

Combining Landscape-Level Conservation Planning and Biodiversity Offset Programs: A Case Study

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Abstract Habitat loss is major factor in the endangerment and extinction of species around the world. One promising strategy to balance continued habitat loss and biodiversity conservation is that of biodiversity offsets. However, a major concern with offset programs is their consistency with landscape-level conservation goals. While merging offset polices and landscape-level conservation planning is thought to provide advantages over a traditional disconnected approach, few such landscape-level conservation-offset plans have been designed and implemented, so the effectiveness of such a strategy remains uncertain. In this study, we quantitatively assess the conservation impact of combining landscape-level conservation planning and biodiversity offset programs by comparing regions of San Diego County, USA with the combined approach to regions with only an offset program. This comparison is generally very difficult due to a variety of complicating factors. We overcome these complications and quantify the benefits to rare and threatened species of implementing a combined approach by assessing the amount of each species' predicted distribution, and the number of documented locations, conserved in comparison to the same metric for areas with an offset policy alone. We found that adoption of the combined approach has increased conservation for many rare species, often 5–10 times more than in the comparison area, and that conservation has been focused in the areas most important for these species. The level of conservation achieved reduces uncertainty that these species will persist in the region into the future. This San Diego County example demonstrates the potential benefits

of combining landscape-level conservation planning and biodiversity offset programs.

Keywords Biodiversity · Biodiversity offsets · Conservation planning · Conservation policy · Covered species · Endangered species · Habitat conservation plans · Mitigation

Introduction

In the face of habitat loss, overexploitation, climate change, and political meddling the plight of endangered and sensitive species has often been characterized as bleak. Habitat loss in particular has been identified as a major contributor to the decline of species worldwide (Wilcove and others 1998; Myers and others 2000; Stuart and others 2004; Schipper and others 2008). Globally, various conservation strategies exist or have been proposed to balance human impacts with the goal of biodiversity conservation. One strategy that is increasingly gaining popularity is that of biodiversity offsets (ten Kate and others 2004; Burgin 2008; Norton 2009; McKenney and Kiesecker 2010). Biodiversity offsets have been defined as “conservation activities intended to compensate for the residual, unavoidable harm to biodiversity caused by development projects” (ten Kate and others 2004). Offset programs generally require avoidance and minimization measures prior to allowing offsets and are implemented on a project by project basis (Kiesecker and others 2009). Biodiversity offset policies have been implemented or are being developed in a number of countries including Brazil, the United States, Australia, South Africa, the United Kingdom, Sweden, Columbia, New Zealand and the Netherlands (ten Kate and others 2004; Norton 2009; McKenney

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and Kiesecker 2010). Offset programs can help industry, government, and conservation groups meet their desired goals (ten Kate and others 2004; Kiesecker and others 2009). Although a variety of potential benefits are possible, challenges exist when developing and implementing these policies (Burgin 2008; Norton 2009; McKenney and Kiesecker 2010). A key concern with offset programs is ensuring that the offsets are consistent with landscape-level conservation goals (Kiesecker and others 2009). Landscape-level conservation goals are often a product of conservation planning efforts. To develop landscape-level conservation plans, specific conservation goals are identified for species, vegetation communities, or ecological processes of concern. Conservation goals may include locations of importance, a number of populations to protect, total occupied area to conserve, a combination of these, or other similar metrics. These goals can then be used to systematically identify a set of areas that if preserved would meet the identified conservation goals (Margules and Pressey 2000). Offset programs in the absence of such broader conservation plans and goals may not sufficiently maintain biodiversity in an area (Kiesecker and others 2009). Blending offset policies and with these landscape-level conservation planning efforts is believed to provide advantages over the traditional offset approach of project by project assessment. The landscape-level conservation-offset combination can provide the advantage of assessing the cumulative impacts of current and future projects and providing a regional context to guide mitigation and avoidance (Kiesecker and others 2009). While such a combined method has been championed as an important component of developing biodiversity offset programs (Kiesecker and others 2009; McKenney and Kiesecker 2010), few such landscape-level conservation-offset plans have been designed and implemented, so the effectiveness of such a strategy remains uncertain. In this paper we assess the conservation effectiveness of a combined landscape-level conservation planning-offset approach by comparing the conservation results of this approach to those of a standard offset policy. We use data accumulated over a 10-year timeframe in which the County of San Diego had both a combined conservation-offset plan (Multiple Species Habitat Conservation Plan; County of San Diego 1997) and a more standard offset policy (Guidelines for Determining Significance; County of San Diego 2009) in different regions of the County. The combined landscape-level conservation plan and offset policy was the result of an effort to develop a multi-species Habitat Conservation Plan (HCP), intended to enhance conservation of endangered and sensitive species in the county while allowing for some habitat loss to occur. The same analysis also allows us to evaluate the conservation impact of implementing regional HCPs.

Habitat Conservation Plans

In the United States, the Endangered Species Act of 1973 (ESA) protects rare species by prohibiting take of species listed under the act, except under specific conditions. Until 1982, the ESA effectively prohibited almost any actions that might affect listed species. These strict prohibitions posed not only economic and political problems but ecological ones as well (Thomas 2001; Wilhere 2002). In an effort to improve the plight of endangered and sensitive species while still recognizing that impacts to their habitat are likely to occur, Section 10 of the ESA was amended in 1982 to allow for the “incidental take” of listed species by nonfederal entities provided that a Habitat Conservation Plan (HCP) was developed prior to the proposed impacts (USFWS and NMFS 1996). Incidental take is defined as take that is incidental to and not the purpose of an otherwise lawful action. Under the amendment to Section 10, a nonfederal entity’s actions which may affect endangered or threatened species can receive an incidental take permit, provided the action will not jeopardize the continued existence of the species.

Critiques commonly applied to the HCP program include: inadequate in aiding recovery of covered species (Audubon 1997; Shilling 1997); limited public participation (Audubon 1997; Hood 1998; Thomas 2001); no scientific foundation (Kareiva and others 1999; Harding and others 2001; Rahn and others 2006); insufficient funding (Audubon 1997; Hood 1998); lack of adaptive management (Kareiva and others 1999; Wilhere 2002); few permit holders requirements (Audubon 1997; Hood 1998); few benefits to covered species (Shilling 1997; Hood 1998) and flawed planning processes (Kareiva and others 1999; Morrison 2000; Harding and others 2001; Rahn and others 2006; Alagona and Pincetl 2008; Wilhere 2009). Many of the same critiques have also been expressed about biodiversity offset programs (Burgin 2008; Norton 2009; McKenney and Kiesecker 2010).

In effect, amending Section 10 created an offset policy for impacts to endangered, threatened, and rare species. The purpose of an HCP is to identify the appropriate conservation strategy that will minimize and mitigate for the incidental take of listed species caused by the action. Appropriate mitigation usually involves avoidance, minimization of impacts, and habitat preservation coupled with long-term management provided by an assured funding source. While the majority of HCPs developed have focused on impacts to a small area or a single species, in the last decade regional HCPs have also been developed to cover much larger areas and provide for the conservation of multiple species and their habitats (USFWS 2009). These large regional HCPs can serve as a case-study for the effectiveness of combining landscape-level conservation planning and offset programs.

San Diego County Multiple Species HCP: Combining Landscape-Level Conservation Planning and Biodiversity Offset Programs

Currently, few data exist that truly quantify the benefits of developing a combined landscape-level conservation plan and biodiversity offset program. One major reason that the impacts of such plans are difficult to quantify is that we cannot know how species would have been conserved if plans had not been developed. To answer this question one cannot simply compare the plan area to adjacent areas because different ownership, land use regulations, species, or planned uses can complicate any potential comparison. For these reasons, conservation plans, and HCPs in particular, vary widely in number of species covered, size of the planning area, proposals for mitigation of impacts, and the entities creating the plans (USFWS 2009). In the County of San Diego we find a unique set of conditions that allows for a rigorous analysis to be conducted that quantifies some of the conservation implications of implementing a landscape-level conservation-offset plan (and a regional HCP) as compared to maintaining a simpler biodiversity offset program.

San Diego County is home to many rare, threatened, and endangered species. On a national and global scale, the region has been identified as a major “hotspot” for biodiversity (Dobson and others 1997; Myers and others 2000). It is also one of the most rapidly growing regions in the country. This combination of high biodiversity, large numbers of rare and unique species, and rapid urbanization has led to conflicts between growth and biological conservation. Over the last several decades the County of San Diego has developed and implemented a biodiversity offset program to ensure that development does not cause the extirpation of rare and sensitive species or vegetation communities found in the County. The offset program requires avoidance and minimization, and when these are not feasible, offsets (commonly referred to as mitigation). While the program has been successful in protecting sensitive areas and species throughout the County, the current biodiversity offset program has resulted in a patchwork of fragmented conservation islands with little assurance of long-term ecological functionality or that these fragments will ever be integrated into a larger reserve system. This provides little certainty that landscape-level goals for species conservation can be met.

In the 1990s the County of San Diego initiated a Multiple Species Conservation Program for unincorporated areas of the county. The goal of this program was to develop comprehensive landscape-level conservation plans that would allow for appropriate conservation of biodiversity and continued growth within the County. Plans were to be developed as federal Habitat Conservation Plans

(HCP) and as California Natural Communities Conservation Plans (NCCP), which are conservation plans similar to HCPs but allow for impacts to species listed under the California Endangered Species Act (CESA) and are meant to be landscape-level conservation plans for biodiversity. One of the major goals of the program was to develop landscape-level conservation-offset plans to guide assembly of a large, ecologically functioning, interconnected system of reserves that allows for natural and evolutionary processes to be maintained. The County of San Diego uses directed biodiversity offsets to facilitate assembly of a portion of the reserve system.

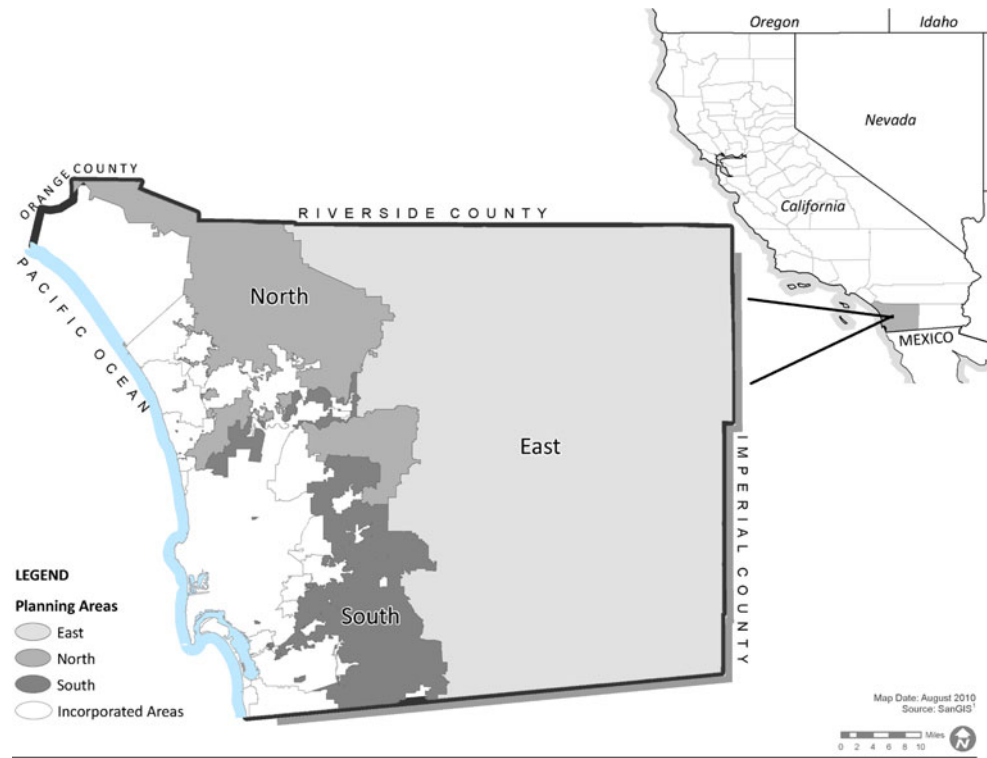
For purposes of conservation planning, private lands within the County of San Diego have been subdivided into three roughly equal-sized planning areas (Fig. 1). While the spatial extent of the planning areas varies, the amount of private land within the planning areas is similar (approximately 120,000 ha). For each planning area a draft landscape-level conservation-offset plan in the form of a multiple species HCP has been produced or is being developed. The plans are developed mainly to provide a conservation-offset strategy for private lands; however, connection to publicly owned natural lands is incorporated to ensure landscape-level functionality. For one of the three areas, the conservation-offset plan has been adopted and implemented for the last 10 years (County of San Diego 1997). Within the other two planning areas, the County’s biodiversity offset program remains in effect. The fact that species of concern are similar within each planning area and that the County retains the land use authority for all the private lands and can therefore determine uses permitted, allows for previously impossible comparisons to be made. Specifically, we can compare the level of conservation resulting from adoption of a landscape-level conservation-offset plan (regional HCP) to similar sized and regulated areas in geographic proximity where only offset requirements exist. This allows us to assess the conservation impacts of a combined landscape-level conservation-offset strategy and of developing regional multi-species HCPs.

Methods

Data

We collected information on conservation acquisitions and development/impacts to natural vegetation communities for the last 10-years (1998–2008) within the three planning areas (South, North, East) of the County of San Diego (Fig. 1). This timeframe corresponds to the first 10 years of the adopted HCP for the southern planning area. Ownership and land usage data are collected by the County and tracked in a GIS database. For this analysis we categorized

Fig. 1 Location of study site and planning areas, San Diego County, USA



conservation acquisitions as any land acquired in fee title or set aside via easement specifically for biological conservation. We categorized impacts as any development, clearing, or other alteration that transformed a natural vegetation community to a disturbed or developed state.

From the lists of species used in the conservation planning efforts, we selected 37 species intended to be covered under each HCP for our comparison. These 37 species were selected because they were the only species used in conservation planning, and proposed for coverage under an HCP in all three planning areas. This suite of species was comprised of 20 animal and 17 plant species, with 15 species listed as threatened or endangered under the ESA (federally listed species). These species cover a range of taxonomic groups (invertebrates, mammals, reptiles, amphibians, birds, and plants) and occur across the variety of vegetation communities found in the county (County of San Diego 1997). For each of the 37 covered species in our comparison, we assessed the quantity of the species' predicted distribution that had been protected by acquisitions or lost to development/habitat modification. We performed a similar assessment for species' documented observation records (identified pre-1998).

Predicted distributions for each species were developed as part of the conservation planning process. To map predicted distributions we used expert-based habitat suitability classifications (Boykin and others 2007). The predicted distribution for a species was identified as the areas where

all required attributes (land-cover type [e.g., vegetation community], elevation, slope, soils, and ecoregion units) co-occurred. For each species, we used the literature and species experts to identify the appropriate range of each attribute. Species observations were taken from the SanBIOS species database. Records for this database are entered by professional biologists from the County of San Diego as well as from various other agencies and firms. SanBIOS represent the most comprehensive and accurate database of observation records for San Diego County.

To assess the level of conservation afforded each covered species through a combined conservation-offset program, we compared the acquisitions and losses of predicted distribution and observation locations between the northern and southern planning areas. We excluded the eastern planning area from this comparison because the limited acquisitions and losses in this planning area did not coincide with the species distribution data. As mentioned before, the amount of private lands within each planning area of the County is similar in size. However, the area of predicted distribution and the total number of observation records varied by planning area. To normalize these data we assessed the percentage of the total predicted distribution or observation locations that had been protected/impacted as opposed to comparing actual amounts. Finally, between planning areas we compared the ratio of acquisition to loss for the predicted distribution of individual species. For each comparison, we used the

Wilcoxon-Signed ranks test to assess the significance in differences between area conserved or lost for each species.

Another measure to assess the effectiveness of the combined approach is the “quality” of conservation acquisitions. We defined quality acquisitions as those that contribute to the landscape-level conservation goals. For the combined approach to produce higher quality acquisitions, we would predict that hectare for hectare the conservation acquisitions in the southern planning area would contain a greater percentage of the predicted species’ distributions. To achieve this scaled comparison, we reduced the realized conservation acquisitions for the southern planning area to be proportionally the same as the northern planning area. We again used the Wilcoxon-Signed ranks test to assess the significance in differences between the percentages of predicted distribution conserved for each species under this scenario.

Results

The southern planning area with an adopted conservation-offset plan experienced nearly 5–10 times the conservation acquisitions (12,914 ha) of the northern (1,904 ha) and eastern (2,467 ha) planning areas. Loss of natural and semi-natural lands in the northern and southern planning areas has been nearly identical (approximately 3,950 ha). Implementation of the HCP in the southern planning area has led to a significantly higher level of conservation for many of the species of concern used in this analysis; including all federally listed species ($P < 0.01$ all species; $P < 0.03$ federally listed species).

In the area with the conservation-offset plan, greater than 20% of each species’ predicted habitat has been permanently conserved in the last 10 years for the majority of species (Fig. 2a). In the northern plan area, with only biodiversity offset policies, the vast majority of species experienced very little conservation (0–5%) of their predicted distribution (Fig. 2a). The same pattern held true for federally listed species (Fig. 2b).

Observation data were not available for all 37 species (north $n = 21$, south $n = 26$). In the southern planning area, greater than 75% of all observation points had been conserved for approximately half of the species analyzed. In the northern planning area this level of conservation was achieved for only one species (Fig. 3a). Again, greater conservation was also seen in the southern planning area for federally listed species (Fig. 3b; $P < 0.03$).

In meeting with the dual role of a conservation-offset program and HCP (biodiversity conservation and development), we found that covered species have experienced a significantly greater loss of their predicted distributions in the southern planning area ($P < 0.01$). However, for nearly

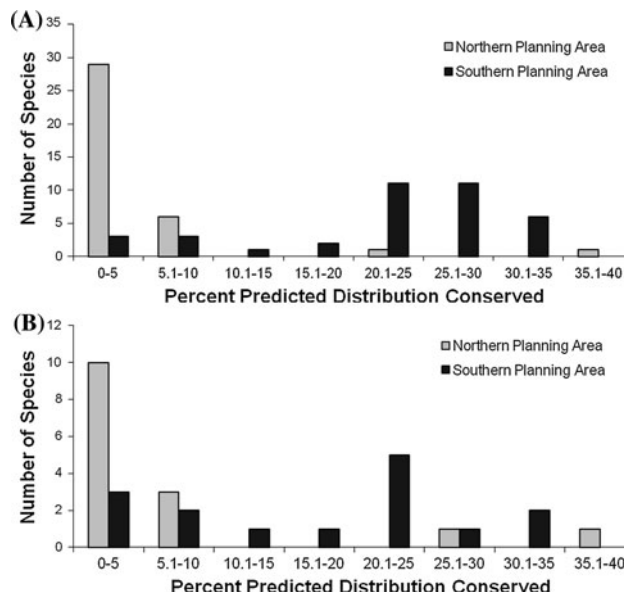


Fig. 2 Percentage of predicted distribution conserved for covered species. **a** All covered species ($n = 37$). **b** Federally listed endangered and threatened covered species ($n = 15$)

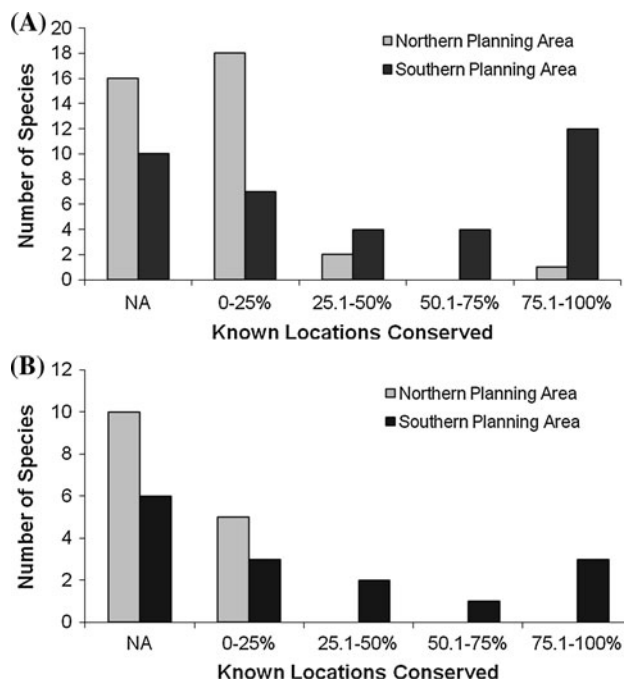


Fig. 3 Percentage of documented locations conserved for covered species. **a** All covered species ($n = 37$). **b** Federally listed endangered and threatened covered species ($n = 15$)

all species this represents less than 5% of their predicted distribution. Only two species in the northern planning area and four species in the southern planning area had lost more than 5% of their documented locations and no species had lost more than 13%.

The ratio of habitat protected to habitat impacted in northern planning area was approximately 1:2; almost twice as much habitat impacted as conserved. In the southern planning area this ratio was approximately 3:1 in favor of conservation. When we evaluated individual species, the same ratio varied widely. In the southern planning area, 31 of 37 species experienced greater conservation of their predicted distribution than loss, and for 25 of those species the ratio was at least 5:1 in favor of conservation. In the northern planning area, 28 of 37 species experienced greater conservation of their predicted distribution than loss, and for 21 of those species the ratio at least 5:1 in favor of conservation.

The total conservation acquisitions in the northern planning area were 15% of those in the southern planning area. When we proportionally reduced each species' conservation in the southern planning area to be 15% of the original, we found that 25 of the 37 species had a greater percentage of their predicted distribution conserved in the southern planning area than in the northern planning area; however, the difference was not statistically significant.

Discussion

Species-Specific Conservation

Our results show that significantly more conservation has occurred for almost all species of concern in the area with a combined conservation-offset plan. While we compared percentages to allow for normalization between planning areas, in many cases 5–10 times the predicted distribution and many more documented locations had been protected for species of concern in the southern planning area. This increased level of conservation has enhanced confidence that these endangered and sensitive species will persist in the southern planning area by decreasing uncertainty of future habitat loss. In addition, the increased conservation can be beneficial for all species as conservation acquisitions can result in the protection of many common species as well (Underwood and Casey unpublished). For example, we found almost all 252 avian species inhabiting the southern planning area have received conservation at or above the level of the covered species (Underwood and Casey unpublished).

Although not statistically significant, hectare for hectare comparisons of conservation acquisitions suggest that species of concern have benefited more from acquisitions that have occurred in the area where the landscape-level conservation-offset plan has been implemented. The lack of a more significant divergence in this metric is likely the result of similar minimization and avoidance protocols in the offset strategies of the two planning areas. Under these

offset policies, in locations proposed for development, conservation of areas that harbor sensitive species is expected regardless of planning area. We believe the reason acquisitions in the southern planning area have achieved greater conservation for the species of concern is that offsite acquisitions have been focused in areas identified by the landscape-level conservation plan as important to meet conservation goals for these species. In the northern planning area offsite conservation acquisitions associated with development impacts often occur wherever a similar vegetation community exists. These acquisitions may or may not contribute to an overall conservation strategy. The lack of acquisitions that contribute to an overall conservation plan in the northern planning area leads us to believe the small differences in quality of conservation acquisitions now apparent will increase as habitat modification and conservation acquisitions continue in the two planning areas.

For conservation practitioners, these results emphasize the importance of having a landscape-level conservation plan to guide development mitigation and conservation acquisitions. This is of particular importance in areas experiencing rapid urbanization. In San Diego County, the absence of landscape-level conservation plans in previous decades led to the conservation of species and vegetation communities in small fragments that now have little ecological viability because they have become surrounded by urbanization. Current landscape-level conservation plans in the county have attempted to remedy this problem by planning for an entire region and clearly identifying areas where offsets and conservation acquisitions should take place and where future development should be limited. To better protect species and ecological functionality, planners and practitioners should ensure that landscape-level conservation plans exist so that development and offset actions contribute towards long-term biodiversity conservation and do not prohibit it.

Achieving Landscape-Level Conservation Goals

In the southern planning area, significant progress has been made toward achieving landscape-level conservation goals. As part of the conservation planning process for each planning area, goals for species, vegetation communities, landscape-level connectivity, and ecological functionality were included. Successful achievement of the conservation goals in a planning area occurs when the entire reserve is assembled. To date the reserve in the southern planning area has been 60% amassed, but less than 20% has been assembled in the northern area. While we can evaluate our progress in meeting species-specific or vegetation community conservation goals, a more difficult assessment is whether or not connectivity and ecological functionality

goals are being met. Unfortunately, we will not be able to assess this component in a rigorous fashion until the remaining 40% of the reserve in the southern planning has been assembled, which includes many significant connections between blocks of existing reserve. Anecdotally, the conservation-offset plan in the southern planning area has resulted in reserves that are much larger, have less edge, and in certain areas are connected. Therefore, we believe it is likely that ecological functionality and connectivity are being maintained at least to some level in the southern planning area.

Our results show that achieving goals of connectivity and ecological functionality in an urbanizing area can be difficult. Although linkages between proposed core reserves have been identified, to date many more core areas have been conserved than linkages. Linkages have been difficult to assemble for a variety of reasons. Linkage areas are often surrounded by urbanization; this proximity to existing infrastructure has led to elevated land costs associated with greater development potential. This same development potential has led to reluctance by owners to sell linkage properties. Difficulty in assembling an entire linkage has also been rooted in the myriad of ownership within a single linkage. This contrasts with many of the core areas which have few owners and a remoteness which reduces development potential. One strategy to increase the certainty that linkages are assembled would be to prioritize acquisitions first to linkages, and then focus on assembling the large core areas. The danger with such an option is that by the time a linkage has been assembled the core habitat has been destroyed.

Differences in Total Conservation

In the northern and southern planning areas, the biodiversity offset programs are similar in terms of requirements. With comparable habitat loss one would expect that conservation in the two planning areas would be analogous. So why have 10 times the conservation acquisitions occurred in the southern planning area when the total area impacted has been roughly similar? The key to greater conservation appears to have been public and private sector commitment to the conservation-offset plan. Various public agencies were involved in developing the plan. Each agency obtained certain benefits from implementation of the plan that helped achieve their organization's mission. These benefits convinced the agencies to make commitments toward land acquisition and long-term implementation of the plan. Of the total acquisitions that public agencies promised to make, 75% have already been purchased. In addition, the non-governmental conservation organizations in the region have focused their acquisitions in the southern plan area because they perceive that those acquisitions

have an increased likelihood of long-term viability as they will be assimilated into a larger connected reserve system. Finally, the development industry has been supportive of the program because it allows for continued development in the least sensitive areas. In the southern planning area, biodiversity offsets as a result of development have assembled a noteworthy portion of the reserve. This combination of public and private commitment to implementing the plan has almost certainly been a major factor in achieving significantly more conservation in the southern planning area. Conservation in the northern planning area has not kept pace without commitments to a similar plan.

These findings demonstrate the importance of inclusive conservation planning. In San Diego County, success to date in assembling a regional reserve system has been achieved because development, government and conservation interests have all agreed to implement the regional conservation plan that was developed by all stakeholder mentioned. Landscape-level conservation plans are created by a variety of organizations. In San Diego County alone there are number of proposed landscape-level conservation plans (i.e., Conservation Biology Institute 2004; Penrod and others 2006; South Coast Wildlands 2008). However, few of these plans contain the mechanisms to acquire lands or otherwise implement the plan. While such plans can serve as useful guides for conservation, a lack of commitment to implement the plans by key players results in few ever being realized. The HCP model of providing incentives to the participants in return for a commitment to conservation actions appears to be an effective approach to ensure that landscape-level conservation plans are realized. Without incentive and commitments, it is unlikely that a public-private coalition such as has been observed in San Diego County would have been assembled. Incentives need not be monetary. The major incentive for government agencies involved in this plan was the simple ability to further their organization's mission. Incentives for private conservation organizations were similar. Commitments are another important component, especially those of the major governing bodies. These commitments both to implementing the plan and to land acquisitions have created a much greater level of certainty that the plan will be implemented and that lands conserved will result in effective ecosystem level conservation. As more combined landscape-level conservation-offset plans are developed, it will be important to ensure that these programs have both the commitment and support of public and private entities.

Long-Term Effectiveness

Habitat acquisition is a key component in the long-term conservation of rare and endangered species. Without protection of the habitat in which they live, many species

would simply go extinct. However, to ensure the long-term survival of rare and endangered species active management of these conservation acquisitions is a critical component (Margules and Pressey 2000). The threats to reserved lands in the urban-wildland interface are numerous, invasive species, unnatural fire regimes, pollution, disease, augmented predation, and impacts from human recreation are only a few (Wilcove and others 1998). The persistent and ubiquitous nature of these threats requires a management and monitoring program to ensure that reserves remain viable for the species which they protect. Our results show that a combined landscape-level conservation and biodiversity offset plan can be an effective tool to promote conservation land acquisition. However, the ability of such plans to sustain acquisitions in a state that benefits the species of concern and maintains ecological functionality has not yet been studied. Such studies would be an important next step in assessing the effectiveness of these plans.

Benefits of Regional HCPs

Our findings may not hold true for all landscape-level conservation-offset plans as our example was also designed as a HCP/NCCP. Without the nexus of endangered species acts and the prohibitions against impacts to listed species, the plan we have used in this example probably never would have been attempted. In addition, the requirements of an NCCP demand that the conservation plan incorporate ecosystem-wide conservation at a level generally beyond that of an HCP. Therefore, regional HCPs prepared in the absence of a companion NCCP may not produce similar results. However, this example illustrates the potential of regional multi-species HCPs, which have been designed to meet landscape-level conservation goals, to increase conservation and protect covered species. Rather than being discouraged and criticized by conservationists, scientists, and politicians, appropriately developed and implemented regional HCPs should be embraced as an important conservation tool that can increase conservation for sensitive species.

Regional multiple species HCPs also address a key issue associated with biodiversity offset programs. These HCPs can be developed as combined landscape-level conservation plans and biodiversity offset programs. Developed in such a combined manner, regional HCPs can streamline both conservation and development by clearly outlining rules for development, identifying areas where avoidance is required, and locations where offsets would be allowed or encouraged so that they contribute to landscape-level conservation goals. At a minimum, our example illustrates the potential of large multi-species HCPs to target and increase conservation for species of concern.

Conclusion

Our results suggest that combining landscape-level conservation plans and biodiversity offset programs can be a more effective conservation approach than a simple biodiversity offset program, especially in a rapidly urbanizing area. We found that conservation acquisitions in the planning area with a combined approach were much greater, and that the offset acquisitions likely contributed more to the landscape-level conservation goals. While it has been hypothesized that combining offset and conservation plans would yield enhanced conservation, our results document such a success.

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