APPENDIX L

SSHCP Preserve Design

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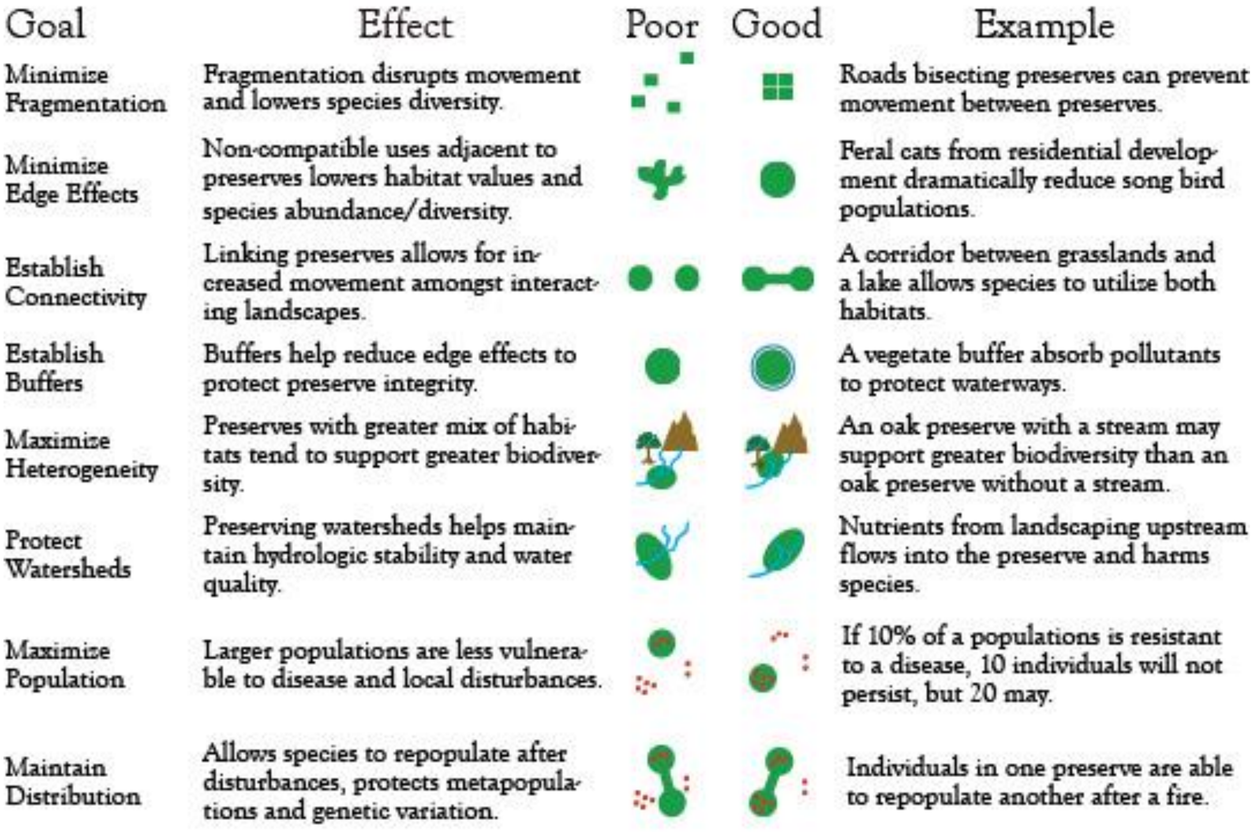
Preserve Design

The proposed approach for determining areas to be targeted for preserve establishment under the South Sacramento Habitat Conservation Plan (SSHCP) is based on land cover types present, known occurrences of covered species within the Plan Area, and known presence of suitable habitat for covered species. Preserves within the Plan Area will be designed, established, and managed according to the following established principles of ecology and conservation biology. These principles are summarized in Table 1 and their applicability to the SSHCP is explained below.

Table 1
Preserve Design Guiding Principles



Goal	Effect	Poor	Good	Example
Minimize Fragmentation	Fragmentation disrupts movement and lowers species diversity.			Roads bisecting preserves can prevent movement between preserves.
Minimize Edge Effects	Non-compatible uses adjacent to preserves lowers habitat values and species abundance/diversity.			Feral cats from residential development dramatically reduce song bird populations.
Establish Connectivity	Linking preserves allows for increased movement amongst interacting landscapes.			A corridor between grasslands and a lake allows species to utilize both habitats.
Establish Buffers	Buffers help reduce edge effects to protect preserve integrity.			A vegetate buffer absorb pollutants to protect waterways.
Maximize Heterogeneity	Preserves with greater mix of habitats tend to support greater biodiversity.			An oak preserve with a stream may support greater biodiversity than an oak preserve without a stream.
Protect Watersheds	Preserving watersheds helps maintain hydrologic stability and water quality.			Nutrients from landscaping upstream flows into the preserve and harms species.
Maximize Population	Larger populations are less vulnerable to disease and local disturbances.			If 10% of a populations is resistant to a disease, 10 individuals will not persist, but 20 may.
Maintain Distribution	Allows species to repopulate after disturbances, protects metapopulations and genetic variation.			Individuals in one preserve are able to repopulate another after a fire.

Source: Sacramento County

Minimize Preserve Fragmentation

Along with outright habitat conversion, habitat fragmentation is a leading cause of biodiversity reduction on both local and regional levels. By definition, habitat fragmentation results in a habitat type being reduced in size and more isolated from adjacent areas of similar habitat types.

The more isolated a given habitat type (and associated species), the more difficult it becomes for those species to migrate, escape harsh conditions and exchange genetic information.

As land use within the HCP area changes over time, areas currently characterized by intact habitat will inevitably become fragmented as parcels change ownership or are divided, resulting in the presence of smaller, separate patches of habitat when compared with current conditions. Some of these patches will be located adjacent to urban areas, agricultural settings, or roadways. Others patches will become isolated and remain as small "islands" in the landscape. Fragmented habitats can have a number of negative effects on species movement. For instance, roads or other barriers can impede or prevent movement of a species across part of its range. Individuals that are forced to disperse across urban or agricultural topography are directly threatened by predation and harsh environmental conditions. Fragmentation can increase distances between suitable patches of habitat, altering movement of dispersal-limited organisms (e.g., seeds, cysts, eggs, juveniles). Patch size, number, and degree of isolation can all have an effect on the movement of organisms between patches (Molles 1999).

Fragmentation not only disrupts movement, it can also alter ecosystem dynamics, especially when corridors are located next to human development, or when natural disturbance patterns (e.g., fire, water flow, erosion patterns) are altered. This can disrupt the "patch mosaics" seen on the unfragmented landscape. Fragmentation also decreases the diversity of animals in an area, including birds, bees and beetles. Some of these decreases may significantly affect ecosystem processes such as pollination and decomposition (Molles 1999).

Species richness is also affected by fragmentation, decreasing as habitat patches ("islands") become smaller and more isolated. Species richness on islands (and in habitat patches) is a balance between immigration and extinction of species. Immigration rates are influenced by the distance from the source of immigrants, while extinction rates are mostly determined by "island" size (MacArthur and Wilson 1967). Plant and animal species that require the frequent exchange of genetic material to re-colonize extirpated populations are especially affected by fragmentation and subsequent isolation of habitat patches. The ability of subpopulations to move between patches is important in the persistence of some species, especially those in "sink" populations, small groups that, left alone, would probably go extinct (Molles 1999). Isolated subpopulations are particularly susceptible to genetic disorders and lower reproductive success caused by inbreeding. This can lead isolated populations to become more vulnerable to local extinction as a result of stochastic events (Ellstrand and Elam 1993).

When habitat is fragmented, the remaining patches are affected by the changes in the physical environment along the perimeter, such as differences in hydrology, light intensity, temperature and wind speed. This "edge effect" (change in the physical nature of the habitat) can extend into the remnants of intact habitat, degrading them as well and reducing their effective area. Edge effects are explained in more detail in Section 2.1.2.

Obviously, minimizing habitat fragmentation and emphasizing the preservation of larger, intact areas are crucial conservation goals for any conservation effort. However, if preservation of landscape level preserves is impracticable, then clustering habitat fragments across the landscape can ameliorate some of the negative effects on movement associated with smaller, fragmented habitats (Kareiva and Wennergren 1995). This allows the fragments to achieve greater species diversity by increasing dispersal opportunities. It is crucial to note though, that the covered species vary greatly in their ability to traverse non-natural areas between preserves (e.g., western burrowing owl [*Athene cunicularia hypugea*], western spadefoot [*Spea hammondii*], and Sacramento Orcutt grass [*Orcuttia viscida*]).

L.1 Minimize Edge Effects

The long-term biological viability of preserves, stream corridors and landscape linkages will be affected by adjacent land use. When the adjacent land uses are different from each other, such as a housing development or a busy road next to a habitat preserve, they will likely have negative impacts on the conservation land. These impacts may include light and noise pollution, vibration, alterations to hydrology, water pollution, illegal dumping of rubbish and toxic chemicals, spread of invasive non-native plants and presence of pets which may adversely affect native species. These impacts are known as edge effects and result in the outermost parts of a preserve or a landscape linkage being adversely affected by these and other external factors. The interior parts of a preserve or landscape linkage, where the edge effects are much less, is known as interior habitat as opposed to edge habitat.

Preserves with a high perimeter to area ratio will have greater edge effects, thus offering less protection to species targeted for conservation. This means that habitat within a single large preserve experiences less edge effect than the same amount of habitat encompassed by a number of smaller preserves. The lower quality of edge habitat makes it harder for many native species to survive. For example, altered hydrology will decrease the habitat quality of vernal pools. The presence of domestic cats or other pets will reduce the reproductive success of ground-nesting birds, including western burrowing owls, and reduce the population of small mammals that are food for native predators. Some animals are adversely affected by traffic noise. Weedy plants and feral animals more easily invade fragmented habitats with edges adjacent to human activities and invasive non-native plants may out-compete the existing vegetation of a preserve. Edge-loving predators benefit from increase in edges, while edge-avoiding species are negatively affected by such an increase.

Different negative edge effects permeate into preserves, stream corridors and landscape linkages to different extents. There is widespread acceptance that a setback width of 100 to 200 feet will protect a stream from runoff water pollution, provided that the ground in the setback contains native vegetation. However, most studies of this effect have been carried out in the eastern and Pacific Northwest portions of the U.S., typically in forested landscapes. A 100 foot wide buffer of hardpan grassland soil such as exists in the SSHCP grassland areas, probably does not provide an adequate setback to filter runoff water pollution when already saturated by previous rains. It is also noted that setbacks sufficient in size to absorb nutrients are often insufficient in size to provide adequate wildlife habitat. For example, the impacts caused by domestic cats may well reach beyond the size of a setback buffer established to protect water quality. Numerous giant garter snakes (*Thamnopsis gigas*) in Yolo County have been killed by domestic cats at locations up to two miles from the closest urban development (see giant garter snake species account, Appendix A). Busy roads in Europe disturb grassland bird species up to a distance of 1.3 miles.

Maximizing the interior/edge ratio of a preserve will reduce these negative edge effects as it will maximize the percentage of a preserve that is interior habitat. A circular preserve has the highest interior/edge ration and the highest percentage of interior habitat. In contrast, a long, thin preserve may be entirely edge habitat. The design of preserves must seek to avoid the latter shape.

Additional key features for vernal pool grassland preserves within the Urban Development Area (UDA) are:

- Wherever possible include entire subwatersheds within the preserve. This minimizes the area experiencing negative hydrologic effects from adjacent lands;
- Wherever possible include a setback area beyond the subwatershed boundary; and
- Where a subwatershed is bisected by the preserve boundary, apply specific preserve design measures such as vegetated swales to prevent runoff from an adjacent site with incompatible land use such as a road into the preserve.

The major landscape scale vernal pool grassland preserves outside the UDA will be large enough for the edge habitat to be a very small percentage of the total preserve acreage, providing that incompatible uses such as housing do not occur as non-preserve "islands" within the preserve. The latter phenomenon could have a severe negative impact on the biological value of these preserves.

Stream corridors are by definition long and thin. Preserve areas along streams must be wide enough to include an adequate setback that protects the waterway, the riparian vegetation and important upland sites such as giant garter snake refugia from adverse edge effects.

Landscape linkages between preserves may also be long and thin due to previously existing development or land use designations in the preserve area. In determining the minimum width of a landscape linkage it is necessary to consider which species are likely to use the linkage corridor for dispersal, how they tend to disperse and how extensive the edge effects is expected to be given adjacent land uses. The minimum widths for landscape linkages described in Chapter 7 of the SSHCP take into account the need to provide interior habitat, balanced with the local land use scenario and the acreage requirement for an individual linkage.

In addition, it is possible to reduce negative edge effects by guiding land use decisions and resulting design in areas immediately adjacent to preserves. The application of “green” site sensitive design requirements to adjacent development will help reduce edge effects. These requirements may include measures such as placing small streets rather than backyards next to preserves, fencing that precludes movement of domestic animals into preserves, landscaping guidelines that prohibit use of known invasive species, and strict avoidance of any stormwater or summer-watering runoff from developed areas into preserves (see Chapter 6 of the SSHCP).

L.2 Establish Connectivity between Preserves

Blocks of habitat that are connected by natural linkages or corridors such as drainages and associated riparian corridors, swales, topographical depressions, ridgelines and other linear vegetated areas (grasslands, woodlands, some agriculture areas), can provide terrestrial corridors (linkages) to other areas of suitable habitat that have been otherwise isolated by fragmentation.

Habitat corridors have been defined in a variety of ways; in simplest terms, corridors are narrow strips of land that differ from the matrix situated on either side (Forman and Gordon 1986). In terms of ecological function, corridors may be defined as linear areas of vegetation that facilitate the movement of plants and animals between other habitat patches (Merriam 1984). In some cases, the corridor may itself provide habitat for an adapted assemblage of plants or animals, and only a dispersal route for others (Rosenberg et al. 1997). For example, a seasonal drainage may provide habitat that will only support a non-specialized assemblage of non-native annual grasses and invertebrates that are more characteristic of a disturbed seasonal wetland, or emergent marsh. Yet this same seasonal drainage may convey seeds and cysts (eggs) of more specialized vernal pool organisms from a source vernal pool complex to another sink vernal pool complex. The vernal pool organisms themselves do not complete their life cycle within the drainage, but individuals, seeds, or cysts may pass from one vernal pool complex to the other through it.

Some corridors provide for movement (linkages), but do not necessarily provide suitable habitat for any of the species moving through them. Example of these includes concrete underpasses under freeways or roads, clear cuts, agricultural areas, roadways, railroads, fence lines, utility corridors, disturbed/modified greenways, and golf courses.

It is thought that in the absence of movement of genetic material, small, isolated populations are more affected by stochastic events, more prone to inbreeding depression and therefore more vulnerable to extinction. These population and genetic aspects as they relate to the value of movement corridors is highly disputed for various reasons (Simberloff et al. 1992).

Movement corridors are used differently by different species, depending on their home ranges, seasonal distributions, food supplies, hibernation needs, reproduction needs, species behavior, and the type and location of the corridor being used. For example, coyotes (*Canis latrans*) and bobcats (*Lynx rufus*) have larger home ranges and will move larger distances in a given time frame than raccoons, skunks, California tiger salamanders (*Ambystoma californiense*) or a western spadefoots (*Spea hammondii*). In addition, some species move on a daily basis (bobcats and coyotes), while other species may migrate only seasonally (e.g., California tiger salamander and western spadefoot). Some observations about wildlife corridors indicate that larger species are more commonly recorded in corridors than smaller ones (Lindenmayer and Nix 1993).

Although corridors can have many ecological benefits, there are also disadvantages associated with corridors (Simberloff et al. 1992). Corridors can facilitate the spread of invasive species, disease and fire at faster rates than would occur without connections between fragmented habitats. Since corridors are often narrow and linear in nature, they typically experience a high degree of edge effects and are more likely to be dominated by a non-native herbaceous understory. They also may be more likely to harbor a higher number of predators (both native and non-native), and may even act like biological sinks. These effects are amplified when corridors are adjacent to urbanized development.

In general, corridors should be wide, continuous, natural, and structurally diverse as opposed to narrow, fragmented, unnatural, and with low structural diversity. Multiple corridors are better than a single corridor and corridors should connect to natural habitats outside of the Plan Area where appropriate (LGIEN 2001).

The SSHCP recognizes that both corridors (habitat corridors such as riparian areas and seasonal drainages) and biological movement linkages (grassland areas that provide connections between vernal pool/grassland preserves) are a necessary component of the overall Conservation Plan. The SSHCP also recognizes that not all covered species will equally benefit from a particular configuration of connective corridors and landscape linkages. For instance, a landscape linkage dominated by annual grassland and with a low density of vernal pool or swale habitat will provide very little value to the majority of vernal pool species. Such a landscape linkage may however, provide important value to other wildlife species, particularly upland reptiles (lizards and snakes), small and medium-sized mammals (including bats) and perhaps some species of birds.

L.3 Establish Buffers

In addition to properly designed preserve areas, buffers should be established around the preserve systems because they reduce the adverse effects of adjacent urban and agricultural land uses. Preserves located close to urban areas are particularly vulnerable to edge effects and anthropogenic alternations of the preserved ecosystem (e.g., changes in hydrology, trash dumping, foot and bicycle traffic, and the invasion of exotic species). Buffers between developed and preserved lands can help ameliorate these negative effects and ensure ecological function is maintained in the preserve as a whole.

Simply defined, buffers are strips of land that are permanently covered with vegetation (NRCS 2001). Buffers can be planted windbreaks, hedgerows, grassed waterways, filter strips, and fenced areas around waterways that exclude livestock. Buffers can act as filters, absorbing various pollutants, trapping sediments, and, in the case of vernal pool preserves, absorbing or redirecting summer irrigation run-off. Well-designed buffers can also provide habitat for some wildlife species and beneficial insects.

Although there is general agreement that buffers are beneficial, there are no biological criteria for “standard” buffer widths because they vary for different impacts, species, habitat and local conditions. Fixed-width buffers are more efficient from a design or planning viewpoint and tend to be adopted as “regulatory standard”, but biologists recommend buffers of varying widths depending on individual situations and ecosystem function. In general, narrower buffers are not as effective as wider buffers.

While buffers are an important component of all preserves within the preserve system, they may be even more important to smaller satellite preserves, which are more susceptible to edge effects than larger preserves. Therefore, isolated vernal pool preserves in the SSHCP should be surrounded by buffers of maximum possible width to minimize adverse effects from adjacent land uses and to ensure continued ecosystem function to the greatest extent possible. As preserves are acquired, buffers will be established within the existing footprint of the preserve. Acquisition of additional land beyond the preserve footprint is not required for a buffer.

L.4 Maximize Heterogeneity within Preserves

Habitat heterogeneity is important to consider in the design of the SSHCP Preserve System. Heterogeneous habitats generally support greater biodiversity. In addition, they are more likely to be ecologically complex and may be more resilient over time.

Heterogeneity should be considered at multiple spatial scales i.e., it can be assessed on a regional, local and site-specific scale. By maximizing preservation of habitat heterogeneity at all of these scales, the likelihood of capturing the full range of ecosystem functions and services needed for the long term survival of covered species is maximized, and the likelihood of long term preservation of biodiversity is enhanced.

An additional consideration in preserve design is heterogeneity arising from juxtaposition of one habitat with other habitat types. For example, vernal swales, seasonal drainages and emergent marshes may interact ecologically with vernal pools in a given landscape setting, e.g., through hydrological connection, dispersal and source-sink dynamics of organisms, and habitat support for foraging or prey organisms. Similarly, the presence of corridors, ridges, and other physical features likely contribute to habitat heterogeneity on a broad scale.

L.5 Protect Watersheds

The protection of watersheds is an important principal for design, establishment, and management of preserves for a number of reasons related to habitat function, hydrologic stability, and water quality.

Since hydrologic regimes are often the main factor in determining the presence of certain wetland flora and fauna, those features of the landscape that support the hydrology of a given wetland feature are of principal importance to maintain in establishing and managing preserves targeting the preservation of wetland dependent species. Hydrology of wetland features may depend on the presence of intact soil profiles in adjacent and upslope positions, intact swale and seasonal drainage morphology in the surrounding landscape, and surface and subsurface flows from upslope positions. Sufficient sub-watershed area should be preserved so that natural sources of surface and sub-surface water influx and outflow remain intact, potential development-related increases in surface runoff are minimized, and point and non-point sources of water pollution are avoided (e.g., runoff from roads, roofs, paved surfaces, utility pipes, landscaped areas, etc.).

The specific hydrologic relationships that may exist between a single wetland feature and its surrounding and underlaying soils, between it and adjacent wetland features, and between the wetland complex and surrounding uplands are ultimately too complex to empirically measure and describe for purposes relating to the SSHCP. The likelihood of long-term habitat stability and long term survival of wetland dependent species is maximized however, if all preserves are designed to protect entire sub-watersheds that support wetland features, wherever possible.

L.6 Maximize Population Size

It is generally accepted concept of population ecology that larger plant and wildlife populations tend to be more stable in the long-term, and less vulnerable to extirpation, compared with smaller populations and/or simpler, less extensive meta-population complexes. For purposes of the SSHCP, population size is defined as the number of interbreeding individuals within a single habitat unit (e.g., number of individuals of a given vernal pool species within a single vernal pool), or the number of interbreeding sub-populations within a given geographic setting (e.g., the number of genetically interrelated vernal pools within a complex or the number of genetically interrelated vernal pools among complexes). At both scales of consideration, bigger populations are preferable for a number of reasons.

Depending on the breeding system of the organism in question, larger populations tend to possess higher genetic diversity, which can buffer the population against negative demographic trends, including genetic bottlenecks, genetic drift, and inbreeding depression. Through higher levels of genetic diversity, larger populations may also be more pre-adapted to cope with changing environmental conditions. Empirical determination of patterns of genetic diversity is technically complex and cost prohibitive for the number of species and at the scale of the SSHCP. Designing preserves to encompass large populations, and management of these preserves to support large populations maximizes the likelihood that maximum genetic diversity is captured.

In addition, populations comprising a larger number of individuals, or a larger number of sub-population components are more likely to persist through local stochastic disturbances (e.g., drought, flood, fire, pollution spill, disease, noxious weed infestations, introduction of feral predators, adverse grazing regimes, negative demographic shifts, etc.) than smaller populations.

L.7 Maintain Species Distribution Across Their Native Range

It is important to consider and maintain the local, regional and range wide distribution of a covered species during landscape-scale conservation planning, for long-term species viability. The most apparent benefit of maintaining a species’ full range is assurance that stochastic disturbances (e.g., drought, flood, fire, pollution spill, disease, noxious weed infestations, introduction of feral predators, dramatic demographic shifts, etc.) that may cause extinctions are limited to localized sub-populations and that the species may persist in portions of its range that escaped the disturbance. Unaffected populations might also serve as sources for natural re-colonization or active restoration of extirpated populations. Species that are highly restricted in their range, either naturally or as a result of human activity, are more vulnerable to extinction over the long-term.

Maintenance of a species’ full range also helps assure preservation of genetic diversity that may be a requisite for long-term vigor and adaptation to changing environmental conditions (e.g., climate change, introduction of new pathogens, etc.). The genetic makeup of a given species is the sum of the combined genetic pool of its various populations. Different populations located apart from one another tend to experience different selective pressures over time. As a consequence, geographically separate populations may exhibit differing genetic diversity, including unique variants of genetically fixed adaptive traits. For example, populations that have evolved in the drier and harsher portions of a species' overall range might harbor genetic traits that pre-adapt those populations to long-term drought cycles.

In addition, maintaining the full range of a species increases the likelihood of capturing persisting meta-population dynamics and other landscape-scale ecological phenomena (ecosystem functions). This includes a higher probability of long-distance dispersal of individuals (and genes) between sub-populations, populations and meta-populations, if both small and large-scale species distribution patterns are maintained. Another important consideration is that preservation of the full geographic range of all endemic species within a region and between regions further ensures that landscape-scale habitat relationships and requirements of other species are met. The attractiveness of particular landscapes to waterfowl migrating along the Pacific Flyway is of particular importance. If populations of species are lost in significant portions of their ranges because of habitat loss, migratory patterns of the waterfowl may change, thus affecting the dispersal potential and long-term population dynamics of other species located in the region (Silveira 1998; USFWS 2005).

L.8 Maximize Preserve Size

In general, larger preserves are preferable to smaller ones for a variety of reasons that relate to ecological complexity, habitat support value, and long-term habitat sustainability. Larger preserves are more likely to be ecologically stable through time (Leidy and White 1998).

Establishment of larger preserves increases the likelihood that habitat variability is encompassed. Multiple landforms, multiple soil associations, and multiple habitat types are all more likely to be present in large contiguous areas, than they are in small isolated preserves. In general, greater habitat diversity is associated with greater biodiversity and more complex trophic relationships (food web). Larger preserves may also support larger and more complex meta-populations of plants and animals. Larger populations and more complex meta-populations are more likely to capture overall genetic diversity and spatial patterns of genetic diversity across the landscape. These larger, more complex populations are also more resilient to local extirpations resulting from chance events (floods, erosion/sedimentation, unfavorable grazing regimes, pathogens, predators, toxic spills, etc.). Larger preserves also result in less habitat fragmentation, and afford greater insulation from edge effect. Since larger preserves may more easily encompass more intact watersheds, the integrity of unaltered hydrological cycles is better assured.

The practicalities of vegetation management are also more favorable in larger preserves. Upland vegetation management options, including viable livestock grazing operations and controlled fire regimes are easier to implement on larger preserves than they are on small isolated preserves that are surrounded by development.

In all cases, preserves established as part of the SSHCP will be made as large as possible. However, it is important to note that smaller preserves can possess significant conservation value. It is also recognized that within the Plan Area rare species are found within urban settings where the opportunity to set aside large preserves no longer exists. In these cases, the application of adaptive management will help ensure the survival of these species in small preserves and will maintain the integrity of the ecological functions of the preserves in the long term.

L.9 Conservation of Ecological Functions and Values

Ecological functions are an array of biological and physical functions that different habitat provide, while ecological values are the values of these functions to society. Some ecological functions, such as providing habitat for animals and plants, are common to all habitat types in the Plan Area. Each of these habitat types is characterized by a variety of structural features, varying patterns across the landscape, and ecological processes that contribute to ecological functions of the habitat. Ecological processes include movement of energy and nutrients through food-webs, and the cycling of chemical constituents through soil, water and air.

Several habitat types in the Plan Area provide ecological functions related to flood control. Streams are the conduit for moving storm-water through the Plan Area and into the major rivers. Seasonal wetlands adsorb floodwaters and reduce the amount of water flowing down streams during storms. Riparian vegetation reduces the flow rate of the storm run-off, allowing more time for groundwater recharge. In addition, wetlands and riparian areas improve stream water quality by removing pollutants and reducing non-point source pollution run-off. All of these functions provide direct benefits to human communities in the Plan Area.

The SSHCP conserves and, in some cases enhances, ecological functions and values through the variety of measures including preserve acquisition, habitat restoration, and habitat enhancement. The direct conservation of functioning stream corridors, seasonal wetlands and vernal pool wetlands will ensure that ecological functions of major portions of the Plan Area continue to exist. Restoration of riparian vegetation along several key reaches of streams in the Plan Area will improve the overall ecological functions of stream corridors, while restoration of highly degraded historic vernal pool areas outside the UDA will contribute to compensation for loss of vernal pools within the take area. Several agricultural conservation measures will reduce non-point source water pollution and provide native habitat patches for beneficial insects and other features. Enhancements of upland and aquatic habitats will improve a variety of ecological functions.

The conservation strategy provides for the conservation of habitat and species, as well as ecological functions at the landscape scale. This approach helps to maximize the level of ecological functioning of the entire Plan Area. For example, the conservation of large vernal pool grassland areas ensures adequate habitat for species that utilize both vernal pools and the surrounding upland habitat, for pollinators of vernal pool plant species and for larger animals that have important roles in the overall ecological functions of vernal pool grasslands. This approach allows for the loss of vernal pools in lower quality habitat areas within the UDA, as well as a small amount of loss in high-quality areas. Coupled with a “no net loss of wetlands” requirement, this landscape-level approach provides for more effective conservation of vernal pool functions and values than a project-by-project approach consisting of avoidance, mitigation and compensation measures. While the project-by-project approach can result in a higher level of vernal pool avoidance on a particular project site, it is likely to result in establishment of small preserves subject to relatively large edge effects from adjacent non-compatible uses, and is unlikely to achieve the conservation of very large vernal pool landscapes that fully conserve ecological functions.

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