EVALUATION OF THE COAL CANYON BIOLOGICAL CORRIDOR

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There are no hopeless cases, only people without hope and expensive cases.
Michael Soulé, Viable Populations for Conservation, p.181

Executive Summary

The Santa Ana Mountains and the Puente-Chino Hills together encompass about 511,000 acres of wildlands containing biological resources of statewide and worldwide significance. The habitat linkage between these two areas, once several miles wide, is now narrow and tenuous due to the Riverside Freeway and associated urban development. Loss of the linkage would have greatest impact on species that exist in low numbers. In the Puente-Chino Hills we expect that at least 21 vertebrate species have populations below 500, and that at least 4 of these populations probably number fewer than 50 breeding adults; these would be vulnerable to extirpation if the corridor is lost. The linkage also benefits the Santa Ana Mountains (where grasslands are rare) because the Puente-Chino Hills may harbor source populations of grassland specialists such as American badger, black-tailed jackrabbit, and grasshopper sparrow. If large carnivores were to become extinct or significantly reduced in the Puente-Chino Hills, populations of medium sized predators would probably increase, with potentially profound impacts on bird communities.

We predict that, after restoration of the underpass area, the Coal Canyon Biological Corridor will allow inter-range travel by most terrestrial vertebrates, by plant seeds and other propagules that depend on mammals or birds for dispersal, and by habitat specialist birds such as the California gnatcatcher. Such travel would be precluded by urbanization of the corridor properties. In addition to its functions as a biological linkage, the corridor would make possible a trail connecting these two important natural areas. If uses of the underpass are limited to carefully managed, non-motorized activities such as hiking, mountain biking, and equestrian uses, this trail connection should be compatible with the biological functions of the corridor.

Fortunately, the opportunity remains to not only protect this natural linkage, but to improve it dramatically. We strongly urge purchase of the properties for preservation, and prompt restoration of the underpass area to natural vegetation. Restoring a natural linkage in what is now a roaded underpass would set a global precedent. We are aware of no other restored biological corridor of this type and scale. Conservation-minded citizens throughout the world could look to Coal Canyon as an inspiring example of how an ecological error was corrected through thoughtful public action.

Introduction

Conservation biologists agree that "hotspots" of biodiversity deserve special attention, as do regions at great risk of biodiversity loss. Southern California is both kinds of region. The southwest ecoregion of southern California contains a greater diversity of vegetation types, vertebrate species, and endemic species (i.e. species not found elsewhere) than any other area of comparable size in the United States (Wilson 1988). This region is also one of the global epicenters of extinction risk, consistently ranking in the top 4 regions of the United States in terms of its number of species and ecosystems at risk of extirpation (Flather et al. 1995, Noss et al. 1995, Noss and Peters 1995, Dobson et al. 1997). One plant community alone (southern California coastal sage scrub) contains over 35 species of plants, 2 insects, 7 reptiles, 4 birds, and 7 mammals that, as of 1993, were either listed or candidates for listing under the federal Endangered Species Act (Noss et al. 1995: Appendix D). Set in the heart of this region of diversity and danger, the Santa Ana Mountains and the Puente-Chino Hills together encompass about 511,000 acres of wildlands (Beier 1993). These particular 511,000 acres contain biological resources of statewide and worldwide significance, including several rare and endemic communities (Table 1).

Table 1. Some of the rare communities and ecosystems in the 511,000 acres of wildlands in the Santa Ana Mountains and Puente-Chino Hills. References in Noss et al. (1995), Burkett (1989), and Beier and Barrett (1993).

›mmunity or Species	Notes
›astal Sage Scrub	′0-90% lost
uvial Sage Scrub	Rare and declining plant community; present in Coal Canyon Biological Corridor
′asslands	Statewide over 99% of native grasslands have been lost. Chino Hills State Park, with the largest protected (ungrazed by livestock) grasslands in southern California, is the most promising reintroduction site for pronghorn in the region.
ɛrnal pools	›95% loss in San Diego County
›uthern California walnut woodland	Southern limit occurs in Chino Hills State Park, less than 1 mile from Coal Canyon.
ɛcate cypress forest	Endangered. The species' northernmost stand (in Coal Canyon) contains the world's oldest and largest trees of this species.
g-cone Douglas-fir forest	Endemic
ıgelmann oak woodlands	The largest remaining woodlands occur in the southern Santa Anas
ınta Margarita River	The least impacted River System in southern California
ın Mateo Creek	The only perennial stream between Santa Barbara and the Mexican

border that is wild throughout the entire watershed.

The habitat linkage between the Santa Ana Mountains and the Puente-Chino Hills, once several miles wide, is now narrow and tenuous due to the Riverside Freeway (State Route 91) and associated urban development. The northernmost protected parcels in the Santa Ana Mountains (Trabuco Ranger District of Cleveland National Forest, CDFG Tecate Cypress Reserve, and Irvine Company NCCP lands) are separated from the southernmost protected parcel in the Chino Hills (Chino Hills State Park) by private land parcels, all of which have Freeway frontage and potential for urban development. Conservation agencies (including CDFG, California State Parks) and organizations (including Friends of Tecate Cypress, Hills for Everyone, Sierra Club, Mountain Lion Foundation) have called for acquiring and preserving a portion of those private lands as a habitat corridor, with the Coal Canyon watershed as the defining topographic feature of the corridor. The proposed acquisition area consists of approximately 653 acres on the south side of the freeway (Saint Claire Property) and 32 acres on the north side of the freeway (Mancha Property).

Small reserves benefit from linkage to larger wildlands through a ''rescue effect,'' whereby animals dispersing into the reserve bolster populations, provide new genetic material, and help prevent local extinctions. Some of these benefits may also accrue to plants. Because the Puente-Chino Hills-Prado Basin area (about 40,000 acres) is much smaller than the Santa Ana Mountains (about 473,000 acres), it would receive a larger benefit from maintaining a connection between the 2 areas. However, even the Santa Ana Mountains are small relative to the needs of some of its species (see ''Costs of losing the corridor'' below); hence, the Santa Anas would certainly benefit from maintaining and enhancing the connection to the Puente-Chino Hills. At present, almost half of the wildlands in the Puente-Chino Hills are in protected status, representing a public investment of over $100 million (California Department of Parks and Recreation is developing an accurate estimate). About 63% of the Santa Ana Mountains is protected (Beier 1993), obviously representing a much larger public investment. The cost of acquiring the Coal Canyon Biological Corridor must be evaluated in light of these investments and the benefits of connectivity to these investments. Although wildland acquisitions are usually evaluated in terms of content (''What scenic, recreational, or wildlife values exist on the parcel?''), the Coal Canyon Biological Corridor, quite correctly, is being evaluated primarily in terms of context (''How does this parcel enhance the biodiversity and recreational values of the larger landscape?'').

The Wildlife Corridor Conservation Authority (WCCA) is a joint powers authority recently

created expressly to maintain connectivity among the protected parcels in the Whittier-Puente-Chino Hills and northern Santa Ana Mountains. Its members include local governments, public representatives, the Santa Monica Mountains Conservancy, the California Department of Fish and Game, and the California Department of Parks and Recreation (CDPR). In cooperation with WCCA, local government entities have recently completed several key land purchases which contribute to this effort, including the acquisition of Powder Canyon. WCCA is currently negotiating additional acquisitions, including acquiring property in upper Tonner Canyon from the Boy Scouts. In addition, the CDPR recently acquired over 900 acres encompassing portions of Sonome Canyon which provides a habitat linkage between the State Park and Tonner Canyon.

In this report, we evaluate the importance of the Coal Canyon Biological Corridor to conservation of plant species, animal species, and ecosystems in the Puente-Chino Hills and Santa Ana Mountains. We considered the scientific basis for the utility of corridors, current and potential levels of movement in the corridor, possible alternative corridors, the biological costs of losing the corridor, and social benefits of enhancing the corridor.

The Scientific Basis for the Utility of Corridors

Scientists have long recognized that larger habitat areas have more species than small areas. Early work on oceanic islands showed that across taxa (including beetles, reptiles, amphibians, birds, and mammals), smaller islands contained fewer species than large islands. Darlington (1957) examined species lists for Caribbean islands and calculated that the number of species doubled as island size increased 10-fold. MacArthur and Wilson (1967) hypothesized that an island's size controlled its extinction rate, and its distance from the mainland controlled the rate of colonization; together these 2 rates determine the number of species expected on the island. Historical evidence analyzed by Diamond (1975, 1984) and Jones and Diamond (1976) supported MacArthur and Wilson's hypothesis that extinction rate depends on island size, and showed that extinction rates are highest for the smallest populations. Rare species are the most likely to be lost as area decreases because small populations depend on immigrants from other areas. The importance of immigration in avoiding extinction of populations on real and virtual islands was dramatically illustrated in a population model by Brown and Kodric-Brown (1977), who coined the term rescue effect.

Habitat fragments on continents manifest similar patterns of extinction as oceanic islands, with fewer species supported on smaller fragments once they become isolated from larger habitat areas. Brown (1971) studied mammals in forest remnants on mountain tops (“sky islands”) in the desert southwest and found many fewer species on the smallest

mountaintops. The desert between the islands created a nearly absolute barrier to movement of small mammals. This has obvious implications for habitats fragmented and isolated by urban areas.

Soulé et al. (1988) studied rapid extinctions of chaparral birds in canyon fragments in San Diego County. They found that extinction risk was strongly related to size of fragment and time since isolation. Surprisingly, extinction risk was not related to how far the fragment was from nearby suitable habitat, apparently because many birds were unable to disperse through even 100m of urban landscape. Soulé et al. (1988) also concluded that habitat corridors can counteract the effects of fragmentation.

Nature reserves by definition are islands of protection in an ocean of lands managed for other purposes; this makes them vulnerable to isolation and subsequent ecosystem decay. Newmark (1987) researched historical species lists of western national parks and noted that mammalian extinctions were related to Park size, with smaller parks (Zion, Bryce, Mount Lassen) losing forty percent of their larger mammal species, while larger parks had suffered few losses. Newmark concluded that the parks had experienced a mammalian faunal collapse, most likely caused by insularization.

Mammalian carnivores are particularly vulnerable to extinction due to fragmentation because they live at low density and their populations require large land areas (Shaffer 1983, Beier 1993, Noss et al. 1996). Top predators such as mountain lions, coyotes, and bobcats are most likely to disappear from fragmented systems. The disappearance of top predators can cause a cascade of effects in the ecosystem. Dominant carnivores can suppress smaller carnivores through competition and predation (Sargeant et al. 1987, Harrison et al. 1989). Conversely, the loss of top predators may lead to large increases in smaller predators (mesopredators) such as gray foxes, raccoons, striped skunks, opossums, and domestic cats, a phenomenon known as ‘‘mesopredator release.’’ Larger numbers of such mesopredators, in turn, can cause decline and even extinction of some prey species, especially birds (Soulé et al. 1988). This occurs because the mesopredators are particularly effective predators on birds and bird nests, which are largely ignored by the larger predators.

Although a paper by Simberloff et al. (1992) is often cited as ‘‘refuting’’ the utility of corridors, these authors do nothing of the sort. Indeed, they strongly agree that landscape connectivity is important in maintaining biodiversity and ecosystem function. They simply argue that a better strategy than corridors is to manage ‘‘the entire landscape... as a matrix supporting the entire biotic community’’ (Simberloff et al 1992:500). We fully agree. However, in urban areas in general, and in the Coal Canyon area in particular, this is

impossible. Our only choice is between habitat fragmentation (which Simberloff et al. agree is disastrous) or a corridor.

Simberloff et al. (1992) also claimed that few empirical studies demonstrate that narrow habitat corridors provide connectivity on a landscape, i.e., that animals will actually use corridors. However, Beier and Noss (in prep.) reviewed 31 empirical studies and concluded that the preponderance of empirical evidence supports the hypothesis that animals can and do use corridors in a way that reduces risk of extinction and/or promotes recolonization of habitat patches. Nonetheless, Simberloff et al. (1992) and Beier and Loe (1992) correctly point out that, for most species, we do not know what corridor traits (length, width, adjacent land uses, etc.) are required for a corridor to be useful. In the case of the Coal Canyon Corridor, questions concerning optimal width and length are somewhat moot because the feasible options are already extremely limited (in terms of remaining habitats or potentially restorable vegetative communities). The issue here is not how wide an ideal corridor should be but whether the extremely limited options that remain are adequate to provide a functional biological linkage. Our review focuses on this critical question.

Current and Potential Levels of Movement in the Corridor

We evaluated the potential for animal and plant movement through the Coal Canyon Biological Corridor in light of several important facts. Although these are self-evident truths to biologists, they may not be as obvious to our audience, and therefore we emphasize them here:

The Coal Canyon Biological Corridor includes the entire Coal Canyon watershed north from the Tecate Cypress Reserve, the entire Mancha Property at the mouth of Coal Canyon, and the southern slopes of Scully Hill in effect virtually all of the currently unprotected land between the Tecate Cypress Reserve and Chino Hills State Park. We caution against equating the biological corridor with its most degraded section, namely the box culvert and vehicle underpass under State Route 91. We emphatically reject the notion that a development project can ‘‘protect’’ the ‘‘corridor’’ simply because it does not occlude the box culvert and leaves vegetation along Coal Canyon wash.

1 The potential for plant and animal movement will be far greater after restoration of the area than it is today. Current usage of the culvert and underpass area (the most degraded portion of the corridor) should be taken as a very minimal estimate of the potential for movement.

1 We evaluated this corridor as a biological linkage between the Chino Hills and the Santa Ana Mountain Range for the largest possible suite of species, not just carnivores. Although (as noted above) corridors are important for large carnivores, and loss of

carnivores can have cascading effects on biodiversity, clearly Coal Canyon is the last possible linkage for all plants and animals. Similarly, although Beier's 5-year telemetry study provides data on mountain lion use of the corridor, our ignorance of how other species may use it does not make this solely a "mountain lion corridor." Although the cougar provides useful information on the importance of the corridor, its location, and the minimum width needed to serve one species, we base our recommendations on the fact that this is the last best linkage for all species.

The most recent (1997) study of animal use of the corridor has focussed on carnivore use of the most degraded portions of the corridor, namely the Riverside Freeway and Santa Ana River. Nonetheless, this estimate of minimum movement potential is encouraging. Chris Haas and Kevin Crooks (UC Santa Cruz, personal communication) have documented use of the Coal Canyon Biological Corridor by coyotes, bobcats, skunks, raccoons, opossums, foxes, and cougars. Their most recent cougar detection was on May 20 1997 (memo from Chris Haas to Andrea Gullo, June 1997). Earlier, Beier (1993, 1995) documented that 3 different mountain lions used the Coal Canyon Biological Corridor to cross between the Santa Ana Mountains and the Chino Hills during 1990-1992. One mountain lion (Male #6) used the Corridor 22 times, splitting his home range between the two areas.

On our field visit to the site (December 15-16 1997) we noted 2 pairs of California gnatcatchers on the Saint Claire property, including one pair within 50 ft of the Freeway interchange. Because California gnatcatchers are extreme habitat specialists with poor dispersal ability, Coal Canyon could provide a critical stepping stone in maintaining connectivity for this species between the Santa Ana Mountains and areas to the north. In addition, deer use this parcel, but fences prevent them from reaching the underpass at the Riverside Freeway. The deer population in the Puente-Chino Hills is apparently small at present. Without a functional corridor for deer to provide a rescue effect, deer in the Puente-Chino Hills could be extirpated, especially if urbanization continues and if a series of wildfires converts much of the remaining woodland and shrubland to grassland.

We are unable to directly assess plant movement through the corridor. To the extent that plant seeds and propagules are transported via the fur and feces of mammals, or via the feces of birds, we expect that the Coal Canyon Biological Corridor will greatly facilitate interchange of plant material between the Santa Ana Mountains and the Puente-Chino Hills. The corridor may also facilitate dispersal via downstream flow of seeds in the Coal Canyon drainage. For instance, Coulter's Matilija poppy occurs at several locations in upper Coal Canyon, and also on the Mancha property in locations where its seeds may

have been transported by streamflow.

For this corridor to realize its full potential for plant and animal movement, the bottleneck at the Riverside Freeway must be improved. Although mountain lions, coyotes, skunks, and raccoons can and do use culverts, most other organisms (including deer, rabbits, rodents, and birds) usually will not do so. We predict that many of these other species would use the vehicle underpass if the underpass and its approaches are improved. The following enhancements are critically important:

Use fencing to direct animals that approach the freeway toward the underpass. The underpass not the culvert should be the focal point of the fencing.

Remove most or all of the pavement in the underpass, and plant woody and herbaceous vegetation in the underpass.

Remove lighting from the underpass and the approach to the underpass. Prohibit night-time traffic in the vehicle underpass.

South of the Riverside Freeway, restore native vegetation to the area between the Coal Canyon sediment basin and the underpass. North of the Freeway, restore native vegetation throughout the Mancha parcel

Consult a hydrologist and civil engineer to evaluate the feasibility of re-routing at least half of the Coal Canyon water flow through the underpass.

Consult an acoustical engineer to evaluate the feasibility of building a sound wall to reduce traffic noise in the area approaching the underpass.

We predict that, after restoration of the underpass area, the Coal Canyon Biological Corridor will:

Allow inter-range travel by most terrestrial vertebrates. Such travel would be precluded by development of the Saint Clair and Mancha properties. Field evidence clearly shows that, even in its current degraded state, the corridor enables inter-range travel by top carnivores such as mountain lions, bobcats, and coyotes. We have every reason to believe that with restoration it would also serve other mammal, reptile, and amphibian species.

Allow inter-range travel by plant seeds and other propagules that are depend on mammals or birds for dispersal. Such travel would be precluded by development of the Saint Clair and Mancha properties.

Facilitate inter-range travel by avian species such as California gnatcatchers. Such travel would be impeded by development of the Saint Clair and Mancha properties, with the greatest impediment facing sedentary habitat specialists like the federally-listed California gnatcatcher.

Possible Alternative Corridors

Our inspection from the ground and air suggests only one potential alternative inter-range corridor besides Coal Canyon. This potential corridor would consist of (south of the Riverside Freeway) the canyon 1 mile east of Coal Canyon ("Mindermann Ranch" on the USGS maps) and (north of the Freeway) the Green River Golf Courses.

This canyon is clearly inferior to Coal Canyon in terms of watershed size (about 10% that of Coal Canyon), proximity to urban development, inclusion of a golf course, and reliance on a freeway underpass that is much smaller (about 6 x 6 feet in cross section) than the Coal Canyon vehicle underpass. Furthermore the value of this canyon as a corridor would be greatly diminished by urban development of the Saint Claire parcel. For instance, Beier and Barrett (1993) documented that most cougars accessed Mindermann canyon via the Saint Claire parcel in Coal Canyon. We conclude that there is no practical alternative to the Coal Canyon Biological Corridor for maintaining and enhancing plant and animal movement between the Santa Ana Mountains and the Puente-Chino Hills.

We also attempted to assess whether portions of the Mancha or Saint Claire properties might be excluded from the Coal Canyon Biological Corridor. We strongly believe that the entire Mancha property must be included in the corridor, with no urban use beyond possible highway or commercial signage. We believe that urban use of the westernmost portion of the Saint Claire parcel would have minimal impact on the biological corridor, as long as the entire Coal Canyon watershed, extending at least 100 m west of the Coal-Gypsum ridgeline, is included in the protected corridor. Additional westward offset would likely be needed to accommodate fire control buffers, urban lighting, and human access (roads and trailheads).

Costs of Losing the Corridor.

Because the Puente-Chino Hills are approximately one-tenth the size of the current regional wildlands (i.e., the greater Santa Ana Mountains including the Puente-Chino Hills), loss of the Coal Canyon Corridor would create 2 islands, with the smaller island about one-tenth the size of the current single entity. The observations and inferences of Darlington (1957), Brown (1971), Williamson (1981), and Wilson (1992) suggest that half the species in the Puente-Chino Hills may become extinct as a result of fragmentation. We are reluctant to make such a dire prediction based on these results, because each case is unique, making it difficult to extrapolate to a particular case. Nonetheless, over time, isolation of the Chino-Puente Hills from the Santa Ana Mountains will probably trigger substantial extinctions in the smaller area, and quite possibly in the Santa Anas as well. The species most likely to be lost are those species most vulnerable to small population size or

inbreeding.

Although identifying such species is an imprecise science, in Table 2 and Table 3 we list those species expected to be most at risk, following two rules of thumb known as the "Rule of 50" and the "Rule of 500." The Rule of 50 reflects the fact that chance variation in birth and death rates, or in sex ratios, is likely to cause rapid extinction in populations of fewer than 50 breeding individuals (Frankel and Soulé 1981: Chapter 6). Many detailed single-species models (e.g. Shaffer 1983, Beier 1993) and several empirical studies (e.g., Berger 1990) have confirmed this rule. According to the Rule of 500, populations with an effective population size of fewer than 500 individuals will suffer loss of genetic information over time, eventually leading to inbreeding depression and increased risk of extinction (e.g., Lande and Barrowclough 1987:98). In either case, a corridor, by effectively creating a larger population, would reduce extinction risk. We emphasize that these rules of thumb represent only crude estimates for short time spans (10-100 years). We would prefer a viability analysis for each species, because each species is different, but such an effort would go far beyond the scope of this report. We offer this species list not to predict population viability or extinction risk for any particular species, but to illustrate the magnitude of what is at stake. These tables may well underestimate the number of species at risk in that even relatively abundant species like shrews and ground squirrels can become extinct on habitat islands similar in size to the Puente Chino Hills (Brown 1971).

Table 2. Estimated population sizes (numbers of breeding adults) for selected vertebrate species in the Santa Ana Mountains (SAM) and Puente-Chino Hills (PCH), calculated by multiplying estimates of density (adults per 100 acres) by the wildland acreage in SAM or PCH. Our calculations optimistically assume that all 38,000 acres of wildlands in PCH will be preserved, and that 526,000 acres will be preserved in the SAM (the current 299,000 acres of protected land plus half [227,000 of 454,000 acres] of the currently-unprotected wildlands). These calculations also assume that our study area has densities similar to those in published studies, which may not be the case.

Species	Santa Ana Mountains	Puente-Chino Hills	Citations on animal density
Southwestern pond turtle	?	<100	Beier, personal observation
California spotted owl	2-10 pairs	<3, likely 0	Beier, personal observation
Black-tailed jackrabbit	low	low	Beier, personal observation
Mule deer	4,000	400	Beier and Barrett 1993 (for SAM and PCH)
Raccoon	>500	200	Fritzell 1978a, Fritzell 1978b
American badger	<500	100-250 [a]	Hein and Andelt 1995, Lindzey 1971, Messick and Hornocker 1981, Clark et al. 1982;
Striped skunk [b]	>500	150	Storm 1972
Long-tailed weasel	>500?	<100?	no density estimates available.
Mountain lion	15-20	1-2	Beier 1993 (for SAM and PCH)

Bobcat	<500	<50	Jones and Smith 1979, Lawhead 1984, Rolley 1985, Rucker et al. 1989
Gray fox	large	<200	Fritzell and Haroldson 1982
Coyote	>500	60	Pyrah 1984, Gese et al. 1989, Babb and Kennedy 1989

[a] assumes PCH grasslands are better badger habitat than SAM chaparral and woodland.
[b] No density estimate available. Therefore we used home range estimates and assumed 50% home range overlap within sex, and 100% overlap between sexes.

Based on estimated densities and habitat areas, we expect that the Puente-Chino Hills have at least 21 vertebrate species with populations below 500, and that at least 4 of these populations probably number fewer than 50 breeding adults (Tables 1, 2). Risk to all of these species would increase in the absence of a corridor. Beier (1993) demonstrated that even rare immigration, as low as one individual per decade, can dramatically reduce the extinction risk for small populations. The Coal Canyon corridor would allow at least this level of immigration for many species. Although most bird species can travel across inhospitable habitat, many of these sensitive birds are habitat specialists and would certainly benefit from stepping stones of suitable habitat within the Coal Canyon Biological Corridor.

The corridor would also benefit the Santa Ana Mountains, where at least 4 species number fewer than 500 adults, and at least 2 species (mountain lion and California spotted owl) number fewer than 50. Indeed some species, namely those that specialize in grasslands, are probably more abundant (or have more productive populations) in the Puente-Chino hills than in the Santa Ana Mountains. Because grasslands occur in less than 3300 acres of the Trabuco Ranger District (Burkett 1989), the Puente-Chino Hills may well represent source populations for grassland specialists such as American badger, black-tailed jackrabbit, kangaroo rat, horned lark, grasshopper sparrow, tricolored blackbird, northern harrier, and black-shouldered kite. For instance, in 5 years of field-work, Beier and his field crews (personal observation) never observed a single jackrabbit in the Trabuco Ranger District; a few individuals were observed on Fallbrook Naval Weapons Station, a grassland-dominated area (similar to much of the Chino Hills) south of the Trabuco Ranger District. As urbanization of the region continues, preservation of the Coal Canyon Biological Corridor will become increasingly crucial for the Santa Ana Mountain Range, second in importance only to the connection between the Santa Ana Mountains and the Palomar Range south of Temecula (Beier 1993, Beier and Barrett 1993).

Table 3. Threatened, endangered, rare, or sensitive vertebrate species likely to exist in small numbers in the Puente-Chino Hills and Santa Ana Mountains, but for which no quantitative estimates are possible. Names in **bold** indicate

species that may exist in higher numbers in the Puente-Chino Hills than in the Santa Ana Mountains, such that the Santa Ana Mountains would benefit from any immigration via the Coal Canyon Biological Corridor. Scott and Cooper (1997) mapped distribution of several of the bird species in the Puente-Chino Hills.

Species
San Diego horned lizard
Western spadefoot toad
Arroyo southwestern toad
Arroyo chub
California horned lark
California gnatcatcher
San Diego cactus wren
Yellow warbler
Grasshopper sparrow
Yellow-breasted chat
Least Bell's vireo
Southern California rufous-crowned sparrow
Bell's sage sparrow
Tricolored blackbird
Northern harrier
Black-shouldered kite
San Bernardino and Stephens' kangaroo rats

The mountain lion and bobcat (and possibly coyote) would be expected to feel the loss of the Coal Canyon Biological Corridor first and most severely. After a 5 year study that included population viability modeling and intensive radio tracking, Beier concluded that Coal Canyon was the only viable linkage between the Santa Ana Mountains and the Puente-Chino Hills for mountain lions (cougars): "The Chino Hills cannot support a population of cougars if it were to become isolated (from the Santa Ana Mountains). Quite simply, if there is no corridor, then there will be no cougars in the Chino Hills" (Beier and Barrett 1993). The City of Anaheim similarly concluded, regarding a proposed urban development on the Saint Claire parcel (then the Hon Company parcel), that "[the project would] result in the loss of potential for a cougar population to occur in the Chino Hills." Beier (1993) also concluded that the cougar population in the Santa Ana Mountains was so small that the additional habitat provided by a linkage to the Chino Hills would enhance the prospect for survival of mountain lions in the Santa Ana Mountains. Conversely, loss of the Puente-Chino Hills, eight percent of the total mountain range, could "push the cougar

population to the steeply rising part of the extinction curve."

Of the 3 carnivores, coyotes are so adaptable that urbanization of the corridor might not entirely preclude immigration (McClure, Smith and Shaw 1996). With an estimated carrying capacity of 60 adults, the Puente-Chino Hills might maintain a coyote population even if isolated. However, after isolation (especially if high-density urban development encircles the Puente-Chino Hills) the coyote population might decrease so that it would be less effective in controlling smaller predators. If large carnivores were to become extinct or significantly reduced in the Puente-Chino Hills, mesopredator release would follow, with profound impacts on bird communities (Soulé et al. 1988).

The Coal Canyon Biological Corridor is the only route available for transport of plant seeds that depend on mammals for their dispersal. The corridor, by providing stepping stones of suitable habitat for birds, will also facilitate seed dispersal by birds. Dispersal of seeds by animals is an important ecological process. The seeds of over 60% of tree species in the temperate zone are dispersed by animals (Perry 1994), and 49 to 66% of woody shrubs and trees in scrublands produce seeds and fruits that are dispersed by animals (Herrera 1984). In a review of recent literature, Fleming and Sosa (1994) conclude that mammals are important in pollination and seed dispersal of plants, but that "the population and genetic benefits of such dispersal are just beginning to be investigated." Although we cannot assign an extinction risk to any plant species due to loss of this corridor, clearly Coal Canyon represents our last best chance to maintain this connectivity.

Although we have stressed the value of the Coal Canyon Biological Corridor in terms of its context, not its content, the 2 parcels contain significant biological resources, including two federally listed species (the California gnatcatcher, and Braunton's Milk-vetch), a rare and 75%-extirpated plant community (Riversidian alluvial sage scrub), and 20 acres of Tecate cypress. With restoration, the endangered least Bell's vireos also might occupy the site. However, the most important value of the land is in providing a biological linkage between two large and critically important wildland areas. The value of the acquisition is far greater than the net acreage and its on-site resources.

Social and Economic Benefits

While the primary goal of this paper is to evaluate the biological significance of the Coal Canyon Corridor, we would be remiss not to address the socio-economic importance of these two major open spaces and the linkage connecting them.

Access to nature is an important amenity for many cities. Indeed, communities throughout the U.S., Europe, and elsewhere are increasingly recognizing the importance of integrating conservation considerations into metropolitan planning (Shaw et al. 1992, Barker 1997).

Many Americans place a high value on access to wildlife near their homes (Shaw et al. 1985, Harris and Shaw 1997). The importance of wildlife viewing opportunities is well evidenced in a recent national survey conducted by the U.S. Fish and Wildlife Service (1996) which found that nationally, 60.8 million Americans 16 years and older participated in some form of wildlife watching or enjoyment near their homes in 1996. This amounts to about 30% of total U. S. population 16 years or older.

Fortunately, conservation planning in metropolitan environments is frequently synonymous with good urban planning when a long term perspective is taken (Porter 1997.) In addition to providing a critical refuge for the region's indigenous biota, the Puente-Chino Hills and Santa Ana Mountains perform a host of functions that enhance the quality of the area as living space for humans. These benefits include watershed protection, air quality enhancement, scenic beauty, outdoor educational opportunities and recreational open space.

Of these benefits, opportunities for environmental education and nature-oriented recreational experiences are tied to the Coal Corridor in two ways. As explained in previous sections of this report, a functional biological linkage is critical for maintaining the communities of native plants and animals found on these lands. This biodiversity is one of the features that makes this area attractive for participants in outdoor educational and recreational activities. The linkage is essential for maintaining the full potential of these lands for outdoor recreation because in addition to its functions as a biological linkage, the corridor would make possible a trail connecting these two important natural areas. If uses of the underpass are limited to carefully managed, non-motorized activities such as hiking, mountain biking, and equestrian uses, this trail connection should be largely compatible with the biological functions of the corridor.

With this linkage, outdoor enthusiasts could hike, or ride mountain bikes or horses from Tonner Canyon in Los Angeles County, continue through San Bernardino County (Chino Hills) and cross via the corridor into Orange and Riverside Counties, continuing on to San Diego County. Along the way, they would experience rare endemic plant communities that include the walnut groves of Tonner Canyon and Chino Hills State Park (totally absent south of the Santa Ana River), southern California's last remaining large grasslands in the Chino Hills, the rare groves of Tecate Cypress in the northern Santa Anas, endemic conifers such as big-cone Douglas-fir and knobcone pine in the central Santa Anas, stands of pure coastal sage scrub in Orange County, and the largest remaining Engelmann Oak woodlands and vernal pools of the Santa Rosa Plateau. These wildlands also include San Mateo Creek, the only 100% wild watershed with a perennial stream between Santa

Barbara and Mexico. Indeed, this region contains greater diversity of vegetation types than any other area of comparable size in the entire United States. Future generations of hikers and equestrians should be able to experience this *world-class* treasure of biological diversity as an unbroken chain. The only paved roads one would cross in this 5-county trip would be Carbon Canyon Road, the Riverside Freeway, and the Ortega Highway.

The Puente-Chino Hills/Santa Ana Mountains complex comprise an archipelago of natural open space thrust into one of the world's largest metropolitan areas. As such, their value for biodiversity conservation, environmental education, outdoor recreation, and scenic beauty are immense. Furthermore, this contiguous chain of natural open space could form the foundation of a comprehensive interconnected system of natural space. throughout Southern California. In the interest of environmental quality, many cities are investing huge amounts to restore habitat linkages and provide a scenic network of natural open spaces within the urban matrix. Although it may seem far-fetched to many, it is not unrealistic to envision a future system of natural and restored opens spaces that connects the Puente-Chino Hills/Santa Ana Mountains with the San Gabriel and Santa Monica Hills through restored habitat linkages. The chances of realizing this vision however, are significantly lessened if the Coal Canyon Corridor is not protected and habitat fragmentation continues.

Conclusion

Coal Canyon clearly represents the last viable opportunity to maintain and enhance a critical ecological linkage between the Puente-Chino Hills and the Santa Ana Mountains. These two areas are naturally connected; indeed, they are fundamentally one ecological system. It is only the very recent, intensive, and unsustainable activities of humans in this region that threaten to sever this natural connection. If such a severance is allowed to proceed, the biological, ecological, educational, recreational, and spiritual impacts will be substantial. We have reviewed some of the expected consequences of severing the Coal Canyon corridor in this report. Suffice it to say that both humans and nonhuman species in the region will be worse off. Some species may become locally or regionally extinct.

Fortunately, the opportunity remains to not only protect this natural linkage, but to improve it dramatically. We strongly urge that the State of California purchase the properties involved and proceed with restoration of the underpass area to natural vegetation. It must be understood that the value of Coal Canyon and the proposal to acquire and restore a habitat corridor here extend well beyond the local area and the southern California region. As reviewed at the outset of this report, this region is of global significance in terms of its biodiversity. Moreover, restoring a natural linkage in what is now a roaded underpass would set a global precedent. We are aware of no other restored biological corridor of this type

and scale. Conservation-minded citizens throughout the world could look to Coal Canyon as an inspiring example of how an ecological error was corrected through thoughtful public action. It will be money well spent.

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