sawtooth goldenbush (*Hazardia squarrosa*), laurel sumac, and lemonadeberry (*Rhus integrifolia*).

Shrubland in general provide challenging training opportunities on Camp Pendleton, as they can be difficult for wheeled vehicles and foot mobile troops to maneuver through. Shrublands also provide good opportunities to practice concealment and camouflage skills since the vegetation is often not tall enough to hide a standing person or vehicle.

I.2.1. Chamise Chaparral

Chamise chaparral is the most common type of chaparral throughout California and is usually associated with xeric south and west-facing slopes, and ridges. The chamise chaparral community at Camp Pendleton is 1-3 m tall and is dominated by the needle-leaved, evergreen shrub, chamise. The canopy is fairly continuous and herbaceous species are uncommon in older stands, although occasional canopy gaps may be occupied by subshrub species such as black sage and deerweed. *Adenostoma* may recover from fire both by resprouting and seedling recruitment. A fraction of the seeds can germinate without fire cues and seedlings are rarely observed in mature stands, but under the right circumstances chamise can slowly invade unburned areas. Despite its ability to recover from fire, high fire frequency with multiple reburns with intervals of 5 to 10 years or less may result in replacement of chamise chaparral by CSS.

I.2.2. Southern Mixed Chaparral

Southern mixed chaparral is a generalized type that includes vegetation dominated by scrub oak (*Quercus berberidifolia*), chamise (*Adenostoma fasciculatum*), and any of several species of manzanita (*Arctostaphylos* spp.) and lilac (*Ceanothus* ssp.). It is often found on somewhat moister and more favorable sites such as north-facing slopes or at lower hillslope positions where soils are deeper. Common species include chamise, Eastwood's manzanita (*Arctostaphylos glandulosa*), rainbow manzanita (*A. rainbowensis*), scrub oak, thick-leaf-lilac (*Ceanothus crassifolius*), green-bark-lilac (*C. spinosus*), birch-leaf mountain-mahogany (*Cercocarpus betuloides*), spiny redberry (*Rhamnus crocea*), and toyon (*heteromeles arbutifolia*). Coastal sage shrub species occur in occasional gaps in the canopy along with poison-oak and chaparral candle. Tree species such as coast live oak and the uncommon Engelmann oak, may occur as single individuals in some stands. Dominant shrub species return after fire primarily by resprouting but also by seedling establishment so that, if fires are not too frequent or too intense, a stand may be expected to return to pre-fire composition within 5 to 10 years. Generally, chaparral shrub species tolerate summer drought with wilt-resistant evergreen leaves that have a waxy coating, which reduces water loss and deep roots that tap underground moisture reserves.

I.2.3. Ceanothus Crassifolius Chaparral

Ceanothus crassifolius chaparral is dominated by its namesake, *Ceanothus crassifolius* (thick-leaf-lilac) with chamise as a codominant in some stands, which together form a monolayer that averages about 6 ft (2 m) in height. The canopy is usually closed with a sparse understory. *Ceanothus crassifolius* chaparral is typically found on more mesic sites than chamise chaparral. The woody shrub or vine, poison-oak, occurs in some stands and the twining shrub, honeysuckle (*Lonicera subspicata*) is an occasional canopy associate. Both dominant species of this chaparral subtype have seeds that are stimulated to germinate after fire. Although chamise is capable of resprouting both after and between fires, thick-leaf-lilac does not form vegetative sprouts after fire and is totally dependent on seedling recruitment to recover from burning. Because of this, it is susceptible to population crashes when fires occur at short intervals. Thick-leaf-lilac has relatively shallow roots but tolerates summer drought with features such as specialized leaf structures that reduce water loss.

I.2.4. Scrub Oak Chaparral

Scrub oak chaparral is found on relatively moist sites and in southern California is common on north-facing slopes below 3,000 ft (900 m) and on all slopes aspects above 3,000 ft. Scrub oak forms a dense, often nearly impenetrable, evergreen canopy on north-facing sites at Camp Pendleton. Birch-leaf mountain-mahogany and toyon are occasional shrub associates. The understory is sparse, but the subshrub, deerweed as well as native bunchgrasses, coast range melic (*Melica imperfecta*) and giant wild-rye (*Leymus condensatus*), are sometimes found in canopy gaps. Although scrub oak, toyon, and birch-leaf mountain-mahogany resprout between and after fires, seedling recruitment has only been observed in old (> 50 yrs) stands. Scrub oak has extensive roots that can penetrate deep underground moisture reserves during summer drought conditions.

I.2.5. Diegan CSS

Diegan CSS is dominated by low (< 6 ft, 2 m), soft-leaved, drought-deciduous shrubs and is typically found on drier sites and steeper slopes of coastal southern California, from Los Angeles into Baja California. Dominant shrub species drop leaves as the summer dry season progresses and thereby effectively reduce their water stress. The community has suffered severe losses to spreading urbanization and as a result, provides the remaining habitat for many endangered and threatened species. Approximately eight rare plant and eleven rare animal species occur in Camp Pendleton CSS. Since the composition of coastal sage stands tends to shift continuously across gradients of exposure, elevation and soil type, a number of coastal sage subtypes have recently been recognized.

I.2.6. Black Sage Scrub

Black sage scrub is dominated in the overstory (>50% cover) by the aromatic shrub, *Salvia mellifera*. Other shrub species occurring in black sage scrub stands at Camp Pendleton include laurel sumac and California sagebrush. Black sage scrub often intergrades with various forms of chaparral, especially chamise. Herbaceous cover is low and there is little bare-ground. The black sage scrub dominant, *Salvia mellifera*, resprouts both between and after recurring fires, although post-fire resprouting is sensitive to fire intensity. Seedlings have been observed at Camp Pendleton in both mature and burned stands. Black sage responds to seasonal drought by reducing transpiring surface area through leaf curling and the loss of larger leaves. Except in the driest years, it is generally possible to find small green leaves on shrubs during the summer. This retention of leaves makes it possible for black sage to respond quickly to the first fall rains.

I.2.7. California Sagebrush Scrub

California sagebrush scrub is a subtype of the relatively low, aromatic, soft-leaved shrubland, Diegan CSS. California sagebrush is often the sole dominant overstory shrub in this subtype, in which it averages about 3 ft (1 m) in height. Laurel sumac, coyote brush (*Baccharis pilularis*), deerweed (*Lotus scoparius*), black sage (*Salvia mellifera*), and California buckwheat (*Eriogonum fasciculatum*) may be local shrub associates. Nonnative annual grasses are common in canopy gaps along with occasional native bunchgrasses (especially foothill needlegrass [*Nassella lepida*]) and forbs such as tocalote (*Centaurea*

melitensis) and mustard (*Brassica* spp.). California sagebrush resprouts from the base both after and between recurring fires and seedling recruitment has also been observed in both mature and post-fire stands at Camp Pendleton. However, both resprouting and seed germination of coastal sage dominant shrubs are variable after fire, and appear to be quite sensitive to such parameters as fire intensity and geographic location. Very short intervals (< 5 years) between fires can eliminate coastal sage and leave sites dominated by nonnative grasses. At Camp Pendleton, rare animal species observed in California sagebrush stands include coastal California gnatcatcher, San Diego horned lizard (*Phrynosoma coronatum blainvillii*), and orange-throated whiptail (*Cnemidophorus hyperythrus beldingi*). Rare plants include thread-leaved brodiaea (*Brodiaea filifolia*), sticky dudleya (*Dudleya viscida*), as well as its congener, many-stemmed dudleya (*Dudleya multicaulis*).

I.2.8. Mixed Sage Scrub

Mixed sage scrub is the most common coastal sage scrub subtype found at Camp Pendleton. Similar to other Diegan CSS subtypes it is a low, soft-leaved shrubland typical of drier sites. No single shrub species dominates the overstory. Instead, a mix of coastal sage species such as black sage, California sagebrush, bush monkey flower, California buckwheat, deerweed, and white sage dominate the shrub canopy. Occasional individuals of the taller, leathery-leaved species, laurel sumac and lemonadeberry are not uncommon. The canopy tends to be more open in mixed sage scrub than in other coastal sage scrub subtypes. Native bunchgrasses, foothill needlegrass and coast range melic, occur in the understory and nonnative annual grasses (wild oats [*Avena* spp.] and brome grasses [*Bromus* spp.]) and forbs (tocalote, mustard, and filaree [*Erodium* spp.]) are often abundant. The twining perennial, morning-glory (*Calystegia macrostegia*), is frequently present in shrub canopies, and a rare succulent plant species, many-stemmed dudleya, can be observed in some mixed sage scrub stands. Most coastal sage dominants resprout from shrub bases both between and after recurring fires, although post-fire resprouting vigor varies within and among species. Seedlings of most soft-leaved overstory shrub species have been observed at Camp Pendleton in mature sage stands.

I.2.9. Coastal Sage – Chaparral Scrub

A mixed community of both low, soft-leaved coastal sage species and taller, leathery-leaved shrub taxa is often found on sites characterized by natural disturbance. Taller evergreen species typical of coastal sage-chaparral scrub include thick-leaf-lilac, holly-leaf redberry, lemonadeberry, toyon, birch-leaf mountain-mahogany, and laurel sumac. Co-dominant coastal sage subshrubs include California sagebrush, white sage, black sage, narrow-leaf bedstraw (*Galium angustifolium*), and deerweed. The canopy of this vegetation type is fairly continuous and, although herbaceous species are uncommon, native perennial bunchgrass species (coast range melic, foothill needlegrass, and giant wild-rye) occur in canopy gaps in some stands. This vegetation type covers approximately 5,700 acres on Camp Pendleton.

I.2.10. Coastal Bluff Scrub

Although coastal bluff scrub is not addressed by Zedler et al. (1997), this vegetation type is found above the beach areas and along the bluffs on Camp Pendleton. The Base supports

approximately 315 acres of coastal bluff scrub, which consists of sparsely to densely spaced, low-growing, drought deciduous shrubs below 100 m elevation where the rainfall, drainage, soil type, and exposure to the sun provide the conditions necessary for development. Coastal bluff scrub may be one of the most limited, and perhaps endangered, vegetation types in southern California as a result of coastal development. This vegetation type is sometimes included within the CSS vegetation described above, but it also contains numerous succulent species, such as coast barrel cactus (*Ferocactus viridescens*), California encelia (*Encelia californica*), and *Dudleya* spp.

I.3. GRASSLANDS

Grasslands are an important feature of Camp Pendleton, with an estimated area of about 40,000 acres or over 30% of the Base. Grasslands were also present historically, through the past and present locations may not coincide exactly. Crespi stressed the presence of grasses in his 1769 diary for the Portolá expedition. Traversing the area from the Santa Margarita River (which was given its name by this expedition) to Las Pulgas Canyon on 20 July, Crespi noted: "We went on over hills of moderate height, all grassy, and halted near the water, which is in the grass…" Further north, between Las Pulgas and Los Christianitos he says: "We traveled in the mountains for they are not rough, but open, with hills and extensive mesas, covered with a great deal of grass and grown with live oaks and alders." In the 1880s, after a century of grazing and some agriculture, the area of the future Camp Pendleton remained one of extensive and beautiful grasslands. Van Dyke describes the area "north of the Santa margarita Creek where it empties into the sea" in a poetic language: "For miles above it there slopes from the shore to the mainland mountains a long stretch of table-land so smooth and solid that one may drive or gallop over it in almost any direction. In years of sufficient rain it is covered with a carpet of alfileria and clover, which, starred with thousands of blossoms, rolls away upward toward the inward hills in a hundred shades of color. It seems the very home of peace – such a land as that of the lotus-eaters."

Unfortunately, we know that the present grasslands are very different from those that Crespi saw, and that the change was well underway by the 1880s as Van Dyke's mention of the exotic alfileria (filaree [*Erodium* spp.]) confirms. The arrival of European culture, of which Crespi's visit was the harbinger, also saw the introduction of aggressive weedy grasses and forbs from the old world. In one of the major transformations of the California landscape, introduced plants, especially the annual grasses, became common almost everywhere and dominant in many places. Camp Pendleton is no exception, and introduced grasses and forbs are now major components of the vegetation. Generally speaking, the areas that have been most disturbed in the past (especially by cultivation) and that are lower elevations tend to have the highest proportions of exotic annual grasses. Grasslands at higher elevations that have never been cultivated have higher proportions of native perennial grasses.

It is generally agreed among students of California grasslands that this exotic invasion is irreversible, and Heady has suggested that the thorough naturalization of these species be recognized by considering them to be "new natives". While that is too bitter a pill for many who value the native flora, it correctly points to the fact that the presence of exotic grasses, in itself, is not evidence that grasslands are seriously disturbed or that they are being

mismanaged. But on the other side, the presence of native perennials is evidence that rangelands are in good condition and that they have not been severely abused in the past. Perennials are sensitive to overgrazing and do not necessarily reinvade effectively after cultivated fields are abandoned.

Because of the ubiquity of exotic grasses, experts differ on the definition of "native grassland". Some consider that presence of native perennials at even a very low abundance qualifies an area to be considered native grassland, while others insist that native perennials must be dominant. For reasons explained above, no one stipulates that exotic grasses must be absent. In the case of Camp Pendleton, grasslands with more than one perennial grass plant per square meter have been considered native. Approximately 25,000 - 30,000 acres of the Base are perennial grasslands and about 10,000 acres are annual grassland under this definition.

At Camp Pendleton, fine-textured soils of coastal terraces are largely covered with grassland, as are the rolling hills with deeper soils at higher elevations. Trees or shrubs mostly cover the rocky and thinner soils where moisture can penetrate to depth. This moisture-determined pattern is, however, everywhere complicated by disturbance history. It seems certain that many areas dominated by grasses would revert to shrublands or even woodland if burning frequency were reduced, or if areas were less frequently disturbed by other means. In other cases the grassland may be stable, but as explained above, it may date to past clearing and cultivation.

Dormant grasslands are very fire susceptible, and there is no doubt that grasslands at Camp Pendleton burned in the pre-European past. We will never know the details of how often they burned or what amount of burning was due to natural causes, and what part was due to accidental or intentional fires set by Native Americans. Crespi comments that in country just south of present Camp Pendleton they "…entered upon some mesas covered with dry grass, in parts burned by the heathen for the purpose of hunting hares and rabbits, which live there in abundance." Ranchers, however, tended to have a negative view of fire since their cattle could use the summer-dry grass as forage. Jerome Baumgartner, who grew up on Rancho Santa Margarita, reminisced that great care was taken to avoid accidental fire: "…fires were considered very serious stuff on the Santa Margarita and any man who did anything that could have started a fire would have been fired… So, most of the men did not smoke much away from the bunkhouse." In recent years controlled and accidental burns have made fire commonplace in Camp Pendleton grasslands. Though the introduced grasses can survive fire as dormant seeds and are quick to reinvade when they do not survive locally, in general fire seems to favor the native flora over the introduced species in grasslands. One of the main reasons seems to be that fire removes the thick thatch produced by annual grasses that inhibits the seedling establishment of other species.

Grasslands are valuable for military training because they allow tracked and motorized units to fire and maneuver cross country. The terrain is usually flat to gently rolling and therefore provides many maneuver opportunities, as well as visibility for reconnaissance and observation for indirect fire. At lower elevations scattered large laurel sumac provide cover and concealment while not significantly impeding movement.

I.3.1. Valley Needlegrass (Native Perennial) Grassland

The mapped extent of "native grasslands" at Camp Pendleton has been based on a relatively broad definition. Camp Pendleton has extensive areas of some of the best perennial grasslands in southern California, and by any definition is the only significant area of coastal native grasslands left in southern California. It is speculated that the reason why needlegrass stands appear to have survived a long history of periodic grazing and drought at Camp Pendleton as opposed to the interior valleys of California is that the mild climate, especially summer fog, might have mitigated impacts on the native perennial grasses. In addition, the high fire frequency at Camp Pendleton appears to have a significant positive effect on density of native grasses.

The needlegrasses, foothill needlegrass, purple needlegrass (*Nassella pulchra*) and nodding needlegrass (*N. cernua*), are the dominant and characteristic native perennial grasses, but there are also twenty-nine other native perennials and fifteen nonnative perennial grasses present on the Base. Nonnative annual grasses are also a significant component of most perennial grasslands and include a number of species of *Bromus,* V*ulpia*, and *Avena*. The most common native forb is blue-eyed-grass (*Sisyrinchium bellum*), although a number of native species such as shooting star (*Dodecatheon clevelandii*), and members of the lily family including showy mariposa lilies (*Calochortus* spp.) and chocolate lily (*Fritillaria biflora*) are locally abundant. Common nonnative forbs include filaree and tansy-mustard (*Descurainia* spp.). Sweet fennel (*Foeniculum vulgare*), is the most obvious of exotics, growing in good years to over 6 ft (2 m) tall, and often achieving considerable abundance.

I.3.2. Nonnative Annual Grassland

Nonnative grasslands occupy about 10,000 acres on the Base. These areas are dominated by one to several of the following exotic grasses: ripgut grass (*Bromus diandrus*), red brome (*Bromus madritensis* ssp. *rubens*), soft chess (*Bromus hordeaceus*), slender wild oat (*Avena barbata*), wild oat (*Avena fatua*), barley (*Hordeum* spp.), and Italian ryegrass (*Lolium multiflorum*). All but the last are annual grasses with very similar life histories. They germinate in the fall or early winter with the first rains and are protected from unseasonal germination by a preference for, if not a requirement for, cool temperatures. Their growth is characterized by extreme plasticity. When conditions are most favorable (high moisture, high fertility, low competition from other plants, no herbivory) individual plants are tall (40 to 200 cm depending on the species), tend to form small clumps and produce hundreds or many thousands of seeds. When stressed by unfavorable conditions, plants of any species can be minute, only a few inches tall and with a single stem. Even such diminutive plants, however, can produce a few seeds. Thus, complete failure of a seed crop is almost impossible even in the worst years, making the species especially well adapted to California's highly variable rainfall.

The heavy growth produced in the better years also is an important factor in the ecology of annual grasslands. When unburned, the course stems of the annual grasses, unlike the litter of most perennials, can form a dense mat over the surface of the soil. Over time, this can become so dense that small-seeded plants have difficulty germinating through the litter.

Removal of this thatch is one of the ways in which burning can help to encourage native species.

The three main factors that have been found to correlate with dominance by nonnative annual grasses are low elevation, low fire frequency, and likely history of long term cultivation in the past. They found that areas of annual dominance had at least minor continued annual grass dominance. These areas often have extensive cover of various nonnative forbs such as sweet fennel, filaree, black mustard (*Brassica nigra*), short-pod mustard (*Hirschfeldia incana*), smooth cat's ear (*Hypochaeris glabra*), and common sow-thistle (*Sonchus oleraceus*).

I.4. COASTAL DUNES

The limited area of natural coastline left in southern California makes the Camp Pendleton shoreline of special interest. Habitats of the coast may be divided roughly into four zones. The *intertidal* zone is regularly inundated by the ocean, while *strand* or *beach* is subject to wave action and deposition and removal of sand and gravel. *Foredunes* are the first line of dunes subject to sand deposition, high winds, salt deposition, but are only rarely subject to wave action or overwash; *backdunes* may be stable (not subject to deposition or erosion by the wind) or moving (having sand deposited or removed). Where cliffs face the ocean, the exposure to high winds and high salt deposition creates another distinctive habitat – coastal bluffs. Except for the intertidal zone, any or all of these may be absent, for example, when rocky cliffs meet the ocean.

On Camp Pendleton, the coastal strip is mostly a relatively narrow stretch of sandy beach lying below a usually steep bluff cut into poorly consolidated sediments of the coastal mesas. Dune development is accordingly limited compared to the extensive dunefields in central and northern California, however, sand still is blown inland from the beach, and this has created low foredunes along much of the coastline. The most extensive foredunes are found at the mouth of the Santa Margarita estuary, White Beach, and a few scattered locations. In these places a mostly seriously disturbed dune community with many of the typical species can be found.

The southern foredune is a sparsely vegetated community with plant cover ranging from 30% to 60%. On Camp Pendleton this plant community is dominated primarily by beach-bur (*Ambrosia chamissonis*, 10% to 30% cover), and substantial populations of red sand-verbena (*Abronia maritima*), sea-fig (*Carpobrotus chilensis*, nonnative), European searocket (*Cakile maritima*, nonnative), and beach evening-primrose (*Camissonia cheiranthifolia* ssp. *suffruticosa*) that cumulatively account for 5% to 15% cover. The substrate consists of shifting sand dunes. On Camp Pendleton this community is estimated to occupy less than 165 acres.

A number of sensitive plant and bird species are associated with southern foredunes on Camp Pendleton. The plants include: Nuttall’s lotus (*Lotus nuttallianus*), Brand's phacelia (*Phacelia stellaris*), coast woolly-heads (*Nemacaulis denudata* var. *denudata*), and Coulter's saltbush (*Atriplex coulteri*). The federally listed endangered California least tern (*Sterna antillarum browni*) and threatened western snowy plover (*Charadrius alexandrinus*

nivosus) also use this habitat. Much of the highest quality remaining foredune acreage occurs within California least tern nesting areas at the mouth of the Santa Margarita River. The vegetative cover has increased and more dunes have formed around the plants since year round fencing was installed at the tern colony in 1980's. Relatively high quality foredunes also occur at White Beach and a few locations in the Uniform training area.

Beach and dune communities are high value for training, because of the amphibious mission of the Marine Corps. The beach environment provides opportunities for amphibious landings. These landings involve simulating mine sweeps, securing defensive positions, and establishing encampments and staging areas ashore. In this type of training Marines learn to maneuver vehicles and equipment through wet and dry sand and moving personnel and supplies through the surf zone. All of the Base's foredune communities at White Beach and the Santa Margarita estuary have been set aside as nesting areas for the federally listed endangered California least tern, so no training disturbance occurs in this community.

I.5. RIPARIAN COMMUNITIES

Riparian woodlands and shrublands occur in drainages, seepages, and riverine areas where water availability is high. Because upland areas in southern California are generally moisture limited, riparian vegetation is distinctly different, functionally and visually, from that of the surrounding drought-stressed habitats. In contrast to the oak woodlands and the sage scrub, riparian vegetation is dominated by winter deciduous trees – willows (*Salix* spp.), cottonwoods (*Populus* spp.), white alder (*Alnus rhombifolia*), and western sycamore (*Platanus racemosa*).

Riparian woodlands are a dynamic vegetation type. The streams and rivers are subject to erosion and sedimentation every year, and to devastating flooding in many. All of the drainages are continually changing, and the plant populations shifting in response. The growth patterns and life histories of the plants are designed to tolerate and exploit this dynamic habitat. Willows and cottonwoods are fast growing and regenerate readily when damaged; they can root from branches, and are capable of establishing millions of seedlings in a single year when conditions are right. This dynamic quality of the vegetation makes it difficult to classify into fixed types.

More than 95% of the riparian habitat historically occurring in southern California has been lost to agriculture, development, flood control, channel improvements, and other human caused impacts (Bell 1993). Oberbauer (1990) reports a 60.8% loss of riparian woodland in San Diego County. Much of the remaining riparian area has been degraded by a variety of human activities, especially as a result of habitat fragmentation and detrimental edge effects. These areas no longer support numerous species formerly extant.

Of the approximately 9,800 acres of floodplain on the Base, riparian habitats currently cover about 8,200 acres; disturbed/developed lands account for the remaining 1,600 acres of floodplain (USFWS BO #1-6-95-F-02). Much of the Camp Pendleton riparian woodland and shrubland is off limits to military training because of proximity to installations, wetland regulations, and endangered species. Where available they provide dense cover.

Their linear arrangement creates concealed avenues of approach for small units. Riparian woodlands are currently used to a limited extent for such foot activities. Compared to the rest of coastal southern California, a high proportion of the riparian acreage on Base is still relatively intact. The Santa Margarita River represents a significant portion of the riparian habitat on Camp Pendleton. Other areas on Base that support riparian communities include the drainages of the San Mateo, San Onofre, Las Flores, Aliso, and French watersheds and portions of Pilgrim Creek (San Luis Rey). Over 5,500 acres of riparian habitat on Base retains at least some value for listed species (USFWS BO #1-6-95-F-02). Riparian areas on Camp Pendleton support three federally listed endangered species: the least Bell's vireo (*Vireo bellii pusillus*), southwestern willow flycatcher (*Empidonax traillii extimus*), and arroyo toad (*Bufo californicus*). Riparian habitat complexes on Base support a diverse avifauna in general, with over 100 breeding species and densities of up to 650 territorial males (various species) per 100 acres. Particularly well represented are neotropical migrants.

The lower Santa Margarita River floodplain is a mile wide in places and supports extensive riparian forest, woodland, and scrub habitats from the edge of the braided channel to the base of riverine terraces. The upper Santa Margarita River, from the confluence of Murrieta and Temecula Creeks (off Base) to the lower floodplain, is contained within a gorge varying from less than 100 to over 1000 feet in width. The Santa Margarita River is the most biologically intact riparian corridor remaining in southern California (USFWS BO #1-6-95-F-02). Recently, the Santa Margarita River floodplain and associated riparian habitat were altered by the construction of the levee (completed in 2000) around the Air Station. The levee (including associated floodwall) runs along approximately 16,800 feet of the Santa Margarita River and provides flood control and protection from significant flood events within the 100-year floodpain.

The Santa Margarita River never supported a rich native fish fauna; only four species or subspecies of true freshwater fishes are native to the coastal streams of southern California (Moyle 1976). The only native lotic fish identified from the river today is the arroyo chub (*Gila orcuttii*). It is not known if three other listed species: speckled dace (*Rhinichthys osculus*), Santa Ana sucker (*Catostomus santaanae*), and three-spined stickleback (*Gasterosteus* aculeatus) had ever occurred in the Santa Margarita River or have been extirpated due to changes in the hydrology, introduction of exotic fishes, or other factors. The river supported Pacific lamprey (*Lampetra tridentata*) and a significant native steelhead trout (*Oncorhynchus mykiss*) spawning run until the 1970s.

The riparian forest, woodland, and scrub habitats along the Santa Margarita River and other streams on Base depend upon periodic flooding to provide substrate, nutrients, and physical energy to cycle the community back to earlier successional stages. Periodic floods of large magnitude, and migration of the river channel, are essential to the deposition of fresh alluvial sediments where seeds of willow and cottonwood can germinate and propagules of willow can take root. Adequate moisture and an absence of heavy flooding are particularly critical to the survival of young trees through their first year. As seedlings and resprouts mature into saplings, and eventually into mature trees, the river continues to deposit sediment on the floodplain. This process results in the formation of river terraces and as

they rise other plant species colonize, resulting in further diversification in the floodplain community.

When cottonwood-willow riparian scrub reaches 4 to 5 years of age, it begins to exhibit the tiered structural diversity required by breeding least Bell's vireo. The vireo, along with southwestern willow flycatcher and many other species may continue to use this diverse community for another 10 to 20 years. Gradually the canopy of the maturing willows and cottonwoods begins to shade out the diverse understory of vascular plants required by these birds. While older riparian gallery forests are valuable to many other species, they do not provide suitable vireo and flycatcher habitat. Annual flooding and occasional large flood events maintain this cycle of succession needed for a mosaic of diverse natural communities.

Giant reed (*Arundo donax*) and tamarisk (*Tamarix* spp.) are plants from Eurasia that readily invade riparian channels in southern California, especially in areas that are disturbed. Giant reed is very competitive, difficult to control, and generally does not provide either nesting or foraging habitat for native animals. Spreading mainly by stolon and other vegetative parts, giant reed invades riparian communities at any stage of succession. It grows very quickly (up to 2 inches per day), is highly flammable and resprouts rapidly after a fire. Because of these characteristics, once giant reed invades a riparian area, it redirects the succession of the community towards pure stands of reed, usually through increasingly frequent fire events.

Native riparian communities are not adapted to repeated fire, and therefore, cannot withstand invasion by these disturbance-adapted plants. Moreover, any type of disturbance, even natural flooding to which native riparian communities are adapted, can open vegetative stands to colonizing propagules and perpetuates giant reed spread.

Giant reed has likely been on Base for many years and is apparently visible in the movie "Sands of Iwo Jima" [circa 1950], reportedly filmed on Base (Jeff Caspers pers. comm.). Base activities from the 1960s through early 1980s were observed to greatly expand the areas infested with giant reed (Larry Salata pers. comm.). Phreatophyte control and flood control channelization of the lower Santa Margarita River during this period were noted as covering miles of riverbed and led to expanding giant reed infestations along the Santa Margarita River (Ibid.). In the fall of 1980 several miles of the lower Santa Margarita River were channelized downstream from the air station (MCAS). Dike repairs on the River were accomplished during this period as well. Large flood flows from the late 1970s and early 1980s caused further disturbance and introduced giant reed propagules over large areas, extending to the Santa Margarita River Estuary. Between 1980 and 1985, impenetrable thickets of giant reed colonized most of these areas disturbed by human activities. Unintentional fires resulting from Base activities have burned riparian areas on the River. These burned areas have largely responded with greatly increased giant reed infestation. The edges around the off-channel spreading structures constructed and maintained for infiltration of surface flows in the floodplain of the Santa Margarita River are currently dominated by giant reed. In-channel infiltration and de-siltation efforts on the Santa Margarita River have disturbed areas of floodplain in the past. Base construction and maintenance activities involving bridges, levees, river crossings, roads, and culverts

continue to contribute to the expansion of giant reed through disturbance of the floodplain. Judging from the observation of giant reed spread in other riverine systems, such as the Santa Ana River, the Service anticipates that giant reed stands will continue to expand along the Santa Margarita River (USFWS BO #1-6-95-F-02).

I.5.1. Cottonwood-Willow Riparian Forest

Cottonwood-willow riparian forest is a tall, broad-leafed, winter deciduous forest found along rivers and streams, and is dominated by western and black cottonwood (*Populus fremontii* ssp. *fremontii, P. balsamifera* ssp. *trichocarpa*) and the tree willows (Goodding's black willow [*Salix gooddingii*], arroyo willow [*S. lasiolepis*], and red willow [*S. laevigata*]). Both cottonwood and willow require moist, bare mineral soil for seed germination. They often form uniform aged stands in areas of receding floods that provide the ideal conditions for seed germination. Other common species found in this habitat include mule fat (*Baccharis salicifolia*), Douglas mugwort (*Artemisia douglasiana*), western sycamore, and several nonnative species like poison hemlock (*Conium maculatum*) and cocklebur (*Xanthium strumarium*). There is little understory vegetation beneath a dense, mature canopy. Where groundwater is adequate, southern willow scrub can develop into cottonwood-willow riparian woodland in the absence of repeated flooding.

I.5.2. Sycamore-Alder Riparian Woodland

Sycamore-alder riparian woodland is an open, tall, winter-deciduous, streamside woodland dominated by western sycamore and white alder. Alder is present at higher elevations along perennial streams, whereas sycamore favors more intermittent streamflow. Western sycamores do not generally form a closed canopy, rather they appear as scattered clumps in a shrubby thicket of evergreen and deciduous species. Sycamores knocked down in flood events readily resprout along the entire length of the fallen trunk, forming clumps of trees that have all arisen from the same individual. Sycamore woodlands are commonly found along rocky stream beds that are subject to seasonal high-intensity flooding. Vegetation associated with sycamore woodlands includes: blue elderberry (*Sambucus nigra* ssp. *caerulea*), Douglas mugwort, poison-oak, California blackberry (*Rubus ursinus*), tree tobacco (*Nicotiana glauca*), black mustard, and a host of nonnative annual grasses. Sycamore-alder riparian woodland covers approximately 460 acres on Camp Pendleton.

I.5.3. Southern Willow Scrub

Southern willow scrub is a dense, winter deciduous vegetation found along the major rivers of coastal southern California. It is dominated by several willow species (arroyo willow, Goodding's black willow, red willow, and narrow-leaf willow [*S. exigu*a]) with scattered western cottonwood and western sycamore trees. Narrow-leaf willow (<20 ft, 6 m), arroyo willow (<30 ft, 9 m) and mule fat (<15 ft, 5 m) constitute the shrubby part of the habitat, with the mature willows (<65 ft, 20 m) forming the tall canopy. Associated understory herbaceous species include poison-oak, western ragweed (*Ambrosia psilostachya*), Douglas mugwort, and many nonnative species such as poison hemlock and cocklebur. Where the willow canopy is very thick there is little understory vegetation. This habitat has been much reduced by urban expansion, flood control, and channelization. Southern willow scrub is an important habitat for many animals, including the federally endangered least

Bell's vireo, which needs the height stratification characteristic of this habitat for nesting (the willow scrub) and foraging (the willow canopy). Examples of southern willow scrub can be seen on the Santa Margarita River.

I.5.4. Mule Fat Scrub

This herbaceous riparian scrub community typically occurs on coarse alluvial soils in intermittent streambeds and on flood plains. It is generally species-poor, being dominated by mule fat (*Baccharis salicifolia*), and often represents an early stage in the establishment of cottonwood- or sycamore-dominated riparian forests or woodlands. Other characteristic species present include narrow-leaf willow, arroyo willow, poison-oak, and hoary nettle (*Urtica dioica* ssp. *holosericea*). Mule fat scrub occurs scattered along streams and rivers from Tehama County south through the Coast Ranges and the Sierra Nevada to San Diego and northwestern Baja California.

I.6. WETLANDS

Wetlands occur where there is standing water or continual seepage that maintains saturated soils. Wetlands may be differentiated on the basis of salinity and the depth and permanence of standing water. On Camp Pendleton the only saline wetland is coastal salt marsh, though anomalous occurrences of salt-tolerant vegetation are found where drainages have been disrupted or modified by human influence. Slightly saline brackish marsh is found as a transition zone between the salt marsh and freshwater riparian habitat where the larger streams enter the ocean. The freshwater habitats vary from permanent standing water, mostly as a thin fringe along riparian areas and along the margins of artificial (Lake O'Neill) and natural (Case Springs) bodies of water, to temporary wetlands of which vernal pools are the major type on Camp Pendleton.

The common ecological property uniting these habitats is presence of saturated conditions that provide ample moisture for growth, but also cause stress by reducing the availability of oxygen to the roots and modifying the availability of nutrients. Wetland plants have a high water requirement but are tolerant of low oxygen or even reducing conditions. Upland plants are excluded because they are killed by the saturated conditions. Typically, however, wetlands grade into surrounding uplands and sometimes the boundary is unclear, causing much debate about the correct method for "delineating" wetlands.

Wetlands are particularly important to birds, including the least Bell's vireo and many others that utilize the wetlands during migration. One of the dramatic ecological changes in the last century is the disappearance of the massive bird migrations. Van Dyke, writing about the Santa Margarita river estuary and the surrounding hills noted that Canadian and snow geese, ducks, and sandhill cranes were "around and above you in their myriads" and that great flocks of Canada geese "stand sunning themselves upon the flowery knolls… others stand in regiments upon the low flats that make toward the shore, and thousands more are floating upon the smooth waters of the inlet." It is to be hoped that wetland restoration in the breeding grounds and along the migration routes may some day bring back the birds in abundance.

Because of their small areas, inability to support vehicles, and environmental sensitivity most wetlands do not provide opportunities for training maneuvers. In some cases the margins of wetlands may provide good concealment for small groups of personnel, and in vehicle maneuvers they provide experience in dealing with obstacles and landscape heterogeneity.

I.6.1. Freshwater Seep

Freshwater seeps occur where soils are saturated with freshwater for much or all of the year. These areas are usually of small size and limited distribution. The most prominent seeps on Base are found in the Morro Hill area (Juliett training area) and in the vicinity of Case Springs. The vegetation of seeps is composed almost exclusively of herbs less than 50 cm (1.5 ft) high, forming a closed canopy. The dominant species are perennial, mostly grassy or grass-like species: pale spike-rush (*Eleocharis macrostachya*), sedges (e.g., *Carex alma*), rushes (*Juncus* spp.), and Italian ryegrass. Freshwater seeps may intergrade into any community type, but are most often found in CSS and grasslands. Although small, these habitats have a disproportionate importance to animal populations, serving both as the primary habitat for some, and as a water source for others. Some of these animals may be endangered species.

I.6.2. Freshwater Marsh

This vegetative community is dominated by perennial, emergent monocots up to 4-5 m (13-16 ft) tall and often consisting of uniform, dense stands with closed canopies. Freshwater marsh occurs in wetlands that are permanently flooded by standing freshwater lacking a significant water current. Prolonged saturation of such areas permits the accumulation of deep, peaty soils. Characteristic species include cattails (*Typha domingensis* and *T. latifolia*), bulrushes (*Schoenoplectus* spp.), sedges (*Carex* spp.), and flatsedges.

Coastal freshwater marsh communities occur in scattered locations along the immediate coast, in coastal valleys near river mouths, and around the margins of rivers, creeks, lakes and springs. This community is now much reduced throughout its entire range due to urban and agricultural expansion, river channelization, and through the implementation of flood control measures.

I.6.3. Southern Coastal Salt Marsh/Brackish Marsh

Brackish marsh is found where freshwater dilutes seawater to a point where many freshwater aquatic plants tolerant of some salinity can grow. On Camp Pendleton, brackish marsh is extensive only in the estuary of the Santa Margarita River.

Coastal salt marsh occupies wetland habitats that are subject to tidal influence and to varying degrees of freshwater input, primarily during the rainy season. Because of their coastal location they are also subject to salt spray and the resulting atmospheric deposition of salt. The plants of salt marshes, mostly herbaceous perennials and low shrubs, are therefore tolerant both of flooding and of high salt content. Three major subdivisions of salt marsh have been recognized at Camp Pendleton. The pickleweed type is characterized by pure stands of the low shrub *Salicornia virginica* at lower more frequently flooded

elevations; alkali-heath (*Frankenia salina*) is a co-dominant at higher elevations. With increasing elevation, a pickleweed/saltgrass association is found in which Pacific pickleweed (*Sarcocornia pacifica*) co-dominates with saltgrass (*Distichlis spicata*). Highest elevations in the marsh are dominated by Parish's pickleweed (*Arthrocnemum subterminale*) and a mixture of upland grass species such as soft chess, red brome, glaucous barley (*Hordeum murinum* ssp. *glaucum*), and sicklegrass (*Parapholis incurva*). Small patches of pickelweed occur on salt pans in the estuary. Disturbed areas support exotic species such as hottentot-fig (*Carpobrotus edulis*), tree tobacco, common sow-thistle, and black mustard. Salt marshes on Camp Pendleton support the following federally listed species: the California least tern, western snowy plover, tidewater goby (*Eucyclogobius newberryi*), and the light-footed clapper rail (*Rallus longirostris levipes*).

An estimated 75 to 90% of California's coastal salt marsh habitats have been destroyed. The Santa Margarita River Estuary is the major salt marsh at Camp Pendleton, providing approximately 159 acres of habitat for 136 species of plants. However, the Santa Margarita River Estuary is periodically closed to tidal exchange and is not as rich in species as southern Californian coastal marshes subject to regular tidal flooding. Although once subject to a high level of disturbance, the Santa Margarita River Estuary is no longer used as a training area and a net increase in salt marsh vegetation has occurred since 1969. Four rare bird species are known to occur at the Santa Margarita River Estuary, three are on both State and federal endangered species lists (California brown pelican, California least tern, and light-footed clapper rail) while Belding's savannah sparrow is a State endangered species.

Because of their small area, wet conditions, and high resource values, coastal salt marshes are not suitable for large scale maneuvers or vehicle use. They do, however, serve a useful function in that coastal marshes are common around the world, and their presence on Camp Pendleton therefore serves to alert troops to their presence and need to be dealt with during landings and troop movement. In this sense they provide training opportunities for military planners on how to avoid restrictive terrain.

I.6.4. Salt Flats

Salt flat habitats are characterized by large flat expanses of hard-packed sand with sparse vegetation. Vegetation includes pickleweed and saltgrass. Salt flats are important nesting areas for the California Least Tern and the western snowy plover.

I.6.5. Isolated Ephemeral Wetlands (IEW) and Vernal Pools

IEW are temporary bodies of water that form where there are depressional landscape features that do not readily drain and rainfall is variable. IEW develop on a variety of soils, usually underlain by hardpan, in a variety of habitats. The soils of clay hardpan prevent the natural rainwater from percolating through, and ponding occurs in depressions on the surface. As the water evaporates, the plants take on a terrestrial life form. In some areas rounded crests separate vernal pools which are known as mima mounds. However, not all vernal pool areas contain mima mounds. On Camp Pendleton, IEW are typically found on the flat coastal mesas and can either be a component of grassland, CSS, or chaparral

landscapes. The ponded water and ephemeral nature of these wetlands have created a unique assemblage of plants and animals to occur in these pools, some of which occur nowhere else.

A vernal pool is a type of isolated ephemeral wetland. Vernal pools are shallow, ephemeral wetlands with very specific hydrologic characteristics, occurring within a Mediterranean climate region, but only within soil types where there is a seasonally perched water table. Vernal pools provide habitat for aquatic macroinvertebrates, such as Riverside fairy shrimp (*Streptocephalus woottoni*) and San Diego fairy shrimp (*Branchinecta sandiegonensis*), and aquatic flora such as American pillwort (*Pilularia americana*) and Orcutt's quillwort (*Isoetes orcuttii*). In many pools emergent aquatic species typical of wetlands also occur, such as pale spike-rush and Mariposa rush (*Juncus dubius*). In the spring as the rains diminish and the pools dry, plants that tolerate some inundation but require the dry phase enter their flowering stage, such as spreading navarretia (*Navarretia fossalis*), little mousetail (*Myosurus minimus*), and San Diego button-celery (*Eryngium aristulatum* var. *parishii*). Most species in this community survive the dry summer as dormant seeds; others die back to underground corms or rhizomes.

The vernal pools located on Camp Pendleton are considered an important resource regionally because they are among the few remaining representatives of this habitat that still exists in San Diego County. Efforts to preserve vernal pool habitat in the private sector have been largely unsuccessful. Between 1979 and 1986, about 68 percent of the vernal pools on privately owned land within the City of San Diego were lost (Bauder and Wier 1991). The vernal pool resource at Camp Pendleton is the second largest in San Diego County, behind only MCAS Miramar, supporting some of the most important examples of endangered and sensitive species dependent on vernal pools in the region. Approximately ten percent of the known vernal pools remaining in San Diego County occur on Camp Pendleton; this is based on the current estimate of approximately 20 acres of vernal pool basin area mapped on Base and the (somewhat outdated) estimate of 202 acres remaining in the County (Bauder and Wier 1991). On Camp Pendleton, four species associated with vernal pools are federally listed as threatened or endangered: Riverside fairy shrimp, San Diego fairy shrimp, San Diego button-celery, and spreading navarretia.

I.7. RUDERAL, DISTURBED, AND DEVELOPED LANDS

Ruderal, disturbed, and developed areas on Camp Pendleton are typically associated with a predominance of exotic species (as a result of natural opportunistic invasions or intentional introductions, e.g., landscaping and agriculture). Ruderal areas those that have generally been severely disturbed (cleared), such as road fills and construction sites, or that are subject to recurrent disturbance, such as roadsides. The disturbances that result in ruderal areas are typically a result of anthropogenic impacts. The flora of such ruderal areas is dominated by introduced exotic species such as weedy grasses and forbs (non-grasslike herbaceous plants). Many disturbed areas are not generally thought of as ruderal, but have been subjected to disturbance from fire or other natural events. When these disturbances occur over large areas, or occur at a relatively high frequency, they too, can become dominated by exotic vegetation. Developed areas on Camp Pendleton are often associated with ruderal and disturbed sites, as well as with landscaping.

I.7.1. Ruderal/Disturbed Habitat (Vegetation)

Areas classified as disturbed habitat (vegetation) are those where past or present physical disturbance (e.g., brushing, tilling, or vehicle activity) is prevalent. In such circumstances over half the area is covered by species adapted to disturbance, especially forbs, or by bare ground. These areas have a potential to support native vegetation if left undisturbed or restored. Approximately 2,718 acres of Camp Pendleton have been characterized as disturbed habitat.

Disturbed habitat is any land on which the native vegetation has been significantly altered by agriculture (see next section), construction, or other land clearing activities. Such habitat is typically found in vacant lots, roadsides, construction staging areas, and abandoned agricultural fields and is dominated by nonnative annual and perennial broadleaf plant species. Characteristic invasive plant species occurring on disturbed sites and detected on-Base include mustard, sweet fennel, tumbleweed (*Salsola tragus*), Australian saltbush (*Atriplex semibaccata*), filaree, tocalote, and nonnative grasses.

Ruderal grassland is a vegetation type that is typically in early successional stages as a result of a severe disturbance by natural or human causes, or because the land is subject to recurrent disturbance. These areas are dominated by pioneering herbaceous plants that readily colonize disturbed ground. The ability of exotic species to invade disturbed areas arises from their relationship to old-world ancestors that have co-existed with humans for millennia, and thus are more adapted to exploit disturbed land. Ruderal communities may provide a certain degree of erosion control for recently graded areas, but such communities are also a threat to biodiversity because they continually distribute nonnative propagules into native vegetation. These exotic species can colonize natural disturbances, such as burns, and they compete with the more desirable natives. However, if ruderal grassland is left undisturbed, it generally undergoes succession towards more stable and less weedy plant communities such as CSS or annual grassland (Zedler et al. 1997).

Many of the same grass species of nonnative grasslands are abundant in ruderal grassland. The flora of such disturbed sites is dominated by introduced, exotic species such as black mustard, short-pod mustard, tumbleweed (*Salsola* spp.), bull thistle (*Cirsium vulgare*), sweet fennel, and prickly lettuce (*Lactuca serriola*). However, several native species, such as goldenbush (*Isocoma menziesii*), telegraph weed (*Heterotheca grandiflora*), and horseweed (*Conyza canadensis*), also thrive along highways and vacant lots.

I.7.2. Agriculture

Currently, about 600 acres of agricultural operations remain at Camp Pendleton, which are located at Stuart Mesa on the Westside of I-5 (Bieber pers. comm. 2009). Agricultural areas of the Base include all land used for strictly agricultural purposes, such as row crops, access roads, barns, utility storage areas, fallow fields, and plowed or cultivated land. Formerly, as much as 10,000 acres of agriculture (row crops and farming) occurred on Camp Pendleton prior to acquisition and use by the Marine Corps (Zedler et al. 1997).

I.7.3. Exotics Dominated

Several areas on Camp Pendleton can be described as being dominated by exotic plants (>70% of the vegetation is nonnative). Although acreages for these situations on Base have not been estimated, there are stands on Base dominated by giant reed, tamarisk, black mustard, sweet fennel, and the like.

I.7.4. Developed Areas

Developed areas include buildings, parking lots, pavement, and roads and often contain cultivated landscape vegetation. Developed areas provide little or no potential for conversion to native plant communities in the foreseeable future. Disturbed lands generally support few plant species offering poor structural diversity. Disturbed sites do not support key habitat components of any endangered, threatened, or candidate species. As of September 2009 developed areas (cantonment and housing areas) on Base, not including roads, total approximately 9,400 ac.

I.8. NON-VASCULAR PLANTS

Within the scientific community an increasing awareness of the ecological importance of non-vascular plants (mushrooms and lichens) in both habitat restoration and conservation has emerged. Their crucial role in the function of healthy ecosystems including: the nutrient mineralization process which provides nutrients to above ground flora, decomposition of organic materials, soil stabilization, their ability to readily absorb and retain moisture, and overall contribution to biodiversity, is significant. Although poorly understood, documented or categorized, the nonvascular plant flora is possibly much richer than its vascular counterpart. Studies have shown that non-vascular plants are important indicators of ecological health and change, however, more research into their relationship with vascular plants is needed (Zink 1997).

Threats to the nonvascular plant community include: 1) habitat destruction through construction and expansion of human activities that not only lead to disappearance of species habitat, but also fragmentation of habitat and increasing distance that propagules must travel; 2) fire (natural or manmade) can result in the absolute death or removal of suitable habitat (e.g., dead wood, old trees, and/or understory); 3) increased air pollution; 4) direct human exploitation (gathering of wild mushrooms for food); 5) exotic species introduction; and 6) climate change (e.g., global warming) (Zink 1997).

I.8.1. Mushrooms

The Mediterranean climate of southern California dictates that the fruiting bodies of mushrooms are most prevalent during the wet winter months, normally from December through March/April. Only during these months, when 80% of the annual precipitation occurs, is there enough moisture in the soil for the fruiting bodies to appear. A large number of mushroom species found on Base are either toxic (cause nausea, vomiting and/or diarrhea) or poisonous (may be fatal). With the significant amount of training being conducted on Base, it is possible that cases of mushroom poisoning may occasionally occur (Zink 1997).

A total of 134 different mushroom species have been identified on Base. All 120 of the epigeous fungi (above ground mushrooms) found have been identified down to the species level, and of the 14 hypogeous fungi (below ground mushrooms or truffles), only 1 was identified to the species level while the other 13 were identified to the genus level only. The 134 species present represent 25 different families, or groups, with the greatest number of species (22) found in the Tricholomataceae family; this large and diverse pale-spored family has more genera than any other family of gilled mushrooms. The Cortinariaceae family characterized by their large brown-spores is the second largest family of mushrooms found on Base with 17 species present. These were followed by the Tuberales group (true truffles) with 14 species and Russulaceae with 13 species present on Base. Four families were also represented by only one species: Bolbitiaceae, Clavariaceae, Hydnaceae, and Schizophyllaceae (a family that consists of only one species) (Zink 1997).

Of the 134 species identified on Base, 61 species were mycorrhizal and 73 were saprophytic (decomposers). Most of the mycorrhizal species found were in the Amanitaceae, Boletaceae, Cortinariaceae and Russulaceae families, and the Tuberales group. Saprophytic mushrooms were concentrated in the Agaricaceae, Coprinaceae, Polyporaceae, Helvellaceae, and Strophariaceae families. The Tricholomataceae family was equally represented by both mycorrhizal and saprophytic fungi on Base (Zink 1997).

The four species of oaks found on Base (*Quercus agrifolia, Quercus berberidifolia, Quercus dumosa* and *Quercus engelmannii*) are obligate ectomycorrhizal, and require the presence of mycorrhizal fungi for successful seed establishment and growth; lack of required fungi leads to the degradation and eventual loss of their habitat (Zink 1997).

Since little to no research has been conducted on mushroom populations, no species is currently listed as threatened or endangered, nor are any species under consideration for such listing, at this time. However, one species unofficially considered to be fairly rare by the scientific community, *Tubaria punicea* (formerly known as *Naucoria vinicolor*), was found growing in a small cluster of three mushrooms on a piece of dead coast live oak in Talega Canyon. The species is currently only known from California, although it is potentially more widespread (Zink 1997).

I.8.2. Lichens

Lichens are a unique category of fungi that live in a symbiotic association with algae and/or cyanobacteria. Instead of deriving their carbon from an external source such as plant roots or decaying organic matter, lichens incorporate a living photosynthetic organism within a fungal body and obtain their required nutrients from the atmosphere. Lichens are classified in to three groups based upon their growth form: 1) crustose lichens look like a crust growing on trees or rocks, they adhere tightly to the substrate, often growing several millimeters into it, and usually cannot be collected without the substrate attached; 2) foliose lichens appear leaf-like, they are loosely attached to the substrate, and have a distinct upper and lower surface; and 3) fruticose lichens are shrubby in appearance, often pendulous or stalked, and can be the largest in size of all lichens. Cryptogamic crusts and lichens are not

as short-lived as mushrooms, and can be found year-round, however, they are also more prevalent during the winter months, while actively growing and reproducing (Zink 1997).

A total of 48 different species of lichens have been identified on Base; all but six of the species were positively identified down to the species level. There were 25 foliose, 18 crustose, and 5 fruticose type lichens found on Base; representing 14 different families, with the Physciaceae family being the largest with 13 species represented. The next largest family represented by 10 different species is Parmeliaceae, followed by the Teloschistaceae family with 6 different species found on Base. Of the remaining 11 families identified, 6 families were represented by only one species (Zink 1997).

Lichens can be found on several different substrates, including trees, rocks and soils. Of the 48 species identified on Base, 32 were found only on the bark of either live or dead trees. Of the remaining 16 species, 10 were found only on rock substrate, 3 only on soil substrate, and 3 on both rock and tree substrate. Of the 13 species found on rock, 9 were crustose and three were foliose type. All three species found on soil substrate were fruticose types from the *Cladonia* genus. Tree substrates had all three types of lichen structures present (fruticose, foliose, crustose) on Base (Zink 1997).

One lichen species not recorded previously in the State, *Pyxine subcinerea*, was discovered on Base in both Talega and Horno Canyons; it is a small, foliose, and corticolous lichen positively identified by Dr. Theodore Esslinger of North Dakota State University. A note of its finding was published as a new species for the State in the Bulletin of the California Lichen Society (Zink 1997).