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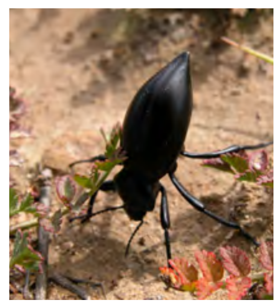
THE GREEN VISIONS PLAN

for 21st century southern california



8. Conservation of Native Biodiversity in the City: An Assessment of MRCA Projects in the Upper Los Angeles River Watershed

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THE GREEN VISIONS PLAN

for 21st century southern california

The mission of the Green Visions Plan for 21st Century Southern California is to offer a guide to habitat conservation, watershed health and recreational open space for the Los Angeles metropolitan region. The Plan will also provide decision support tools to nurture a living green matrix for southern California. Our goals are to protect and restore natural areas, restore natural hydrological function, promote equitable access to open space, and maximize support via multiple-use facilities. The Plan is a joint venture between the University of Southern California and the San Gabriel and lower Los Angeles Rivers and Mountains Conservancy, Santa Monica Mountains Conservancy, Coastal Conservancy, and Baldwin Hills Conservancy.

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INTRODUCTION

The Los Angeles region presents a dilemma for conservation planners. The least disturbed natural lands are found in the mountain ranges that ring and bisect the metropolitan area while the most disturbed lands are found in the flat plains of the valleys. Based on the current distribution of parklands, the mountains and foothills have historically received significant conservation attention, while the rivers and plains of the valleys have not.

As the culmination of a variety of influences, greater emphasis is now placed on the valleys and plains. This emphasis has evolved out of a desire to reclaim rivers as a part of public space, an increasing need to undertake watershed planning to meet regional water quality goals, and identification of a need for access to open space. This report identifies the various strategies that make up a well-rounded approach to urban conservation to benefit biodiversity and analyzes a set of projects proposed for the upper Los Angeles River watershed for fulfillment of these strategies. I concentrate on a single aspect of urban conservation, the protection of native biodiversity.

This report begins with a series of reviews to illustrate the mix of strategies necessary for an urban conservation program to maximize native biodiversity. Multiple approaches are necessary because not all species are distributed in the same manner spatially, and they respond to the urban environment in different ways. A strategy to preserve bobcats may not be effective at maintaining diversity of dragonflies. Based on this review of strategies, I identify the approaches that would be appropriate to maximize biodiversity in the upper Los Angeles River watershed. I then evaluate whether the proposed projects are representative mix of these strategies, and make suggestions of what strategies might be incorporated into projects to improve the mix of strategies.

CONSERVATION STRATEGIES FOR FOCAL GROUPS

The challenging reality of biodiversity conservation is that no one taxonomic group is a perfect, or even excellent, indicator of diversity in other groups (Fleishman et al. 2000). Similarly, no single conservation approach will be efficient at maximizing biodiversity for all taxonomic groups. Corridors, for example, may be essential for large mammals, but unnecessary for some birds and insects. A comprehensive urban conservation strategy must recognize and incorporate the different responses of taxonomic groups to the urban landscape. In this section I review the responses of several taxonomic groups to urban environments, and identify conservation strategies necessary to maintain native diversity within these groups.

Mammals

The body size of mammals varies over a wide range, from tiny pocket mice to mountain lions. Given this 10,000-fold range in body size, it is not surprising that mammals perceive and navigate within the landscape on fundamentally different scales. I therefore consider the conservation needs of mammals at three scales – for large mammals, mid-sized mammals, and small mammals.

Large mammals in and around the San Fernando Valley include puma (*Puma concolor*), coyote (*Canis latrans*), mule deer (*Odocoileus hemionus*), and bobcat (*Felis rufus*). For those species with the largest ranges and least tolerance for urban development, conservation depends on maintenance of the connections between and within the regional system of large reserves. This approach has been identified and pursued at a regional scale through the connection of the Santa Monica Mountains with the Simi Hills, Santa Susana Mountains, and Angeles National Forest and applies to puma, which has such large range size and low density that connection with the Santa Monica Mountains is likely to be essential to its survival. Use of such wildlife corridors through the urban-wildland interface may depend on the quality of the habitat in the linkage, but also on the absence of artificial lighting. Beier (1995) notes that puma will avoid nocturnal movement through lighted areas, and may indeed miss landscape linkages because of this tendency.

Bobcat may persist in smaller fragments (Riley et al. 2003), but it tolerates relatively little fragmentation. It is particularly susceptible to the hazards of the urban edge, including death by roadkill (Tigas et al. 2002) and ingestion of anticoagulant rodenticide (S. Riley, pers. comm.). In studies of the species in San Diego, its presence in a fragment was related to fragment size, but not to the distance to the nearest source population (Crooks 2002).

Mule deer permeate into the urban-wildland interface to some degree, but are mainly restricted to the larger blocks of connected habitat of greater than the average 0.5–1 km^2 home range of the species (Mackie et al. 2003). Few opportunities remain to reintroduce mule deer to the urbanized valley floor of the upper Los Angeles River watershed.

Coyotes represent the largest mammals that might be maintained within a reserve system in the urban area (Crooks 2002). Presence of coyotes within urban fragments is important to maintain native bird diversity (Crooks & Soulé 1999). Coyotes are especially important to nesting birds because they prey on mesopredators (e.g., raccoons, opossum, striped skunk, feral cats) subsidized by humans through direct feeding and provision of resources in the form of refuse, water, and pet food (Crooks & Soulé 1999). These “subsidized mesopredators” in turn are responsible for the decline and extirpation of native birds and mammals in urban fragments (Crooks & Soulé 1999; Hawkins 1998). Coyotes are relatively urban tolerant, and while they can be perceived as a threat by urban residents, their presence in natural habitats offers many benefits for native biodiversity. Connectivity between larger natural areas (5 acres and up) and the surrounding mountain areas would benefit coyotes, which use corridors (rail lines, channels, power lines, etc.) (Riley et al. 2003; Tigas et al. 2002; Way et al. 2004). Riley (pers. comm.) reports coyotes using the Los Angeles River channel to make their way from the western San Fernando Valley to the Sepulveda Basin. Use of connections involving undercrossings would be benefited by restoration near undercrossings to guide species, or installation of fences to guide animals (Ng et al. 2004).

The dominant feature of mid-sized mammals is their diverse responses to urbanization; some species are quite urban tolerant, while others are entirely adverse to urban habitat. For example, ringtails (*Bassariscus astutus*) are found rarely in the Santa Monica Mountains, and never in suburban or urban settings, while opossum are quite comfortable in suburban backyards and alleys. Conservation of mid-size mammals in this particular region appears to be a function of sufficient habitat area (e.g., for gray fox, weasel, spotted skunk, or even ringtail) and less on distance between fragments. For some mid-sized mammals (opossom, raccoon) no conservation actions are needed.

Persistence of native small mammals in the study area depends on maintenance of appropriate habitat (Dickman & Doncaster 1987) and management of exotic predators. Movement of small mammals through an urban matrix is possible in a smaller city with a temperate climate (Dickman & Doncaster 1989), but far less likely in highly urbanized regions such as Los Angeles, which does not support native vegetation in its interstitial spaces and is far more densely developed than the region studied by Dickman and Doncaster (1989). In studies of urban small mammal populations, species richness increased with fragment area, but only if the habitat area was of undisturbed native habitat (Dickman 1987). Larger area alone did not increase species diversity. Fragments supporting native small mammals can be quite small, however (Dickman 1987), and recent observations show that native dusky-footed woodrats persist in urban fragments in Los Angeles as small as 2 ha (pers. obs.).

Native small mammal diversity, even within large blocks of habitat such as the Santa Monica Mountains, decreases with human disturbance of all forms (Sauvajot et al. 1998). Because small mammals are prey items for domestic cats, the presence of cats may result in local extinctions of small mammals. Crook's survey of cat predation in San Diego confirmed the prominence of native mammals in the diet of free-roaming cats. Notwithstanding observations in forested ecosystems in temperate climates (Dickman & Doncaster 1989; Sakai & Noon 1997), movements more than short distances between habitat fragments (>15 m) are unlikely in southern California except in limited circumstances (Bolger et al. 1997a; Sauvajot et al. 1998). Conservation strategies concentrating less on connectivity across marginal habitats and more on habitat quality and size, and exotic species control are more likely to succeed for small mammals. This does not diminish the importance of continuous corridors of appropriate habitats, such as rail lines and utility right-of-ways unbroken by roads and buildings (Yalden 1980).

Arthropods

Researchers have recently realized that urban areas may serve as important sites for the conservation of native arthropod biodiversity (Eyre et al. 2003; McIntyre 2000; Watts & Larivière 2004). Insects and other arthropods constitute the majority of earth's biodiversity (Samways 1990), though they have received far less conservation attention than larger and more charismatic species (Clark & May 2002). Because the home range required and the area necessary for stable populations are much smaller for arthropods than for larger species (most vertebrates), small reserves in urban areas can contribute significantly to an overall conservation strategy. The smaller scale of insect conservation allows for many opportunities in even the densest city.

Conservation planners are accustomed to making decisions based on traditional assumptions about the size and configuration of conservation lands. These include the presumption that more isolated urban remnants support fewer species and smaller remnants support fewer species. Because the relative meaning of “more isolated” and “smaller” is geared toward vertebrates, e.g., birds (Crooks & Soulé 1999; Crooks et al. 2001) or mammals (Bolger et al. 1997a), the habitats that may be valuable to insects are presumed to be ecologically insignificant. Recent research, however, has illustrated that even small remnants (50-1000 m^2) isolated (500 m) from other native vegetation are useful in sustaining populations of invertebrates and serve as stepping stone habitats (Abensperg-Traun & Smith 1999). In this study of remnant woodlands in Australia, patch size or isolation had no influence on the occurrence of any of four target arthropod species.

Conservation strategies for arthropod biodiversity should address to the mobility, life history traits, and habitat characteristics of subject groups. I identify the following groups: a) sedentary, slow-growing, K-selected, flightless, habitat specialists; b) mobile, flightless, habitat specialists; c) flighted, habitat specialists; and d) mobile, habitat generalists.

The first category includes species that are sedentary, slow-growing habitat specialists. These species include scorpions, trap-door spiders, tarantula and many other predatory species. They tend to be slow growing and may even exhibit parental care, as do scorpions (Polis 1990). Lifetime mobility of such species is measured in meters. Connectivity between suitable habitats may be severed by inhospitable conditions of only 2-3 meters (Forman 1995). Populations of such species can be maintained in quite small areas for long periods if habitat conditions are maintained. A conservation strategy for organisms with these characteristics would concentrate on permanent protection of existing habitats, and controlling adverse impacts on such habitats. For example, some predaceous arthropods are less active during the full moon (Skutelsky 1996; Tigar & Osborne 1999); chronic nocturnal illumination of remnant habitats could therefore be expected to reduce long-term viability of these species.

A second group of invertebrates are those that are more mobile, and will move tens of meters within suitable habitat. They include ants and beetles, as well-known example. Habitat connectivity is threatened by roads as wide as 6 meters (Forman 1995; Mader 1984). Many of these species do not require native vegetation, but rather survive in areas with appropriate physical conditions (e.g., soil, hydrology) (Günther & Assmann 2005), even brownfields (Eyre et al. 2003). Conservation for these species requires provision of a wide range of habitat types across the landscape (Watts & Larivière 2004). Conservationists should identify natural range of microclimatic, topographic, edaphic, and hydrological conditions and ensure that they are protected in place or restored where appropriate. Unlike conservation efforts for large carnivores, these habitats can be quite small and even in the middle of urban areas. But in urban areas, roads probably already fragment such habitats, so promoting connectivity is not a productive strategy except to minimize or reduce internal fragmentation and provide contiguous protected lands.

The third group includes flying habitat specialists, including many butterflies, native bees, and grasshoppers. For these species, inter-patch distance affects colonization and population persistence (Bergman & Landin 2002; Hanski 1999; Hanski et al. 1996). Dispersal ability varies within groups, but it is not uncommon to have butterfly species that regularly cross two-lane highways, and others whose movement across such barriers is limited (Munguira & Thomas 1992). Hence, conservation strategies should focus on protection of suitable habitat areas, even at a very small scale. This may include habitat elements outside of recognized protected areas in the form of beneficial landscaping. Secondary strategies are to enhance connectivity through corridors (Haddad 1999; Sutcliffe & Thomas 1996). Some investigators have concluded that stepping stones of suitable habitat may be more effective than corridors in promoting inter-patch dispersal (Schultz 1998). Dispersal over inhospitable habitat for habitat specialist species may be restricted to 1 km or less, while others can locate specialized habitats nearly anywhere within an urban matrix.

The last group contains those species that are highly mobile habitat generalists and human commensals. These species have no difficulty traversing urban areas and exploit available niches within the urban matrix. These include mosquitoes, some ants, and many common garden species of beetles, millipedes, centipedes, true bugs, and butterflies. These species are not a conservation concern, and may include many invasive exotic species as well.

These four conceptual groups illustrate that invertebrates do not perceive the landscape in the same manner as do humans. Rather, to some the landscape is permeable, while to others it is completely impermeable, depending on habitat preferences and mobility. Several conservation strategies derive from an assessment of the needs of species in each of these classifications.

- Provision of a wide variety of habitat types, especially encompassing diversity in soil and natural disturbance regimes (Eyre et al. 2003).
- Provision of a network of small reserves in urban areas to complement large reserves (Baz & Garcia-Boyero 1996). Small fragments 1–2 ha help support rare butterflies, but more species are found in large fragments than small, mainly because of presence of food resources more than area (Rodrigues et al. 1993).
- Provision of small stepping-stone habitats to aid dispersal of species (Abensperg-Traun & Smith 1999).
- Provision of suitable habitat elements outside of reserves (e.g., native landscaping, Smith et al. 2005).

These strategies address primarily the location and type of projects and not the design of the project itself. Many other approaches are possible to increase resources for native arthropods by providing important microhabtat features such as nesting sites for bumblebees (Buchmann & Nabhan 1998; Dodero & Hanson 2003).

Birds

Urbanization generally increases bird biomass but decreases bird diversity (Batten 1972; Emlen 1974). Urban-tolerant species replace others that do not tolerate urbanization; overall diversity may be greatest in suburban landscapes with urban and native components (Blair 1996). Urban environments also tend to favor granivores, aerial insectivores, and ground foraging insectivores (Allen & O'Connor 2000; Emlen 1974). But beyond these generalizations, birds react in different ways to the dominant feature of urbanization — fragmentation.

The following discussion should not detract from the well-established tenet of conservation biology that conservation of the full complement of bird species within a landscape requires preservation of large habitat blocks that are free from edge effects. Interior specialists exist for most habitat types, and they cannot be conserved with small or linear habitat patches within urban landscapes.

This issue aside, birds may respond to landscape attributes at many different scales (Hostetler & Holling 2000; Johnson 1980). While it is a rough generalization, size influences that scale at which birds perceive the environment (Fernández-Juricic et al. 2001; Hostetler & Holling 2000). Johnson (1980) identifies first-order selection (choice of the landscape tract), second-order selection (choice of home range, wintering area, or stopover site within tract), third-order: selection (choice of habitat patches), and fourth-order selection (identification and procurement of resources within patch). Larger birds usually responding at a broader scale (e.g., kilometers for landscape tract for a raptor) and smaller birds responding at a more local scale (e.g., several hundred meters for landscape tract for a wren) (Hostetler & Holling 2000).

Because of these differences, some species may identify and exploit very small urban patches, even down to single trees in the case of migratory warblers, while others avoid urban areas altogether (Berry et al. 1998). If adequate or appropriate resources are not available at any of the selection scales, then birds will not use the habitat. Furthermore, what one species may perceive as a series of isolated fragments is seen by another more mobile species as a large patch.

Because of the frequent correlation between body size and perceptual scale (Fernández-Juricic et al. 2001; Hostetler & Holling 2000), urban landscapes may support a combination of small and large species, without native middle-sized species. As described by Morton (1990), small species may persist in small patches, while large species move among sets of small patches. Mid-sized species can not be supported in small patches or exploit sets of them across the landscape and consequently are missing from urban faunas. Chace and Walsh (in press) illustrate this with the relative tolerance of many species of raptors to urbanization (e.g, red-tailed hawk, Cooper's hawk, American kestrel, peregrine falcon).

The ways in which birds perceive the landscape has implications for conservation strategies within urban areas. Large blocks of intact habitat are rare within the urban matrix, and certainly these would be important to a conservation effort were they to exist. But the lack of these larger blocks, which would support the full range of species, does not mean that certain configurations of habitats will not support other native species. Rather, it would be possible, through a series of small habitat blocks to support smaller native species less tolerant to edge effects, along with wider ranging raptor species that use networks of natural and urban spaces as habitat. For example, in a study of forest fragments in an agricultural landscape, Fischer and Lindenmayer (2005) found that 75% of bird species in their regional pool were found in patches less than 1 ha. This result may not transfer directly to urban areas with their greater edge effects, but it is illustrative. Cooper (2002) located breeding pairs of the sensitive California gnatcatcher near the urban interface in the moderately fragmented Puente Hills.

Smaller native habitat blocks therefore can play a role in a regional conservation strategy (Fischer & Lindenmayer 2005). They may be enhanced by management actions within protected habitats and in the surrounding urban matrix. Fernández-Juricic (2000) has demonstrated convincingly the value of tree corridors near source populations of woodland birds in urban landscapes (Haas 1995). This argues for proactive steps to make the urban matrix around native habitat fragments better for birds through native plantings. This applies most easily to riparian areas, where an intensive street tree planting program of native trees may complement riparian resources.

Disappearance of small native bird species from urban fragments may result from degradation of the habitat itself as a result of human disturbance, not edge effects themselves. For example, Kristan et al. (2003) attribute disappearance of cactus wren and possibly California gnatcatcher from near edges to habitat degradation rather than edge-aversion per se (Bolger et al. 1997b). This leads to a potential conservation strategy of restoring or maintaining high-quality habitat in urban fragments.

Recent research is building a compelling case that persistence of birds in urban fragments depends not only on habitat characteristics but on the level of disturbance by humans (Knight & Gutzwiller 1995). Chace and Walsh (in press) review the adverse effects of human visitation, even by passive recreationists, including lower reproductive success (Miller et al. 1998), decreased hatchling success (Hunt 1972), decreased ability to feed young (Leseberg et al. 2000), increased predation (Kury & Gochfeld 1975), and decreased parental attendance (Safina & Burger 1983). The patterns of occupancy by birds has been correlated to number of visitors in a number of studies by Fernandez-Juricic (2001). These effects are also differential across body size, with larger species having larger perceptual fields and therefore more sensitive to human visitation (Fernández-Juricic et al. 2001). These results lend further weight to previous recommendations that public access to preserved sites be limited to distinct trails that themselves leave certain areas of the site undisturbed (Tilghman 1987).

A well-established literature documents edge effects of residences and other urban uses surrounding reserves. These include outdoor house cats and other subsidized mesopredators, collisions with structures, and noise. Domestic cats, both feral and outdoor pets, pose a significant threat to bird, mammal, and reptile biodiversity in urban fragments. Crooks and Soulé documented that each outdoor cat on average consumes 24 rodents, 15 birds, and 17 lizards per year, most of which are native species (1999). Hawkins (1998) recorded lower native bird diversity and abundance in a park canyon with a feral cat colony compared to a canyon without a cat colony. Furthermore, human refuse subsidizes many bird predators, such as opossums and raccoons. The presence of these subsidized mesopredators is correlated with local extirpation of bird species, but can be offset by the presence of larger carnivores such as coyotes (Crooks & Soulé 1999).

For those birds that survive in urban fragments, collisions with human vehicles and structures present a chronic threat. These include collisions with windows (Klem 1989), electrical wires, and of course vehicles. Techniques are available to minimize such mortality, and should be considered as part of infrastructure planning and public education near protected areas. Road noise also may have a significant adverse effect on birds and other wildlife (Reijnen & Foppen 1994; Reijnen et al. 1996; Reijnen et al. 1995; Reijnen et al. 1997). Planning of urban reserves should incorporate this information in planning phases to identify mechanisms to reduce traffic noise through site planning or barriers.

To maximize diversity of native birds, several strategies can be pursued. They include:

- Provide habitat blocks with minimized edge effects.
- Provide large habitat blocks for human-intolerant species.
- Provide dispersed habitat elements that cumulatively support raptors within an urban matrix.
- Provide small, high-quality habitat patches for species cued to habitat quality.
- Provide trees or other habitat elements within matrix to connect reserve areas.
- Provide specialized habitats, such as wetlands, oak woodlands, grasslands, and sage scrub.
- Minimize human recreation in parts of natural areas to allow disturbance-intolerant species to persist.
- Manage populations of feral cats and discourage outdoor cats near habitat areas.
- Implement programs to minimize bird collisions with windows and vehicles.

Reptiles and Amphibians

Development to reduce flood hazard has minimized habitat for native amphibians within the upper Los Angeles River watershed, while a few reptile species are found in the urban area.

Those reptiles that thrive in degraded habitats may be found throughout urban regions in appropriate habitat. Alligator lizards and fence lizards are two common examples. Other species are far less tolerant of human disturbance and have declined precipitously. These include most snakes, legless lizards, and horned lizards, which have been excluded by a combination of direct habitat destruction and edge effects. For example, horned lizards, which once were common in the San Fernando Valley, have all but disappeared because of the loss of their preferred prey item, harvester ants (Suarez et al. 2000). These large, native ants have been displaced by invasive Argentine ants that are promoted by sources of summer water provided by humans (Erickson 1971; Holway 1998a, 1998b; Human et al. 1998). Disturbance and water from residential development can thereby promote invasion of exotic invertebrates, reduce native invertebrate populations, eliminating the prey base for some native reptiles. Argentine ants can be minimized by reducing human disturbance and removing sources of supplemental water.

Many species of snakes have been persecuted, and their habitat destroyed. Only larger blocks of native habitat will continue to support a diverse community of reptiles, and no particular actions are necessary to promote disturbance-tolerant reptiles in smaller blocks because they already persist in quite disturbed habitats. While habitat loss is the primary threat to snakes, in habitats remaining in urban contexts, spillover light from adjacent development may contribute to the decline of nocturnal species (Perry & Fisher 2005). Fisher and colleagues have not found certain nocturnal snakes in fragments that support native diurnal snakes and their leading hypothesis for this phenomenon is light pollution (see unpublished data reported in Perry & Fisher 2005). Additional light likely makes these species vulnerable to additional predation; some nocturnal snakes are documented to concentrate their activity during the darkest nights around the new moon. With light pollution, those darkest conditions are eliminated from otherwise suitable habitat fragments.

A few amphibians are urban tolerant — pacific slender salamanders are found in backyard gardens in Los Angeles (Cunningham 1960). Other smaller species such as tree frogs can disperse some distance from standing water habitat, but these are becoming rare. Spade-foot toads require ephemeral pools for their life cycle, but can persist in even quite degraded pools without native plant elements (e.g., at Los Angeles International Airport).

Some general strategies can be derived from reptile and amphibian conservation.

- Wide corridors are needed around riparian zones to allow for upland portions of life cycles. For example, nest sites for turtles may be up to 400 m away from streams, and on average 45 m (Spinks et al. 2003).
- Native soils should be protected for burrowing species (e.g., legless lizard).
- Summer irrigation and other artificial water should be excluded from within and around naturally xeric habitats to minimize abundance of Argentine ants.
- Dumping of exotic pets should be strongly controlled both because of the invasive potential of the species and for their role as disease vectors.

Fish

Virtually no native fish remain in the upper Los Angeles River watershed. All of the now-rare or endangered species of native fish were once found in this region, at least on the main stem of the Los Angeles River where it entered the San Fernando Valley. These included: speckled dace, arroyo chub, Pacific lamprey, unarmored threespine stickleback, Santa Ana sucker, and southern steelhead. Restoration of elements of the former hydrology of the Los Angeles River and its tributaries, combined with massive pollution control, would be necessary for recovery of these species. A conservation strategy leading in that direction under current conditions would be to increase infiltration in the watershed so that peak flows in the main stem are reduced and future projects will have a margin of safety to engineer a solution.

Floristic Diversity

The typical practices of landscaping in southern California result in a wholesale removal of native vegetation and its replacement with a suite of hydrophilic exotic plants. Unlike other regions of the United States, very little of the native flora remains or regenerates within developed areas. The urban matrix increases overall plant diversity by introducing exotic species (Pavlik & Pavlik 2000), but native plant diversity suffers. Native plants persist only if they are disturbance tolerant or are accepted as landscape plants (e.g., native oaks). The best approach for increasing native plant diversity in the urban matrix is therefore to encourage its use as water-wise and ecologically friendly landscaping material. The results of encouraging native landscaping can be seen in a trend to higher native plant diversity around newer structures in Phoenix, Arizona (Hope et al. 2003).

As for reserves, research on the vegetation condition of remnant urban vegetation in a similar environment to Los Angeles (Perth, Australia) showed that small reserves were highly fragmented and infested by exotic weeds (Stenhouse 2004). Stenhouse concludes that these reserves should be preserved and managed because "they are highly valuable for representing the vegetation types that once occurred there" (Stenhouse 2004:389). In Los Angeles, larger reserves outside the dense urban fabric will play a much larger role in preserving native floristic diversity, while small urban reserves are necessary to restore floristic diversity, especially for species that depend on riparian and grassland habitats.

Plants also depend on mutualisms wherein animals disperse and "plant" seeds. These relationships range from ants to scrub jays. As some have noted, acorns do not fall uphill! Elimination of large seed dispersing ants by invasive Argentine ants has negative consequences for those plants whose seeds are dispersed by the native ants (Carney et al. 2003; Christian 2001). Invasion of exotic insects can alter the dominance of the plant community away from large-seeded species favored by ants (Christian 2001). Vegetation communities, therefore, depend on protection of the wildlife communities that inhabit them for well known services such as pollination, and lesser known functions such as seed dispersal.

Interdependence

Although the foregoing sections identified strategies for conservation actions that target specific groups, it remains true that effective conservation efforts must account for the interdependencies between and within species in these groups. Ecosystems are characterized by complex food webs, which are networks of energy transfer that connect even peripherally related species. They are also characterized by many groups not discussed here that play integral roles in ecosystem function — lichens, mosses, soil microorganisms, bacteria, algae, viruses, and an almost incomprehensible array of other species. Urban conservation must strike a balance between the desire to protect intact ecosystems and the demonstrated benefits of smaller fragments to the overall maintenance of biodiversity.

Summary

The foregoing discussion illustrates the variety of different approaches that must be emphasized to target conservation efforts on particular taxonomic and functional groups. Table 1 summarizes these strategies, indicating primary, secondary, and subsidiary strategies to accomplish the goal of maximizing native biodiversity. These approaches are not mutually exclusive, but require creativity and innovation to match these needs with the possibilities within existing urban environments. Projects may be designed that incorporate several strategies – for example, a small wetland with adjacent scrub and grassland uplands that targets amphibians, flighted pollinators, fragmentation tolerant small mammals, birds that use stepping stone habitats, and migratory birds.

Table 1. Conservation strategies for different taxonomic and functional groups within urban areas.

Group	*Primary Strategy*	*Secondary Strategy*	*Other Strategies*
Mammals			
Large mammals	Large, unfragmented habitat blocks	Landscape connectivity, underpasses, etc.	Eliminate use of anticoagulant rodenticide
Mid–sized mammals (raccoon, opossum, striped skunk, spotted skunk, ringtail)	Maintain large habitat blocks, no action necessary for urban tolerant species		
Small mammals (desert woodrat, deer mouse)	Protect large blocks	Protect habitat fragments	Manage exotic and subsidized predators
Arthropods			
Sedentary, flightless, habitat specialists	Protect range of habitats	Reduce disturbance in habitats	Limit use of pesticides
Mobile, flightless, habitat specialists	Protect range of habitats	Contiguous connectivity	Limit use of pesticides
Flighted habitat specialists	Protect range of habitats, even small	Stepping stone connectivity	Native landscaping, provide key habitat elements
Mobile habitat generalists	Limit use of pesticides		
Birds			
Small urban-tolerant residents and migrants	Network of small habitats	Native and other beneficial landscaping	Manage exotic and subsidized predators
Small and medium sized habitat specialists	Larger habitat blocks	Manage exotic and subsidized predators	Reduce human disturbance (hiking, biking, pets, etc.), control noise
Large urban-tolerant residents	Network of small and large habitats	Provide key habitat elements (e.g., nest boxes)	
Urban-intolerant species	Large habitat blocks	Landscape connectivity	
Reptiles and Amphibians			
Urban tolerant species	Protect small fragments	Manage exotic and subsidized predators	

Group	*Primary Strategy*	*Secondary Strategy*	*Other Strategies*
Upland habitat specialists (lizards, horned toads, etc.)	Protect fragments	Reduce edge effects such as irrigation	Manage exotic and subsidized predators
Snakes	Protect larger blocks	Reduce persecution	Control exterior lighting
Wetland species	Protect and restore wetlands, including vernal pools	Maintain wide corridors around wetlands	Control dumping of exotic pets, control exterior lighting
Ephemeral wetland specialists	Protect existing habitats	Avoid conversion to perennial wetland	Control dumping of exotic pets
Fishes	Increase watershed infiltration to allow future river restoration	Treat polluted runoff	

CONSERVATION STRATEGY FOR CONNECTIVITY

As discussed above, some wildlife species depend on connectivity between habitat fragments to maintain presence in those fragments. As described by the theory of island biogeography, populations of species on islands are susceptible to periodic extinction and depend on recolonization from other sources over time. This model has been analogized to cities (Davis & Glick 1978) and applies for some species. For other species, the edge effects from the land uses surrounding the "island" and the suitability of the urban matrix for the species are far more important than size or isolation (Walter 2004). Nevertheless connectivity is an important component of conservation strategies for a range of species.

To investigate the challenges and opportunities for conservation for the Los Angeles region, we identified a suite of species that require connectivity for long-term persistence in urban fragments, and about which some information is known concerning dispersal and habitat preference (Lam, Martino, and Longcore, unpub.) These species included an ecologically important generalist predator (coyote), and indicators of a range of habitat types: California quail for scrub and chaparral, loggerhead shrike for grasslands, Lorquin's admiral (butterfly) for riparian forest, and acorn woodpecker for oak woodlands. For each of these species we developed a simple vegetation-based habitat model using information from the California Wildlife Habitat Relation Database and a base map from the CALVEG project. Each suitable habitat site (as defined by the model) was connected to other areas within the presumed dispersal distance of the species. Then the nearest neighbors outside the dispersal distance were identified and a shortest distance connection was noted. The resulting maps (Figs. 1–5) allow for an analysis of the existing and potential connections for these example wildlife species.

The initial interpretation of these connectivity maps is to confirm the obvious, that the upper Los Angeles River watershed is highly urbanized and the valley floor is nearly devoid of meaningful wildlife habitat. I assess the MRCA projects on whether they facilitate any of the connections identified for our five target species.

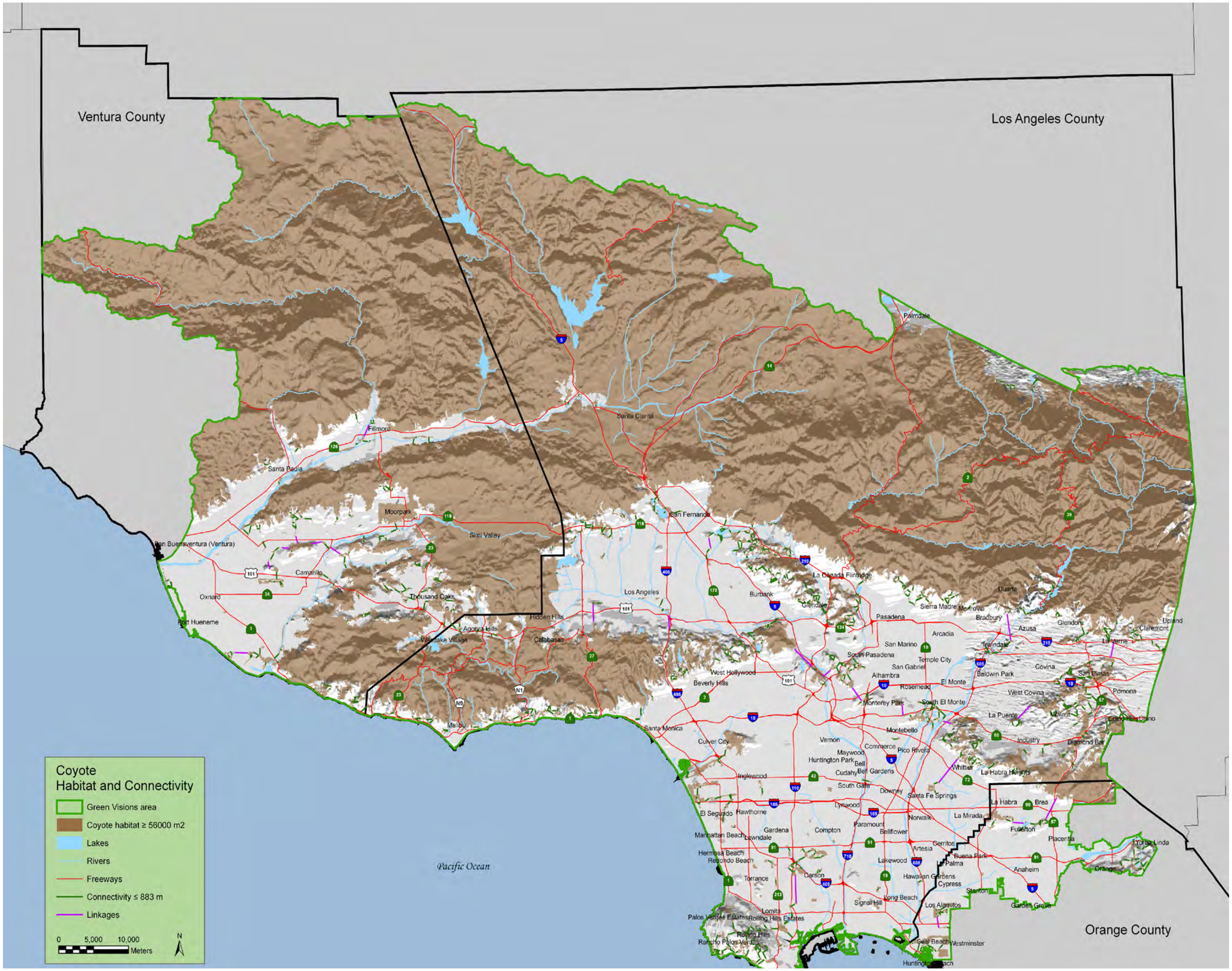

Figure 1. Potential habitat for coyote with existing (green) and missing (purple) connections.

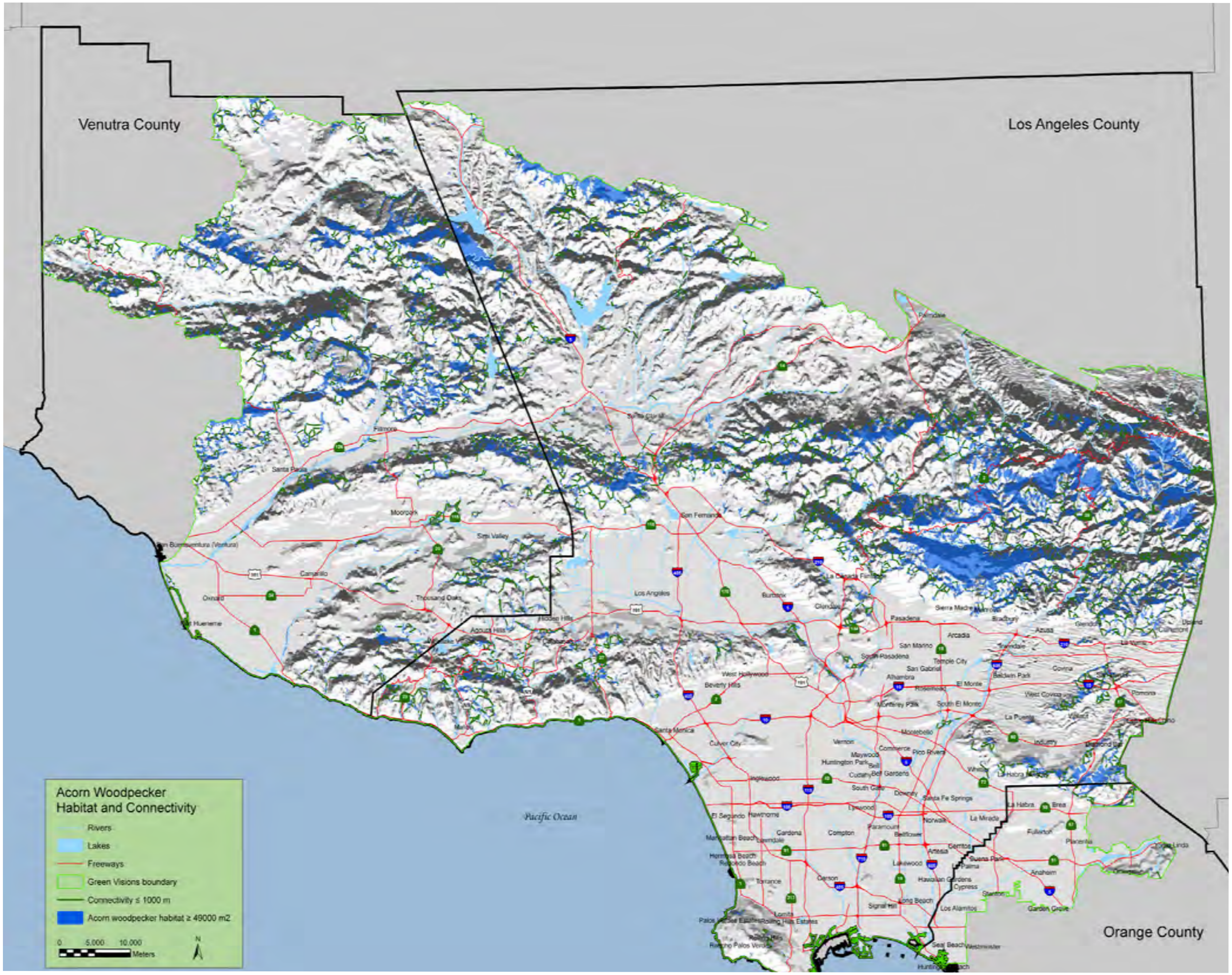

Figure 2. Potential habitat for acorn woodpecker with existing (green) and missing (purple) connections.

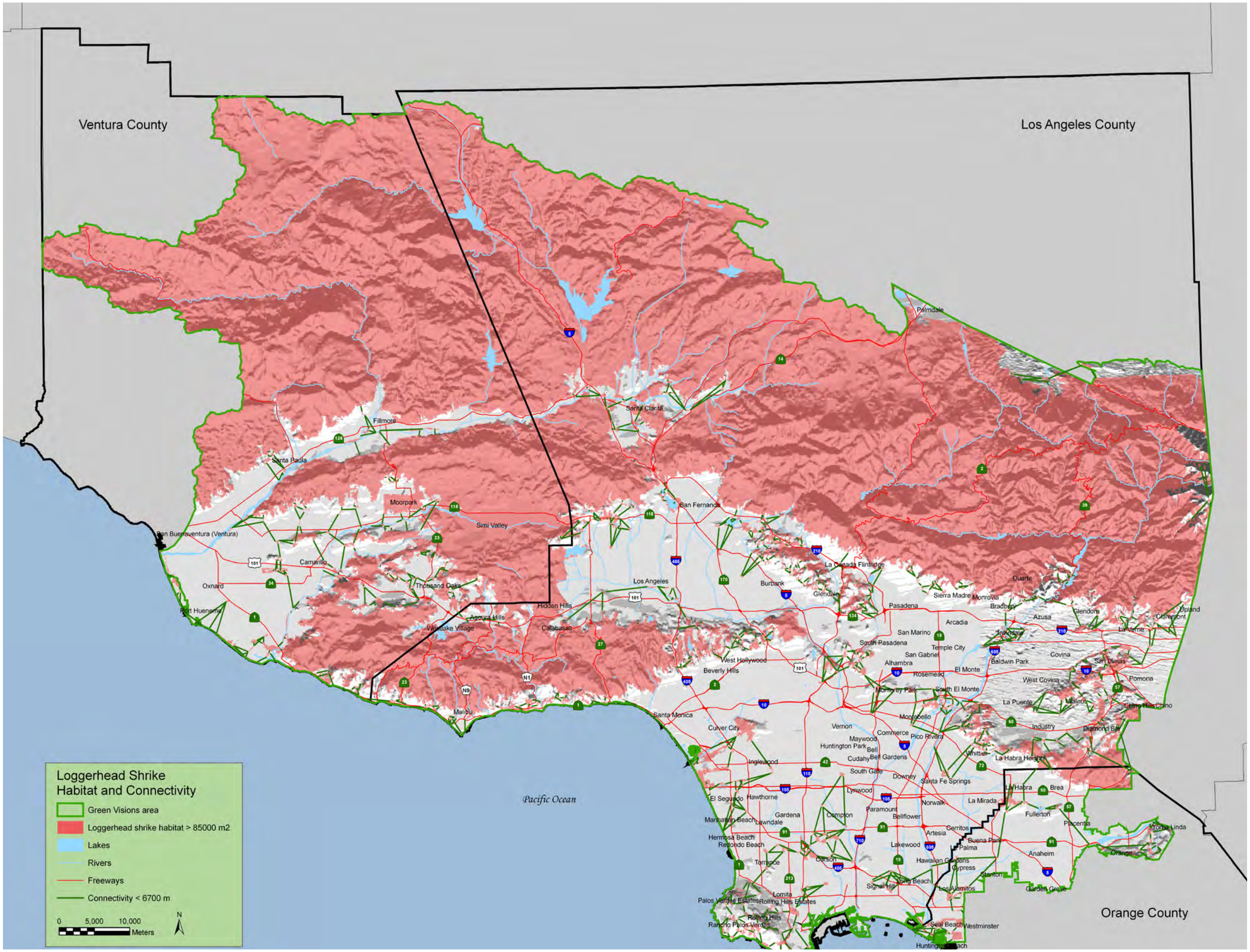

Figure 3. Potential habitat for loggerhead shrike with existing (green) and potential (purple) connections.

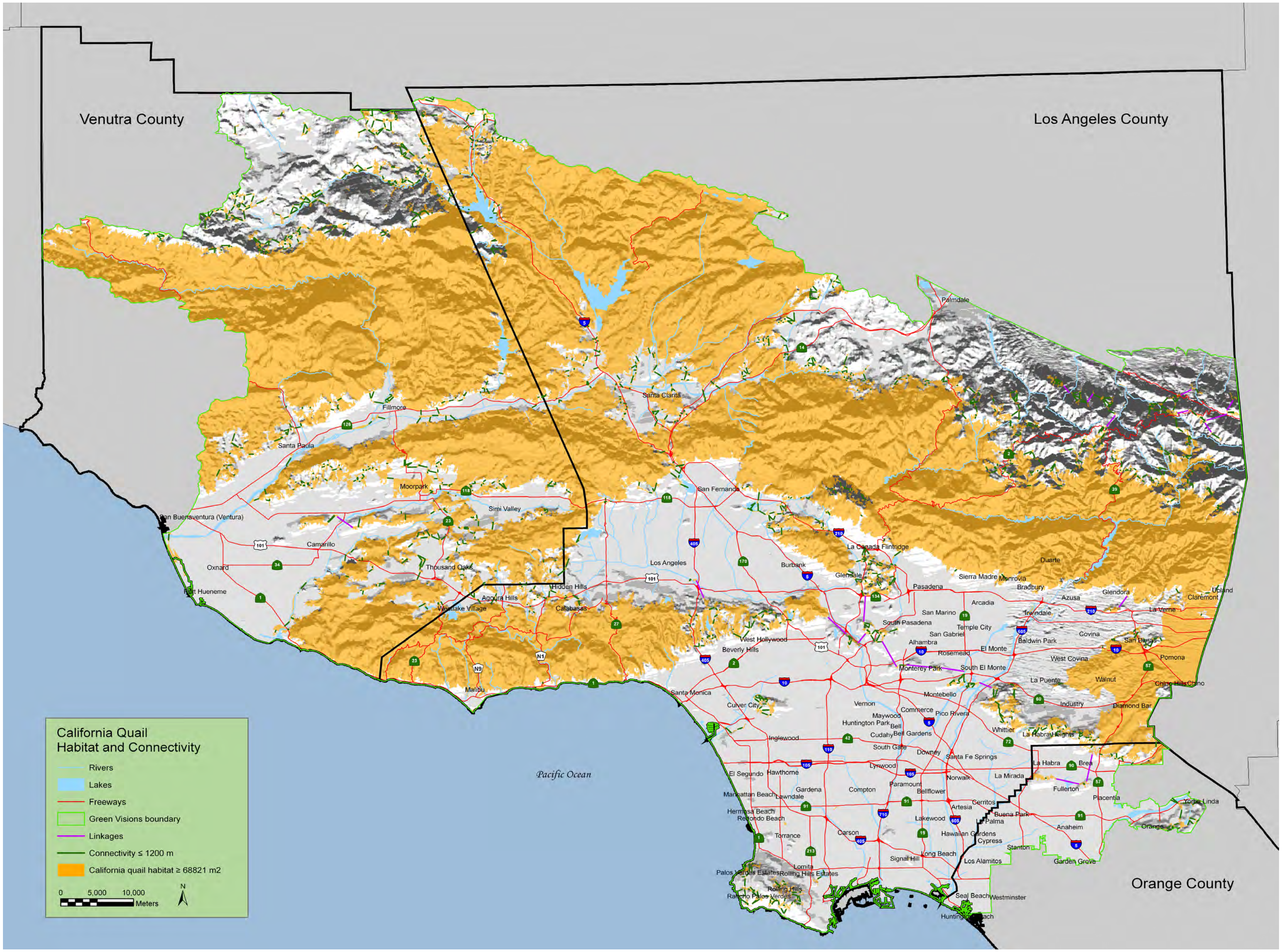

Figure 4. Potential habitat for California quail with existing (green) and potential (purple) connections.

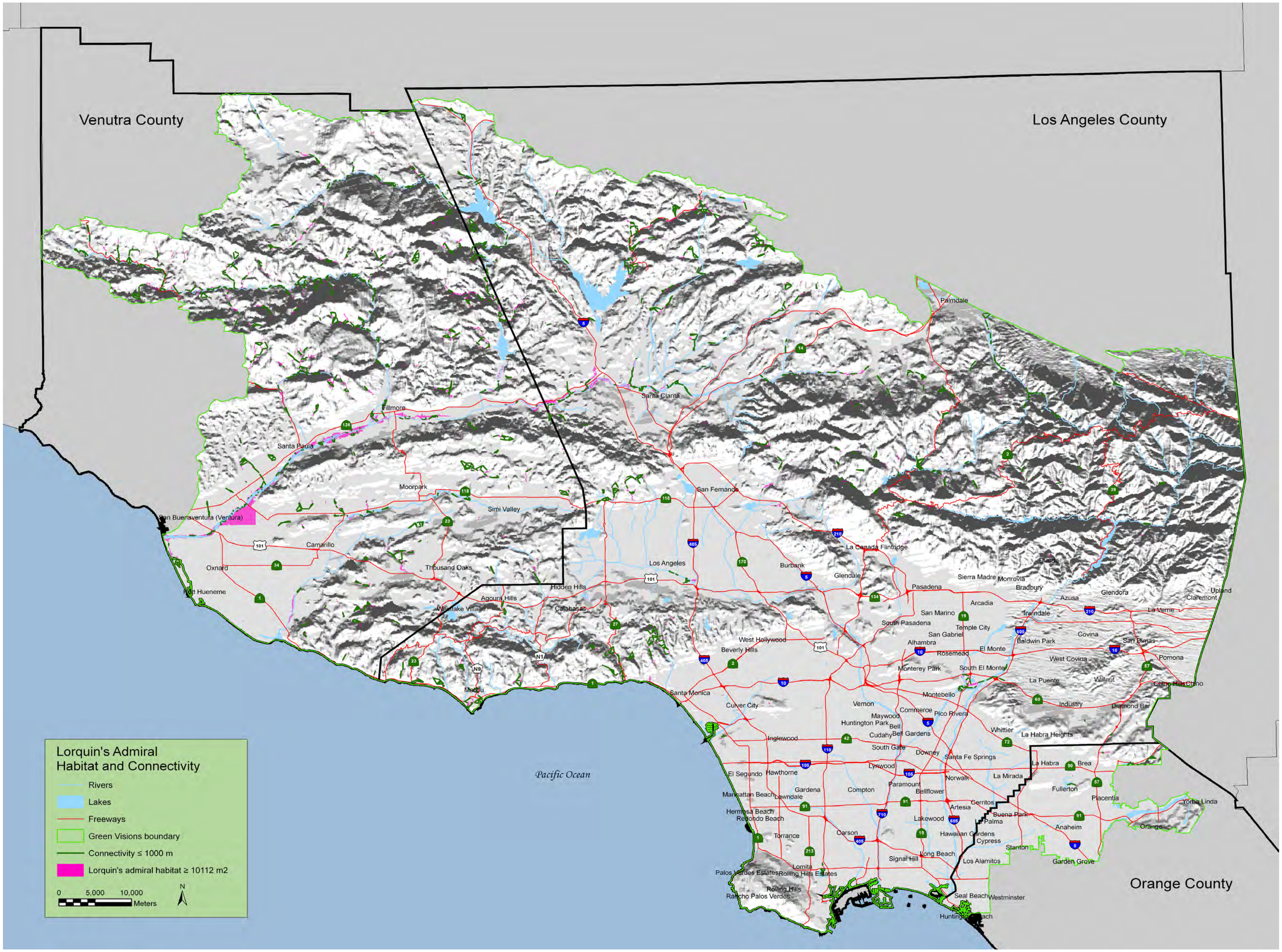

Figure 5. Potential habitat for Lorquin’s admiral with existing (green) and missing (purple) connections.

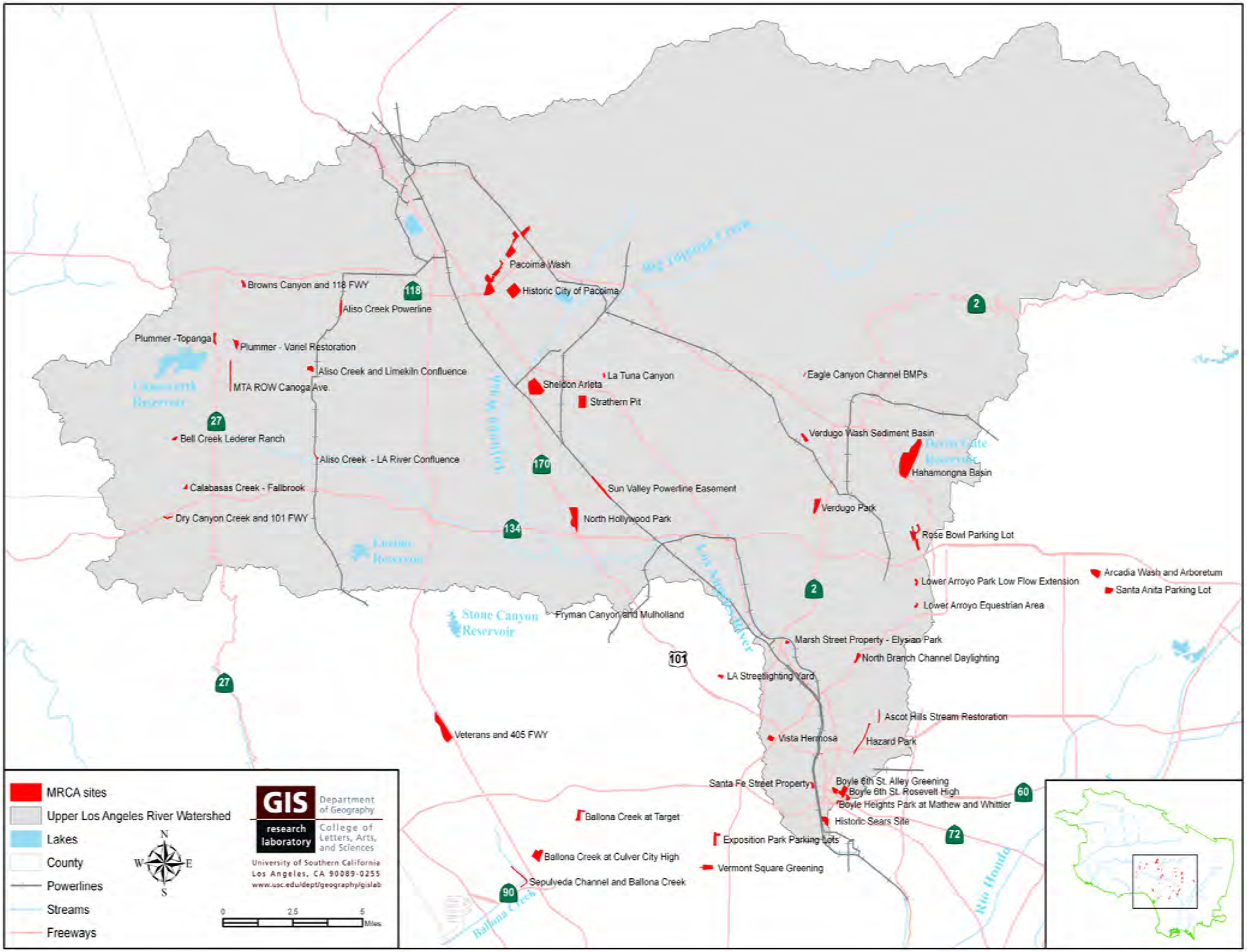

Figure 6. Location of proposed MRCA projects in upper Los Angeles River watershed.

TYPOLOGY OF CONSERVATION STRATEGIES

Based on the literature review and analysis above, the following conservation strategies could be used to maximize biodiversity in urban areas.

1. Range of vegetation communities
    a. Grassland
    b. Scrub/chaparral
    c. Oak woodland
    d. Riparian
    e. Wetland
2. Range of hydrological conditions
    a. Ephemeral
    b. Perennial
    c. Floodplain
3. Represent a range of reserve sizes
    a. Micro reserve (> 1ha)
    b. Small reserve (1–10 ha)
    c. Medium reserve (10–100 ha)
    d. Large reserve (>100 ha)
4. Provide connectivity for target groups
    a. Stepping stones between natural areas
    b. Continuous connectivity between regionally important areas
    c. Local connections to urban fragments
5. Enhance the urban matrix around natural areas
    a. Use of native landscaping
    b. Promotion of street trees and other efforts to increase canopy, especially near riparian zones.

These conservation actions are in addition to sound management and internal design of conservation lands by minimizing fragmentation, controlling the effects of end users such as trampling (Liddle 1975) and disturbance of wildlife, reducing other urban edge effects such as artificial night lighting (Longcore & Rich 2004), and restoring and maintaining vegetation communities appropriate to each site.

Project Assessment

The proposed projects fulfill a range of conservation objectives, or at least have the potential to do so based on their geographic locations and configurations. The site design of each project will greatly influence how the project contributes to the goal of maximizing regional native biodiversity. The choice of locally appropriate vegetation will be central to this question. A range of vegetation types, each appropriate to its geomorphologic context, is central to increasing native biodiversity. The locations of projects are depicted in Figure 6 and project characteristics are summarized in Table 2.

Representation of vegetation types

The majority of projects proposed currently involve some sort of woodland restoration, either in the form of riparian vegetation (willows and sycamores) or as oak woodlands. These vegetation types are extremely rare and have suffered some of the greatest percentage losses, so their restoration is important to the biodiversity of the region. Many fewer of the projects concentrate on scrub or grassland vegetation, which would have been dominant through large swaths of the San Fernando Valley historically. While scrub vegetation is indeed abundant in the surrounding mountains, the species associations that would

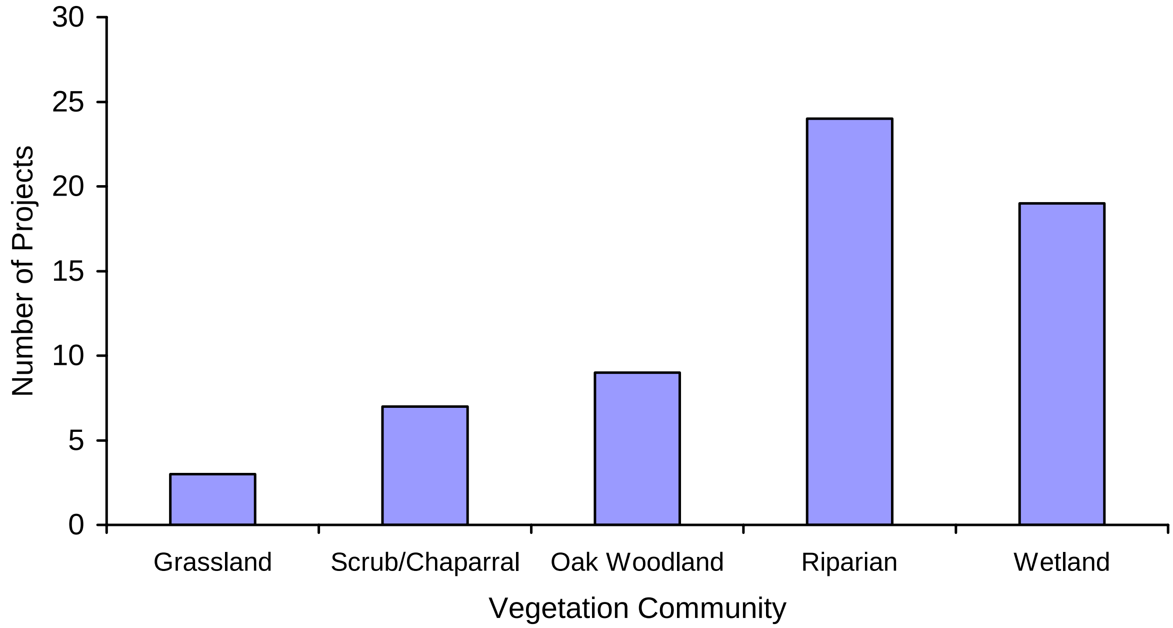

Figure 7. Distribution of vegetation communities in projects proposed by MRCA

be found in the flatter valleys are not well protected or represented in open spaces. To maximize regional biodiversity, future projects should also include concerted efforts to restore grassland (i.e., Los Angeles prairie, see Schiffman, 2005) and alluvial sage scrub vegetation communities. Only a handful of projects include the restoration of native grasslands. Native grasslands are as or more imperiled as riparian vegetation in the Los Angeles basin — that is, almost completely extirpated from the valley floors — and therefore should receive similar conservation attention.

Representation of hydrologic types

The proposed projects seem to include projects that would restore both perennial and ephemeral streams and wetlands. Maintaining this diversity is important, and the goal for the region should be to recreate the approximate proportions of perennial and ephemeral streams (Wolch et al. 2004). There seem to be fewer projects that offer the opportunity to recreate seasonally inundated floodplains, except as detention basins. The physical process of flooding and alluvial sedimentation is important to the development of native vegetation types, and by extension for native biodiversity as a whole (Eyre et al. 2003). Projects that can recreate these natural processes (e.g., including a floodplain), rather than achieving water management goals through more engineered solutions (e.g., building detention basins) are likely to make a greater contribution to native biodiversity.

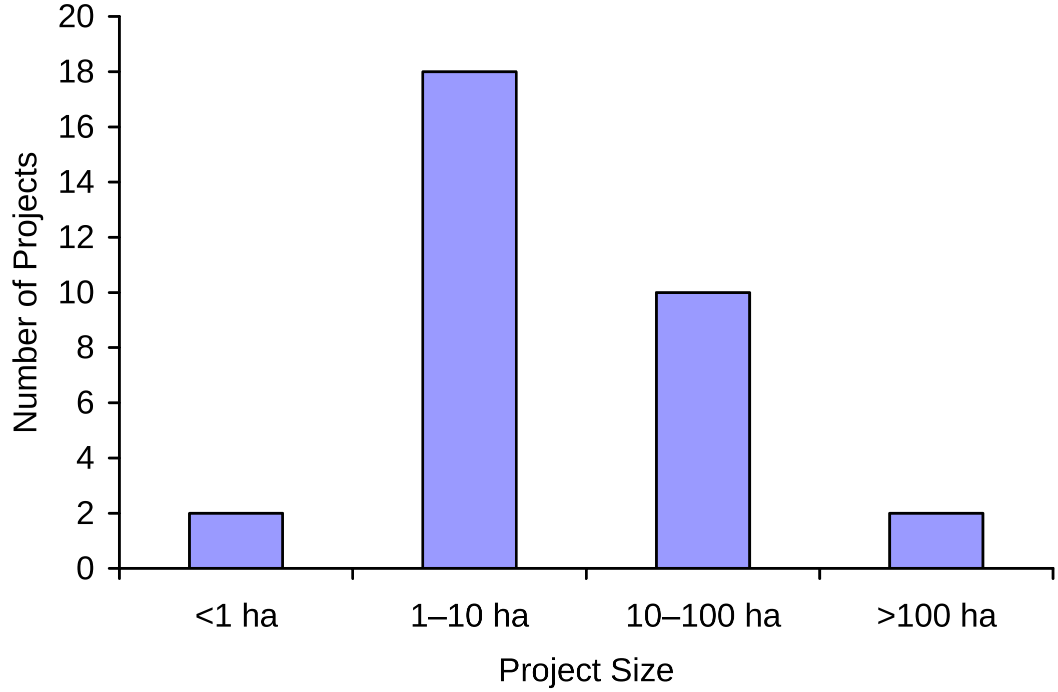

Figure 8. Size distribution of proposed projects proposed by MRCA.

Representation of range of reserve sizes

As might be expected for an urbanized area, most of the proposed projects are smaller (1–10 ha) with a good representation of larger projects (10–100 ha). Understandably, there are few projects greater than 100 ha because of the expense and availability of land in the urban area. Very few microreserves (<1 ha) are envisioned. As projects are developed in the future, even very small reserves should be included in the project portfolio because of the ability of these small reserves to serve as stopover sites for migratory birds, represent rare vegetation or unique geomorphologic conditions, and protect populations of small-bodied organisms such as butterflies. The largest proposed projects should be pursued vigorously as opportunities arise, and the current portfolio of projects would be complemented by inclusion of more microreserves where they are the only opportunities to introduce native habitat into large areas of otherwise residential, commercial, or industrial land uses.

Connectivity

The projects considered here for the most part do not address regional connectivity. This is to be expected, given the geography of the region and the urban character of the projects. The one exception to this is the Verdugo Park enhancement, which would provide needed natural habitat as a stepping stone between large open areas. The projects along utility rights of way and along river channels offer the best opportunities to extend continuous corridors from the surrounding foothills into the urban core. The utility rights of way are especially important because they represent opportunities to provide corridors of upland habitats (grassland and scrub) that are not well represented in the current project mix. The projects would, however, act as stepping stones near native habitats and contribute to the overall permeability of the urban matrix. While not linking up larger blocks of native habitat, these functions would allow the urbanized portion of the valley floor to support greater biodiversity and to provide more diverse recreational and educational experiences.

Enhance urban matrix

The project mix contains several projects that would enhance the urban matrix through greening projects such as tree planting. While urban matrix projects do not serve all species, they are an important component of increasing the over usefulness of the city for native birds and particularly migratory species. These projects can be used to create resources for native wildlife away from significant natural open spaces. In the future include greening adjacent to river corridors to soften the edge between riverside greening projects and surrounding neighborhoods.

Table 2. Characteristics of projects proposed by the MRCA for the upper Los Angeles River watershed. Vegetation types and hydrology for each project are based on preliminary project descriptions and landscape location. Size: 1: <1 ha, 2: 1-10 ha, 3: 10-100 ha, 4: >100 ha. Connectivity: X: increases overall urban permeability, XX: stepping stone near native habitat, XXX: significant link between wildlands. Matrix indicates project to enhance urban matrix.

Project	**Vegetation Community**					**Hydrology**			**Size**	**Connectivity**	**Matrix**
	Grassland	Scrub/ Chaparral	Oak Woodland	Riparian	Wetland	Ephemeral	Perennial	Floodplain			
Plummer-Topanga Detention basin, swales and passive recreation	X	X	X	X	X		X	X	2	XX	
Bell Creek Lederer Ranch				X	X		X	X	2	XX	
MTA ROW Canoga Ave Miniparks and swales along utility line			X	X		X			2	X	
Calabasas Creek-Fallbrook Sycamore swales and detention along channel with passive recreation				X			X	X	2	XX	
Aliso Creek – LA River Gathering place and laid-back river terrace				X	X		X		2	X	
Aliso Creek – Limekiln Detention areas and passive recreation along creek				X	X		X	X	2	X	
Aliso Creek Powerline				X	X	X		X	2	X	
Plummer – Variel Restoration Creekside detention basins, swales and passive recreation				X	X	X		X	2	X	
Browns Canyon at 118 Creekside infiltration and passive recreation site		X	X	X		X			2	X	
Dry Canyon Creek at 101				X		X			2	XX	
Fryman Canyon at Mulholland Entry park to protected land in mountains		X							1*	n/a	
Verdugo Park Existing lawn and drainage ditch to be restored with native communities	X	X	X	X		X			3	XXX	
North Hollywood Park. Low flow diversion through existing park		X		X			X	X	3	X	

Project	Vegetation Community					Hydrology			Size	Connectivity	Matrix
	Grassland	Scrub/ Chaparral	Oak Woodland	Riparian	Wetland	Ephemeral	Perennial	Floodplain			
North Branch Channel Daylighting. Major storm drain				X	X				2	X	
Strathern Pit. Large permanent wetland.				X	X		X		3	XX	
Sun Valley Powerline Easement. Detention basins combined with multiple use recreation.			X		X				3	XX	
Pacoima Wash River Parkway. Low flow diversion and stream creation.			X	X	X	X	X	X	4	XX	
La Tuna Canyon. Water infiltration site bordering flood control channel.					X	X			2	X	
Sheldon Arleta. Upland habitat and potential recreation on capped landfill, with adjacent street tree planting.	X	X							3	X	X
Historic City of Pacoima. Street greening and alley conversion with local infiltration.									3	X	X
Hahamonga Basin. Local park to infiltrate stormwater.		X	X	X	X	X			4	X	
Rose Bowl Parking Lots. Remove asphalt and infiltrate stormwater.					X	X			3		X
Lower Arroyo Park Low Flow Extension. Daylight drain to create parkway.				X	X	X			2	XX	
Lower Arroyo Equestrian Area. Daylight drain to create parkway.				X	X	X			2	XX	
Arcadia Wash and Arboretum. Stream daylighting and restoration.				X	X	X	X		3	X	
Santa Anita Parking Lot. Restore channel to allow infiltration.				X	X		X		3	X	
Eagle Canyon Channel BMPs									1		
Verdugo Wash Sediment Basin Restore edges of existing detention basin			X	X	X	X			2	X	
Hazard Park Restore degraded wetland, daylight stream			X	X	X	X			3	X	

Project	Vegetation Community					Hydrology			Size	Connectivity	Matrix
	Grassland	Scrub/ Chaparral	Oak Woodland	Riparian	Wetland	Ephemeral	Perennial	Floodplain			
Ascot Hills Stream Restoration				X	X				2	X	
Marsh Street Property (Elysian Park) Conversion of industrial site to neighborhood park			?						2	X	X
Historic Sears Site Potential riverside park to treat site runoff				X	X		X		2	XX	
Santa Fe Street Property Conversion of brownfield site			?						2	X	X

CONCLUSION

A full consideration of the determinants of native biodiversity in urban areas leads to a variety of options for conservation that may not focus on the most well known approaches. Although connectivity and area remain the most important factors for regional conservation, other strategies are available and even preferred in dense urban areas where the dominant matrix is entirely urban. These strategies include protecting a range of vegetation communities, hydrological conditions, and reserve sizes, in addition to enhancing the urban matrix through the use of native landscaping and street trees. Together, these strategies should maintain higher native biodiversity over a greater area of the city.

The projects proposed by the MRCA in the upper Los Angeles River Watershed are unevenly distributed among the conservation strategies identified. Future projects might include more projects to restore grasslands and scrub habitats to balance out the under-representation of these vegetation communities in the current projects. Projects to recreate natural hydrological processes, especially those including ephemeral wetlands and natural alluvial terraces would also increase native biodiversity. The MRCA might also consider the development of microreserves wherever remnant native habitats might be found in the city. These remnants serve a vital role for small-bodied species and can contribute significantly to regional biodiversity. Connectivity for the upper Los Angels River watershed should be pursued through critical linkages between larger habitats (e.g., Verdugo Park project), and gradual development of continuous greenspaces along both the channel/river system (for riparian species) and utility rights of way (for upland species and provided the rare opportunity to restore grassland and scrub habitats).

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