TWS 2007 Keynote Address

COUGARS, CONNECTIVITY, & MISSING LINKAGES: TWO DECADES OF EXPANDING VISION & PARTNERSHIPS

PAUL BEIER[1], Northern Arizona University, Flagstaff AZ 86011-5018, 928-523-9341

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Today I will summarize my experience conserving wildlife corridors. My experience began almost 20 years ago in 1988, when I started a 5-year study of mountain lions (*Puma concolor*) in Southern California. During those 5 years, I learned some lessons about the importance of corridors for mountain lions. I learned that southern California still had magnificent wildlands and I became passionate about conserving those wildlands and their mountain lion populations. In the first few minutes of today's talk, I will summarize the main results of that research on mountain lions. I've spent the last 15 years after that project trying to apply those scientific lessons to conservation. I'll spend most of this talk describing the lessons I learned about applying science to conservation.

It is daunting to be asked to deliver a Keynote Address when the program theme is "Thinking like a mountain." I can't yet think like a mountain in the sense Aldo Leopold meant, but over 20 years filled with many mistakes and a few good ideas, I believe I am getting closer to that ideal.

I hope that by listening to my story, you can avoid some of my mistakes and learn these lessons faster than I did. I'll tell you right now what the lessons are:

Work for a positive vision, not just to fight bad projects.

You cannot be a leader by asking people to follow you. You can lead ONLY by serving and working as part of a team. For a scientist, one of the hardest parts of this teamwork is to let the entire team participate in everything – even in scientific issues where you are supposedly the expert.

Corridors must be designed to serve all native focal species. Although I love mountain lions and large carnivores, if they are used as the sole focal species for conservation planning, they can have a NEGATIVE umbrella effect.

Conservation of corridors is not just about getting animals across the road, and it is not just about conserving land; it is about both of these, and regulating land use, and managing edge effects, and educating people, and engaging private landowners as stewards.

In other words, conserving corridors requires us to think like a mountain in that we must be open and expansive in terms of who we work with, what species we conserve, and what issues we address.

MOUNTAIN LION STUDY, SANTA ANA MOUNTAIN RANGE, 1988-1992

In 5 years of full time field work, I have learned 2 facts about mountain lions and wildlife corridors:

1) Every mountain range in southern California will lose its mountain lion population if it becomes isolated by freeways and urbanization. Each mountain range can retain its mountain lion population if it remains connected to adjacent populations. The Santa Ana Mountains, the San Jacintos, the San Bernardinos, the San Gabriels, and the Santa Monicas are each too small to sustain a cougar population on their own (Beier and Barrett 1993, Beier 1993, Beier 1996). In this landscape, if connectivity will be maintained at all, it will occur only via corridors or linkages through urban and agricultural areas.

2) Radio-tagged juvenile mountain lions were amazingly successful in finding and using the 3 corridors through urban landscapes in my study area (Beier 1995). Because these 3 corridors were simply shards of habitat that had escaped development, rather than deliberately designed wildlife corridors, it was obvious that cougars (and probably other animals) would readily use corridors that were deliberately designed to serve them. Because 2 of these corridors will come up again in this story, I will list them now. The first was Coal Canyon, the last wildland linkage between the Santa Ana Mountains (south of SR-91) and their smaller neighbor to the north, the Chino Hills. The second was the connection from the Santa Ana Mountains to the Palomar Mountains, which was the only larger neighboring wildland. The Santa Ana-Palomar Linkage roughly followed the Riverside-San Diego county line, sandwiched between an expanding Temecula on the north and expanding communities of Fallbrook and Rainbow, and avocado ranchettes on the south.

These 2 discoveries were exciting. I spent the next 15 years, continuing through today, trying to turn these scientific findings into conservation action. I will describe lessons learned in this effort in more-or-less

[1]paul.beier@nau.edu

chronological order. Although I listed only 4 lessons at the start of this talk, there will be several more headings below, reflecting the fact that I had to learn some lessons a second time in a slightly different form. I suspect I will keep learning the same lessons again and again, each time getting a bit closer to making them a part of who I am, until eventually I stop thinking of them as rules at all.

WORK FOR POSITIVE VISION, NOT AGAINST BAD VISIONS

For 7 years I wrote comment letters on environmental reviews of projects that would sever connectivity. I won some and lost some. In 1991, I was a plaintiff in a lawsuit against the City of Anaheim over the city's approval of 1,500 new homes in Coal Canyon, the sole corridor between the Santa Ana Mountains and the Chino Hills. Coal Canyon had one residence at the time. My lawsuit bought some time, and that development is dead now. I was also a plaintiff against the Transportation Corridor Authority over the Foothill South Toll Road, a 20-km abomination through an area with zero human residences and a state park. Sixteen years later, the Foothill South Toll Road is still being planned, and hundreds of homes have been built along its route, but no pavement has been poured yet. These comments and lawsuits had to be done, but they were not fun. Worse yet, usually even when I 'won' a battle, I often merely caused a delay or helped scale back a project. The landscape almost invariably was more fragmented when the battle was over. Maybe not as bad as it would have been if conservationists had been silent, but defensive actions became a one-way ratchet that sometimes stopped bad actions, sometimes allowed a marginal loss of connectivity, but never created a permanently protected corridor. Every time the loaf of bread was re-sliced, conservation's part a loaf remained at best the same size.

The first breakthrough came after 7 years. In 1998-1999, I was one of 15 conservation biologists who developed the South Coast Regional Report (Hunter et al. 1999). It depicted the major public wildlands of the region, and 10 circles indicating areas critical to connecting these public investments. Instead of gasping at maps of the latest development that would sever connectivity, we created a map reflecting our positive, loving vision for the land. I was so excited that my hand trembled when I was first asked to help draw lines on the map. This was a turning point. As I will describe momentarily, the turning point from reactive to proactive was not sufficient, but nonetheless it was critically important. If, as a result of this talk, one or two people here take fewer than 7 years to move from fighting against threats to fighting for a positive vision, this talk was worth my time.

BE RADICALLY COLLABORATIVE - I: START COLLABORATING FROM THE VERY FIRST STEP OF IDENTIFYING AREAS WHERE LINKAGES ARE AT RISK

I admire all the people who worked on the South Coast Regional Report. I still get warm fuzzy feelings about them, our workshop, and the lesson I learned from the experience, but ultimately the Report was a fine positive vision that landed with a dull thud and has collected dust since its release in spring 1999. The problem was not with its vision, but with the narrow authorship. The authors were a bunch of scientific conservationists like me trying to tell the good people in the U.S. Forest Service, the California Department of Fish and Game, and other agencies what they needed to do. Some of these folks were sympathetic, but they had a hard time selling it up the chain of command because some of their bosses felt their agency was doing a fine job of pursuing its mission without having me tell them what their mission was, thank you. It is pointless for me to whine that we were offering helpful advice, or that the agencies should have been grateful. I needed to be collaborative from the very first step of the process. That really meant inviting everyone to attack the problem of increasing isolation of wildlands, and to *radically* trust them to do so. Instead of asking them to "trust me – I'm a scientist," I had to say "I trust you and promise to work towards whatever solution we come up with together."

So on November 2, 2000, we did just that. (In a paper advocating radical collaboration, it seems wrong to highlight individual people, but I simply must not let readers think the "we" is "me." The Missing Linkages workshop was organized by Kristeen Penrod. She also wrote the Missing Linkages report released 7 months later. She is one of the true heroes of this story.) We started over, this time collaboratively, to develop a positive vision for a connected landscape, this time for the entire state of California instead of the South Coast ecoregion. The Missing Linkages workshop at the San Diego Zoo had 6 co-sponsors: California State Parks, The Nature Conservancy, the U.S. Geological Survey, the San Diego Zoo, and the California Wilderness Coalition. More important, its 250 participants were mostly from the state and federal land agencies that manage wildlands and wildlife. All of these people had been growing increasingly concerned about the increasing isolation of the lands and populations they managed, and they were excited that they were being asked to help define the problem.

The statewide Missing Linkages report (Penrod et al. 2001), released on August 7, 2001, was first and foremost a map of 232 "potential linkages" within California or connecting California wildlands to those in neighboring states (U.S. and Mexican). On the release

date, almost every daily newspaper in the state of California had a front-page story on the release of the report. How did this report get so much more publicity than the South Coast Regional Report had garnered 2 years earlier? The key factor was that each newspaper could call the local National or State Park, National Forest, BLM office, or Game and Fish office and find someone who had been at the workshop and was eager to point out what local linkage was at risk, and what it meant to the readers of the paper. A group of scientists could never have pulled that off. The effort now has more than 25 partners, including scientific and educational agencies (Conservation Biology Institute, San Diego State University Field Station Programs, San Diego Zoo, U. S. Geological Survey), federal land management agencies (U.S. National Park Service, U.S. Forest Service, U.S. Marine Corps Base Camp Pendleton), state agencies (California State Parks, Department of Fish and Game, Resources Agency, Santa Monica Mountains Conservancy), and conservation non-governmental agencies (California State Parks Foundation, California Wilderness Coalition, The Nature Conservancy, The Wildlands Conservancy).

BE RADICALLY COLLABORATIVE - II: SCIENTISTS CANNOT LEAD BY ASKING OTHERS TO FOLLOW US. WE CAN ONLY LEAD BY SERVING

Of the 232 potential linkages identified in the Missing Linkages report, 69 were in the South Coast Ecoregion. In August 2001, 10 days after the release of the statewide Missing Linkages report, a nascent NGO (non-governmental agency) called South Coast Wildlands invited representatives from 12 major state, federal, and private conservation groups to a meeting to discuss how to repeat the Coal Canyon success story throughout the South Coast Ecoregion. Represented by its Executive Director, Kristeen Penrod, and one of its Science Advisors (me), South Coast Wildlands did not mention the fact that we had no budget, no office, and no legal status. Our miniscule size, as it turned out, became the foundation of our strength. We walked into the meeting prepared to negotiate anything, except the goal of conserving and restoring connectivity. We had a list of a dozen priority linkages and a proposed analytic approach, but they were all on the table. When our partners suggested we hold another workshop to identify the top priority linkage areas, we agreed! When they suggested changes to our approach and what each report should contain, we again agreed!

We walked out the door with $25,000 in pledges, which was soon followed by another $300,000. Within a few weeks, we held a prioritization workshop, which produced a list of 15 priority linkages that did not completely overlap our original list of 12 priorities. More important, at the prioritization workshop we let the partners determine the criteria and criteria weights that yielded the list of 15. We participated in the arguments, of course, but our only demand was that the criteria be applied uniformly to all potential linkages and that we could explain the criteria rationally. Over the next 5 years as we produced our 15 linkage designs, we met with partners every time there was an important issue to be resolved, including many scientific issues that scientists typically reserve for themselves. We held workshops to invite all interested persons to suggest focal species for our linkage designs. We held workshops to let partners weigh in on our GIS methods and our field methods. We radically believed that scientific issues can be explained in a way that conservation investors can understand and we trusted our partners to come up with good solutions, but our partners did better than good; in all cases the result was better than what we would have invented on our own. I no longer *believe* the motto of collaboration that "None of us is as smart as all of us," I now *know* that it is true.

If South Coast Wildlands had simply produced 15 linkage plans during 2002-2005, the plans would have attracted indifference, or perhaps some well-deserved criticism for their shortcoming, and then they would have gathered dust. In 2001, however, we asked all interested stakeholders "How can we help all of you identify and protect the most important wildlife linkages in southern California, and who else should be invited to this discussion?" The stakeholders became partners. They threw money at us. When our reports were complete, they rushed to implement them. Ironically, they gave us *more* authority than we asked for precisely *because* we never asked for it.

The upshot of all of this collaboration: Leadership is not about getting others to follow you. Leadership is offering to serve all the potential players interested in solving a difficult problem fairly and fully. If we started in the typical style of academic scientists ("How can I get these folks to fund my research or planning agenda?"), we would have failed. We insisted only on scientific rigor, consistency, and honesty, and we radically trusted our partners to set the agenda.

Many of you have probably experienced 'workshop burnout' and cringe at the idea of endless workshops. The key is to make sure that the goal of each workshop is clearly defined, and take time to explain what it is and what it isn't to every potential invitee. Not all stakeholders need or want to attend every workshop. In one paragraph, you can provide enough information to let each person decide whether to attend. If you can't say it in a

paragraph, your goal is not clearly defined. Some workshops will be large, others small, but each will have the right people engaged in the task at hand.

We also invited developers and their consulting biologists to some of our workshops. Developers only occasionally attended, and when they did, their participation consisted mostly of thoughtful listening rather than active contribution. Nonetheless our invitations demonstrated that our process was transparent, inclusive, and honest. I urge you not to worry about what you'll do if a developer wants to participate in conservation plans of this sort. You should just make it clear that you welcome input from anyone who wants to advance the scientific rigor of the conservation plan and its implementation. Developers are invariably polite and are not going to try to change your planning group into a development agency any more than you would ask them to become a conservation agency. They are people too and you've nothing to lose by treating them with courtesy and openness.

CONSIDER THE NEEDS OF THE ENTIRE BIOTIC COMMUNITY: NO SPECIES LEFT BEHIND

Apart from the efforts described herein, most published linkage plans were developed solely to serve the movement needs of large carnivores, or other single focal species. In contrast, each of the 15 linkage designs for the South Coast Ecoregion (you can read them all at www.scwildlands.org) was designed to serve the needs of 14 - 32 focal species. A total of 109 species were identified in all 15 linkages, including plants, invertebrates, amphibians, reptiles, fish, birds, and mammals. Mountain lions, mule deer (*Odocoileus hemionus*), and badgers (*Taxidea taxus*) were focal species in most linkages. Steelhead (*Oncorhynchus mykiss*), western pond turtle (*Actinemys marmorata*), and western toads (*Bufo boreas*) each appeared in the focal species lists for about half of the linkages.

Why did we include so many focal species? Our first reason was that our ultimate goal was to conserve natural patterns and mechanisms of community regulation, gene flow, pollination, seed-dispersal, interspecific interactions, energy flow, and nutrient cycling. We reasoned that conserving all the parts (species) was the first step. If we couldn't design for literally *every* species, we could at least select a large suite of species that met diverse criteria. For instance we selected area-sensitive species because they would be first to disappear when connectivity was lost. We selected top carnivores because they are an essential part of top-down regulation and the evolutionary environment for other species. We selected species most closely tied to each vegetation type in the linkage area because they most needed closely-interspersed patches of each vegetation type, and we selected species that were most sensitive to the threats (roads, fences, lighting, pollution, conflicts with residential pets or livestock) in the linkage area. We wanted a corridor that was as close as possible to a functioning ecosystem, not a narrow gauntlet through which a few individuals might pass with a bit of luck.

Because of my association with mountain lion research, people often assume that I am trying to promote "mountain lion corridors." Mountain lions were indeed regularly selected as a focal species because they are area-sensitive top carnivores. They can also be useful because they are sensitive to the secondary and tertiary effects of anticoagulant poisons: Sauvajot et al. (2006) reported that two mountain lions in southern California died from anticoagulant poisoning apparently acquired by preying on coyotes that had eaten poisoned rodents. Large carnivores also make great flagships for garnering public support. However, I strongly argue that mountain lions and other large carnivores should never be the sole focus of a linkage planning effort. First, many large carnivores are habitat generalists, and able to move long distances in a short period of time. A mountain lion or bear could move through a corridor that would never be useful to a habitat specialist such as a tree squirrel. Perhaps more importantly, successful implementation of a single-species "carnivore corridor" could have a *negative* umbrella effect because land use planners and conservation investors will become less receptive to subsequent proposals to provide corridors for less charismatic species. Large carnivores best serve biodiversity if they are part of a large group of focal species. Finally, some of the people who live in a linkage area may perceive large carnivores as a threat to human safety and property. Such persons can be more productively engaged as allies by de-emphasizing large carnivores, and emphasizing the importance of the linkage to other species.

CONSERVING A LINKAGE REQUIRES A COMPREHENSIVE PLAN - I: THE PLAN REDUCES THE RISK THAT A CONSERVATION PARTNER GETS STUCK WITH A WORTHLESS INVESTMENT

During November 2000, the very month of the statewide Missing Linkages workshop, another event illustrated the power of a coordinated and comprehensive plan. The Coal Canyon corridor was conserved! Various conservation donors, lead by the State of California, gave $40M dollars to buy the private lands, including the property slated for the infamous 1,500-home Cypress Canyon (appropriately named for the threatened endemic Tecate Cypress it would have put at risk). At the same time, CalTrans promised to relinquish the freeway interchange at Coal Canyon and convert it into a wildlife underpass. (The true heroes of Coal Canyon are:

Claire Schotterbeck of Hills for Everyone, Geary Hund and Rick Rayburn of California State Parks, and Gordon Ruser and Connie Spenger of Friends of Tecate Cypress.) Of course these two actions were no coincidence: they happened together because of a plan. Conservation investors would have been idiots to buy the land if the 10-lane Riverside Freeway (SR-91) prevented wildlife movement between the Santa Anas and the Chino Hills. CalTrans would have been similarly foolish to make the freeway permeable if 1,500 homes were built adjacent to their new wildlife crossing structure. Quite rationally, each partner was loath to take the first step on their own. It was essential to have a plan that specified what each partner would do, so each party could be reassured that they would not end up with a meaningless investment. We can debate whether a cup with 50% of its maximum capacity for liquid is half-empty or half-full, but 50% of a corridor, or even 80% of a corridor, is no corridor at all. It took years of negotiations before everyone agreed "I'll do my part if everybody else does theirs."

I believe and hope that Coal Canyon has built so much confidence among Southern California's linkage partners that they can trust each other without needing the years of negotiation involved in the Coal Canyon agreements. Most other corridors in Southern California involve many more acres in more parcels and crossed by more miles of highways than we had in Coal Canyon. In these other threatened linkages, we'll have to rely primarily on zoning and easements and development agreements, rather than outright purchase. In some cases, we'll have to engage people living in the linkage area as co-stewards. In these cases, it will be impossible to hammer out all the agreements ahead of time. Even if (as I hope) conserving California's other linkages does not require complex signed agreements, a comprehensive plan will be essential for conserving every linkage. It provides each stakeholder with the big target and allows each stakeholder to determine how they can contribute to conservation of the linkage.

CONSERVING A LINKAGE REQUIRES A COMPREHENSIVE PLAN - II: THE PLAN MUST INCLUDE ALL RELEVANT STRATEGIES

Like other most published linkage designs, one of the main products of each of the 15 linkage designs for the South Coast Ecoregion is a map highlighting lands in need of conservation. Such maps are a huge improvement over the vague arrows or polygons on a statewide or regional "missing linkages" map. The map is a critically important part of a linkage conservation plan, but it is not the whole plan. In developing our 15 linkage plans, we visited each linkage area to assess how it was impacted by urbanization, roads, border security, livestock operations, and other conditions that might affect utility of the linkage. We occasionally found surprises. For instance, a mapped oil refinery seemed to block one potential linkage, but we found it abandoned and posted for sale. In another case, mapped riparian vegetation proved to be dominated by invasive exotic plants. Accordingly, our reports identify locations for new or improved crossing structures across roads. Our plans also include recommendations for highway, residential, and livestock fencing, for managing outdoor recreation, lighting, livestock husbandry, pet control, and invasive species.

Perhaps most importantly, our reports include suggestions to engage human residents in a linkage as stewards of the linkage. In some of the linkages, we found trophy homes, new 10-acre ranchettes, or sprawling rural sites consisting of an old home surrounded by old and new vehicles, trailers, and piles of moved earth. Each landowner is living out his version of a rural lifestyle, and cannot be expected to move away because the area is now recognized as an important linkage. There is no reason they cannot be engaged as proud stewards of the linkage, though. Few if any rural residents include hostility to wildlife as part of their vision of their dream home. Coercive measures are unlikely to be successful, but collaborative measures should be effective, just as they were in other aspects of linkage design. Inexpensive steps include directing artificial night lighting toward structures and away from wildlands, bringing in livestock and pets at night, creating wildlife-friendly fences, and promoting natural vegetation outside of fire-safe zones. Our plans do not provide a complete blueprint for engaging landowners, which will require sustained efforts to tell people why the linkage is important and to provide information on how they can voluntarily help.

CONSERVING A LINKAGE REQUIRES A COMPREHENSIVE PLAN - III: DO NOT JUST *MITIGATE* – AIM TO *IMPROVE* CONNECTIVITY

In some parts of California or the United States where connectivity is largely intact, conserving a linkage may simple be a matter of retaining a significant portion of what currently exists, but most linkages in the South Coast Ecoregion are highly degraded and require a bolder vision. Nowhere is this more evident than in the case of highways. All 15 linkages were traversed by major highways, none of which had sufficient numbers of high-quality crossing structures for wildlife. We made bold recommendations for construction of new wildlife crossing structures. In several cases, we recommended vegetated wildlife overcrossings, similar to the famous structures in Banff National Park in Canada. For example, we recommended vegetated overcrossings on SR-118 between the Simi Hills and the Santa Susana

mountains, along I-15 south of Temecula, and on SR-58 just south of Morongo Valley. CalTrans is actively planning such a structure on SR-118.

We accept that the transportation agencies will not make these improvements immediately, and that they will not undertake these efforts as stand-alone projects to benefit wildlife. Instead these major changes will be implemented when they next add lanes or otherwise upgrade the relevant freeway segments. Often this will require waiting a decade or more, but the final result will be a highway and landscape that are more permeable to wildlife than what we have today.

RECAP OF THE MAIN LESSONS

1) Conserving connectivity cannot be done solely by fighting against fragmentation. Although bad projects must be fought, success is possible only if we are fighting *for* a vision of a connected landscape.

2) We must partner with anybody interested in sharing our goal, from the very outset of the effort. Leadership is not about getting other people to follow you, it is about inviting all the players to sit down and think about how to solve very difficult problems in as fair and honest a way as possible.

3) Corridor designs must address a diverse set of focal species; not just mountain lions and bighorn, but a diverse group of focal species that collectively represent the entire biotic community. Carnivores can have a 'negative umbrella effect' if they are used as the sole focal species for corridor design.

4) Corridor designs must address all issues. Except in rare cases, a plan to conserve a corridor is not just about "getting the animal across the road." It is also not just about conserving land. Although these two issues are paramount, the plan must also address zoning, management of artificial night lighting and livestock, and how people living in the corridor will be engaged as stewards.

5) Corridor designs must aim beyond mitigation. The goal is not to slow down the rate at which things get worse, but to produce a landscape that is more permeable than today's landscape.

A FEW FINAL WORDS

Please read the Acknowledgments section. My keynote address is based on personal reflections regarding activities in which many persons served as my teachers. The main themes of this paper were developed in more scientific detail, and with less emotion, in two papers: Beier et al. (2006) described the South Coast Missing Linkages effort in detail and Beier et al. (2008) discussed 15 important decisions and assumptions in designing corridors and linkages, with special emphasis on GIS procedures. When writing this essay, I came across an important paper by Knight et al. (2006) that makes many of the same points and provides additional insight into collaboration conservation planning.

Our 15 plans are still plans: none of them have been fully implemented. However, many encouraging developments are occurring. For example, Marine Corps Base Camp Pendleton is taking a leading role in protect the western third of the Santa Ana-Palomar linkage using federal funds earmarked for reducing urban encroachment on military bases. The Northern San Diego County Multiple Species Habitat Conservation Plan (MSHCP) has given conservation priority to over 90% of the San Diego county portion of this linkage. The proposed reserve system for the Western Riverside County MSHCP has also incorporated some of our recommendations in this linkage.

The role of science is not ending with release of our reports. During implementation, partners translate the Linkage Design into priority parcels for conservation action, take appropriate conservation measures, and discuss the biological and economic tradeoffs of omitting specific parcels from the conservation plan. They may decide to allow development on a few key parcels in the Linkage Design, and will have to choose whether easements, purchase, or zoning would be the most appropriate tool for conserving the linkage value of a particular parcel. Decision-makers will need scientific input on the likely consequences of many of these proposed compromises. Although conservation scientists are uncomfortable discussing departures from an optimal solution, we must realize that these decisions are better made with our input than without it. A new set of GIS tools in CorridorDesigner software (being developed by my lab) will provide stakeholders with meaningful ways to evaluate how various alternatives will meet the needs of each focal species. However, this software tool is no substitute for the sustained involvement of passionate scientists with a deep commitment to interactive, collaborative analyses.

Despite its infamous traffic jams, Southern California has a human infrastructure without equal on the planet. People, water, information, electric power, natural gas, automobiles, and trains move across this landscape with remarkable efficiency. The region is also a global hotspot of biodiversity, and still has large wildlands in which most ecosystem processes are relatively intact. Working with many others, I have spent 20 years trying to create a green infrastructure that is commensurate with these other types of infrastructure. Many of you are engaged in similarly ambitious conservation plans. We have much to learn from each other, and I hope my experiences contribute in some way to making you more effective in advancing your conservation vision.

ACKNOWLEDGMENTS

The southern California linkage designs are available at www.scwildlands.org. An ArcGIS Toolbox with many of these GIS procedures, parameterized models for about 25 species (limited to vegetation types occurring in Arizona), and tools to compare alternative linkage polygons, are available free at www.corridordesign.org. The designs produced by South Coast Wildlands were supported by The Wildlands Conservancy, Resources Legacy Fund Foundation, The California Resources Agency, U.S. Forest Service, The Nature Conservancy, California State Parks, U.S. National Park Service, Santa Monica Mountains Conservancy, Conservation Biology Institute, San Diego State University Field Stations, Southern California Wetlands Recovery Project, Mountain Lion Foundation, California State Parks Foundation, Environment Now, Anza Borrego Foundation, Summerlee Foundation, Zoological Society of San Diego, and South Coast Wildlands. The South Coast Wildlands approach was developed by C. Cabañero, K. Daly, C. Luke, K. Penrod, E. Rubin, Wayne Spencer, and me. The Arizona Missing Linkages Project was supported by Arizona Game and Fish Department, Arizona Department of Transportation, U.S. Fish and Wildlife Service, U.S. Forest Service, Federal Highway Administration, U.S. Bureau of Land Management, Wildlands Project, and Northern Arizona University. My teachers include A. Atkinson, T. Bayless, C. Cabañero, L. Chattin, M. Clark, K. Crooks, K. Daly, B. Dickson, R. Fisher, E. Garding, M. Glickfeld, N. Haddad, J. Jenness, S. Loe, T. Longcore, C. Luke, L. Lyren, B. McRae, S. Morrison, S. Newell, R. Noss, K. Penrod, E. J. Remson, S. Riley, E. Rubin, R. Sauvajot, D. Silver, J. Stallcup, M. White, and many others. It has been an honor and a joy to work with all of these fine people and organizations.

LITERATURE CITED

Beier, P., D. R. Majka, and W. D. Spencer. 2008. Forks in the road: choices in GIS procedures for designing wildlife linkages. Conservation Biology. In Press.

Beier, P., K. Penrod, C. Luke, W. D. Spencer, and C. Cabañero. 2006. South Coast Missing Linkages: restoring connectivity to wildlands in the largest metropolitan area in the United States. Pages 555-586 *in* KR. Crooks and MA Sanjayan, editors, Connectivity Conservation, Cambridge University Press.

Beier, P. 1993. Determining minimum habitat areas and corridors for cougars. Conservation Biology 7:94-108.

Beier, P. 1995. Dispersal of juvenile cougars in fragmented habitat. Journal of Wildlife Management 59:228-237.

Beier, P. 1996. Metapopulation modeling, tenacious tracking, and cougar conservation. Pages 293-323 *in* D. R. McCullough, ed., Metapopulations and Wildlife Management. Island Press.

Beier, P. and R. H. Barrett. 1993. The cougar in the Santa Ana Mountain range. Final Report, Orange County Cooperative Mountain Lion Study, Department of Forestry and Resource Management, University of California, Berkeley.

Hunter, R. 1999. South Coast regional report: California Wildlands Project vision for wild California. California Wilderness Coalition, Davis, California.

Knight, A. T., A. Driver, R. M. Cowling, and 13 others. 2006. Designing systematic conservation assessments that promote effective implementation: best practice from South Africa. Conservation Biology 20:739-750.

Penrod, K. L., R. Hunter, and M. Merrifield. 2001. Missing Linkages: restoring connectivity to the California landscape. California Wilderness Coalition, The Nature Conservancy, US Geological Survey, Center for Reproduction of Endangered Species, and California State Parks.

Sauvajot, R. M., P. Beier, and S. P. D. Riley. 2006. Mountain lions in fragmented, urban landscapes: experiences from southern California. Abstract, 2006 Annual Meeting of The Wildlife Society.