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Original Article

Maximizing the Ecological Contribution of Conservation Banks

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ABSTRACT In 1995, California established the first conservation banking program in the United States to provide a new financial mechanism to conserve wildlife and natural communities in rapidly developing regions. Conservation banks are lands protected and managed for conservation of species of concern. Developers may purchase species credits from a conservation bank to offset adverse impacts of development at another site. Conservation banks facilitate pooling of mitigation resources from multiple development projects to protect planned habitat reserves of greater ecological value than can be achieved with project-by-project mitigation. In this study, we conducted the first ever assessment of the ecological performance of the California Conservation Banking Program. Specifically, we investigated to what extent conservation banks contribute to achieving regional conservation objectives. We hypothesized that conservation banks within a region should have similarly high ecological values if they are appropriately evaluated and prioritized based on principles of conservation planning. We created a new ecological value metric to evaluate and rank conservation banks and used it to compare potential conservation banks or reserves within a region. We found the ecological value of banks within regions varied and concluded that maximizing the ecological contribution of conservation banks requires prioritization of lands for potential bank sites and reserves. Our analysis identified circumstances where conservation banking is not an appropriate mitigation mechanism to protect rare species and natural communities. We concluded that limited funding for conservation planning should be directed toward regions where species of concern are wide-ranging, biodiversity is highly variable, threats to species of concern are highly varied, and there are many potential conservation bank sites.

KEY WORDS conservation banks, conservation planning, ecological value reserves, reserve design.

In 1995, California established the first conservation banking program in the United States with the goal of providing a new financial tool to protect species and habitats threatened by rapid development (Wheeler and Strock 1995). Eight years later, the U.S. Fish and Wildlife Service (USFWS) issued federal guidelines for implementing conservation banks across the United States (USFWS 2003). There are now >120 approved conservation banks covering 100,000 acres (approx. 40,500) nationwide. More than a quarter of the banks and acreage are in California (USFWS 2012). State wildlife departments and the USFWS continue to approve more conservation banks each year.

The California Conservation Banking Program is modeled after the federal wetlands mitigation program but without the regulatory framework or standards. It was conceived to address challenges encountered by conservation planners and managers. In the early 1990s, California was aggressively implementing the Natural Community Conservation Planning (NCCP) program, a new approach to protecting threatened, endangered, and sensitive species and the ecosystems upon which they depend (Pollack 2001). The federal equivalent of an NCCP is a regional-level habitat conservation plan. An early focus of the NCCP program was developing large regional plans for conserving the most important remnants of coastal sage scrub vegetation community (hereafter, "habitat") of Southern California. These ambitious plans designated networks of habitat reserves, within planning areas averaging >500,000 acres (approx. 202,343 ha), to protect the remaining natural communities in areas of rapid residential and commercial development. A major challenge was determining how to pay for the purchase of title or easements of reserve lands within planned habitat networks. A conservation bank program was considered as one of several mechanisms to fund creation and maintenance of conservation reserves within an NCCP (Wheeler and Strock 1995, Mead 2008). Conservation banks were developed to pool mitigation resources from multiple projects to fund protection of larger and more carefully selected conservation sites within a region.

When designated in the context of a regional plan, conservation banks should contribute to achieving important conservation goals by protecting wildlife habitat through a network of reserves and corridors based on conservation

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principles. For a bank site proposed outside of an NCCP or regional habitat conservation plan, conservation bankers and wildlife agencies rely on an initial biological assessment and site visits to evaluate habitat values and to evaluate location with regard to adjacent land uses and ecological processes affecting the site. However, the initial biological assessments of conservation banks, performed early in the site review process, generally lack comprehensive evaluation in a regional ecological context (Table 1). In addition to the biological assessment, bank proponent and wildlife agency reviewers may consult USFWS Recovery Plans, if such plans exist for the proposed covered species. Although recovery plans contain information on threats to species and important habitat, they lack key information for assessing ecological values of sites in a region (Table 1). Unlike regional conservation plans, recovery plans do not prioritize lands at the regional scale for habitat connectivity, maintaining biodiversity, regional representation of rare natural communities, or assessing the threat level (Noss et al. 1997, USFWS 1998, Margules and Pressey 2000, Lambeck and Hobbs 2002, NMFS 2010); also, recovery plans do not designate a network of reserves or a financial mechanism for protecting sets of properties that together ensure habitat connectivity.

The ecological and development diversity among state regions make California a particularly viable place to investigate the potential of conservation banking. In California, conservation banks have been established under a wide range of circumstances indicative of the state's complex mix of urban development, working landscapes and natural communities. The 29 conservation banks approved by the California Department of Fish and Wildlife provide specific protection for species of concern and their habitats, from coastal sage scrub in San Diego County to saltbush scrub and alkali sinks in the Southern San Joaquin Valley to vernal pools near Sacramento and Santa Rosa. The ecological value of existing conservation banks has not been assessed, particularly for stand-alone banks that were established without the benefit of regional conservation planning.

The following principles of conservation planning (Forman 1995*a*, Poiani et al. 2001), for which there are simple parameters that can be recorded as part of the basic biological site assessments, can be used to compare ecological value of conservation bank sites:

Conserve Large Blocks of Habitat

One expectation of the conservation bank program is that pooling of required mitigation resources would fund protection of larger areas of habitat than is possible under the single project mitigation scheme (Wheeler and Strock 1995).

Maintain Habitat Connectivity

Ecologists and planners have considered numerous metrics for habitat or landscape connectivity (Pascual-Horton and Saura 2006, Kindlmann and Burel 2008, Magle et al. 2009, Prugh 2009). In the limited context of a budget-constrained assessment of a stand-alone site, connectivity data are limited and only the basic metrics are practical. They include percent edge connectivity and possibly nearest-neighbor estimates. This contrasts with the more complex connectivity analyses typically performed to design a reserve system under an NCCP or regional habitat conservation plan. In this study, connectivity to adjacent habitat is one criterion used to compare sites.

Conserve Habitats with High Biodiversity

A practical principle of conservation is to focus limited conservation resources on areas of high biodiversity (Noss 1987, Noss et al. 1997, Meyers et al. 2000). We initially used species richness, from the California Department of Fish and Wildlife species richness database, as a

Table 1. Types of species and ecological information provided by conservation bank (CB) site biological assessments, endangered species recovery plans, and regional conservation plans. Prepared by David Bunn, May, 2012.

	Type of ecological assessment or plan		
Type of information	**CB site biological assessments**	**Recovery plans**	**Regional conservation plans**
Site topography	X		
Site and surrounding hydrology	X		
Site soils	X		
Archaeological resources	X		
Site natural communities or habitat types	X		X
Species' habitat critical factors	X		X
Site special-status species counts	X		
Taxa surveys	X		X
Species' description and taxonomy		X	X
Species' historical and current distribution		X	X
Species' life history and ecology	X	X	X
Species' reasons for decline and threats		X	X
Species' status on reserve	X		X
Species' status on adjacent lands	X		X
Regional vegetation communities			X
Regional connectivity analysis			X
Regional existing and planned land use			X
Forecast growth and development			X
Regional gap analysis			X
Lands conservation prioritization			X
Regional reserve system plan			X

surrogate for biodiversity. We found that species richness, whether for plants or animals, was too coarse to use as a criterion at the scale of conservation banks. Thus, we used a criterion of habitat diversity as a surrogate measure of biodiversity.

This study investigates the extent to which the California Conservation Banking Program contributes to achieving primary objectives of conservation planning. Because of the great diversity of development pressure and ecological conditions, it is not appropriate to compare sites across regions (Forman 1995*b*, Bunn et al. 2007). Thus, we focused our analysis at comparing sites within each region. We hypothesized that conservation banks within a region should have similarly high ecological values if they were appropriately evaluated and prioritized based on principles of conservation planning. We created a metric and framework for analysis to assist conservation banking practitioners and wildlife agency staff in evaluating the ecological value of a proposed conservation bank where regional planning was lacking. By comparing differences in covered species and regional characteristics within this case study, we identified when regional planning was most necessary to evaluate and select bank sites with ecological value.

STUDY AREA

We evaluated the 29 approved conservation bank sites within the California Conservation Banking Program. Based on general ecological features and regional development pressure and circumstances, these banks could be placed into 5 geographic regions (Fig. 1). These regions were the Sacramento Region (an area in the Central Valley from Colusa to Los Banos), the Santa Rosa Plain, the East Bay Hills, the Southern San Joaquin Valley (western side of Southern San Joaquin Valley including the east side of the Temblor Range), and the South Coast (from the San Gabriel Mountains to the border with Mexico). These geographic regions differed from one another by level of urban development, population density, degree of habitat degradation and fragmentation, intensity of agricultural activities, and impacts of non-agricultural industrial uses. The Sacramento Region was primarily flat cropland or rolling rangeland on the valley edge. Most of it had been farmed or grazed for decades. Santa Rosa Plain had served primarily as dairy pasture for many decades. The Santa Rosa Plain parcels were small compared with privately owned lands of the Central Valley. The 2 banks in the East Bay were among the rolling hills of non-native grasslands that had been grazed by cattle for decades. The Southern San Joaquin Valley lands were affected by multiple agricultural and industrial activities. Large parcels, in the thousands of acres, were managed for oil production, for water conveyance and storage, and as rangeland. There was a matrix of service roads, irrigation canals, reservoirs, power lines and pipelines, pump stations, and oil pumpjacks. Southern California was heavily urbanized with highly fragmented natural communities on the hillsides and ravines between cities and sprawling residential communities.

Figure 1. Conservation banks established by the California (USA) banking program since 1995 and clustered into 5 geographic regions.

Generalizations can also be made about landscape conditions and conservation approaches in these 5 regions. The Southern California and Southern San Joaquin Valley Banks were set up to conserve habitat benefiting numerous species associated with those habitats. Most Southern California sites were designated in context of an NCCP and regional federal habitat conservation plan. One bank site, Cajon Creek, was established to mitigate aggregate mining operations on-site. Two of the 3 Southern San Joaquin Valley sites were part of conservation plans associated with permitting of industrial activities on large working landscapes (i.e., Coles Levee Plan and Kern Water Bank). Conservation banks of the Sacramento Region and East Bay Hills were designed to specifically benefit a small set of covered vertebrates or vernal pool invertebrate and plant species under an existing or modified rangeland management scheme. Banks on the Santa Rosa Plain were wetland restoration and creation projects to benefit vernal pool invertebrates and flowers and the California tiger salamander (*Ambystoma californiense*).

METHODS

Our initial procedure was to assess size and locations of sites, and associated trends and adequacy of available ecological information to evaluate the ecological value of the 29

conservation banks. For each conservation bank, we reviewed information contained in the biological site assessment, in completed recovery plans for covered species, and in relevant completed NCCPs and regional Habitat Conservation Plans (Appendix I [online]). We also assessed whether relevant species recovery plans and regional plans were completed prior to approval of each site (Appendix I [online]). For each bank, we also reviewed bank agreements, management and monitoring plans, and annual monitoring reports (CDFG 1997–2011) (using data at the headquarters and 5 California Department of Fish and Wildlife regional offices). For each conservation bank we recorded: 1) year of approval; 2) ecological purpose; 3) whether it included habitat preservation, restoration, or creation objectives; 4) species or habitats covered for credits; 5) size of the site; 6) diversity of habitat types; 7) presence of riparian or wetland habitats; 8) county; and 9) whether the bank was affiliated with a regional habitat conservation plan. Shapefiles of conservation bank sites were loaded into Google Earth Pro for measuring edge connectivity, reviewing local context, and checking the area of each natural community identified in site biological assessments.

We then applied criteria based on the principles of regional conservation planning to estimate the comparative ecological value of conservation banks. We used the criteria of site size, percent edge connectivity, and habitat diversity (Appendix II [online]). Habitat diversity was scored based on the number of natural communities (representing $\geq$5% of the site) plus an extra point for presence of riparian and wetland communities. The extra weight given to wet areas was justified because inland waters, wetlands, and riparian habitats are particularly critical to maintaining biodiversity in all eco-regions of the state (Roberts et al. 1977, Naiman et al. 1993, Moyle and Yoshiyama 1994, CDFG 2003, Dudgeon et al. 2007).

The next step was to create an Ecological Value Metric (EVM) by summing values across all parameters to be able to rank banks based on overall conservation value (Table 2). For the purposes of constructing the EVM, the size and connectivity criteria were adjusted to a 1–5 scale as specified in Table 2. Habitat diversity values were unadjusted, with a range of 1–7. The EVM was constructed as follows:

$$\text{EVM} = \text{Size Index} + \text{Connectivity Index} + \text{Habitat Diversity Index}$$

For the analysis, banks were categorized into the 5 geographic regions (Fig. 1 and Appendix II [online]). To confirm our assumption that it is not meaningful to compare conservation banks across regions, we tested whether there were regional differences in conservation criteria (i.e., size, edge connectivity, habitat diversity) and in the EVM using the nonparametric Kruskal–Wallis test (R Version 2.9.2, 8-24-2009; The R Foundation for Statistical Computing; www.R–project.org.). Based on the EVM, conservation banks were ranked within each region and the range of EVM values noted. Then we qualitatively compared differences between the highest and lowest performing banks in each region. Those comparisons included reviewing bank objectives with regard to species or habitat coverage, a closer examination of the regional connectivity value of the site, the extent of riparian or wetland habitat, and habitat value of adjacent lands.

RESULTS

Analysis of data obtained on the 29 conservation banks in California revealed several trends in the conservation banking program. The number of new banks approved peaked in 1997 and has since declined, with no new banks approved in the state program since 2008. The average bank size has decreased over the years from an average size of 971 acres (approx. 393 ha) in the first 8 years to an average size of 424 acres (approx. 172 ha) in second 8 years. All new banks since 1997 have been stand-alone banks, evaluated without the benefit of regional planning analyses. The Santa Rosa Plain banks were established within the planning area of the Santa Rosa Plain Regional Plan for Vernal Pools, but this plan does not cover the full range of taxa and natural communities typically addressed in a regional conservation plan (CH2MHILL, 1995).

The 29 conservation banks in the California Program cover 28,151 acres (approx. 11,392 ha) of the state's 100 million acres (approx. 40 million ha). The smallest bank is the 8.11 acres (approx. 3.3 ha) Alton South site on the Santa Rosa Plain and the largest is the 6,069-acres (approx. 2,456 ha) Coles Levee Reserve in Kern County (Appendix II [online]). The 26 banks outside of the Southern San Joaquin Valley Region (which contains 3 banks substantially larger than is common in any other region of the state) average 638 acres (258 ha). The Santa Rosa Plain has the smallest banks, averaging 25.8 (median = 28) acres (approx. 10 ha). The Sacramento Region and East Bay Hills have similar-size banks, averaging 468.9 (approx. 190 ha) (median = 345) and 647.0 acres (approx. 262 ha) (median = 647), respectively. Larger banks are in the Southern California and the Southern San Joaquin regions averaging 1,051 (median = 444) and 3,851 (median = 3,267) acres (approx. 425 ha and 1,558 ha), respectively. Three of the conservation banks were established to mitigate activities on industrial sites: Cajon Creek, Coles Levee Reserve, and the Kern Water Bank.

Levels of Ecological Assessment for Prioritizing Potential Bank Sites

We found that for >70% of approved banks, information was incomplete, lacking regional conservation habitat plan analyses or species recovery plans for the species of concern, at the time they were evaluated (Appendix I [online]). Only 8 of 29 conservation banks were sited within the reserve network of an NCCP, thereby benefitting from the extensive regional analysis of habitat connectivity and gap analyses of natural communities. Among the 21 banks not affiliated with a regional conservation plan, species recovery plans were available for all covered species for only 6 of those sites (Appendix I). Thus, it was not possible to fully assess the ecological value of most bank sites.

Table 2. Ecological values for California (USA) conservation banks ($n = 29$) in acres, acre ranking by size, connectivity, connectivity ranking, habitat diversity, and their Ecological Value Metric (EVM).

Conservation bank	Acres (approx. ha)	Acres rank[a]	Connectivity[b]	Connectivity rank[c]	Habitat diversity[d]	EVM[e]
Sacramento Region						
Orchard Creek	632.2 (256)	3	0.81	5	5.00	13
Brushy Creek	120 (49)	2	0.98	5	4.00	11
Agua Fria	1,824.5 (738)	4	1.00	5	1.00	10
Bryte Ranch	573 (232)	3	0.28	2	3.00	8
Pope Ranch	391 (158)	2	0.15	1	5.00	8
Haera Wildlife	299 (121)	2	1.00	5	1.00	8
Dolan Ranch	252 (102)	2	0.32	2	4.00	8
Byron	140 (57)	2	0.81	5	1.00	8
Springtown Natural Community Reserve	51.74 (21)	1	0.55	3	3.00	7
Jenny Farms	405.56 (164)	2	0.13	1	1.00	4
Mean	469 (190)		0.60		2.80	
East Bay Hills Region						
Ohlone Preserve	640 (259)	3	1.00	5	6.00	14
Pleasanton Ridge	654.1 (265)	3	1.00	5	5.00	13
Mean	647 (262)		1.0		5.5	
Santa Rosa Plain Region						
Slippery Rock	38.06 (15)	1	0.47	3	3.00	7
Alton North	22.67 (9)	1	0.47	3	3.00	7
Swift–Turner	34.18 (14)	1	0.15	1	4.00	6
Alton South	8.11 (3.3)	1	0.24	2	3.00	6
Mean	26		0.33		3.25	
Southern San Joaquin Valley (SJV)						
Coles Levee Ecosystem Preserve	6,059	5	0.98	5	7.00	17
Kern Water Bank	3,267	5	0.70	4	6.00	15
Palo Prieto	2,226	5	1.00	5	3.00	13
Mean	3,851		0.89		5.33	
Southern California (SCL)						
Daley Ranch	3,058	5	0.79	4	6.00	15
Cornerstone Lands	2,600	5	1.00	5	5.00	15
Crestridge	2,355	5	0.52	3	6.00	14
Chiquita Canyon	1,158	4	0.89	5	4.00	13
Carlsbad Highlands	180	2	0.92	5	4.00	11
Heights Pala Mesa	321.3	3	0.77	4	4.00	10
Cajon Creek	567		0.70		2.00	9
Whelan	136	2	0.63	4	2.00	8
North County Habitat	14.15	1	0.54	3	4.00	8
Manchester Ave	123	2	0.29	2	3.00	7
Mean	1,051		0.71		4.00	

[a] Acre rankings = 1 for ≤100 acres (40.5 ha), 2 for 101–500 acres (40.6–202 ha), 3 for 501–1,000 acres (203–405 ha), 4 for 1,001–2,000 acres (406–809 ha), and 5 for >2,000 acres (809 ha).
[b] Connectivity is percent of site edge connected to adjacent habitat.
[c] Connectivity rank: 1 for Connectivity 0–0.2; 2 for Connectivity 0.21–0.40; 3 for Connectivity 0.41–0.60; 4 for Connectivity 0.61–0.80; 5 for Connectivity 0.81–1.0.
[d] Habitat diversity based on 1 point for each natural community representing ≥5% of the site, plus 1 point if the site has riparian or wetland habitat.
[e] Ecological Value Metric—The metric combines the 3 criteria of Acre Rankings, Connectivity Rank, and Habitat Diversity. For the purposes of constructing the EVM, the size and connectivity criteria are adjusted to a 1–5 scale. The habitat diversity values were unadjusted with a range of 1–7.

Regional Variation in Bank Ecological Values

The conservation variables and EVM scores are listed for each conservation bank by region in Table 2 and Appendix II (online). Comparison of conservation criteria and the EVM between the 5 geographic regions showed that median value for size, connectivity, and the EVM varied significantly among regions ($P < 0.05$). The median score for habitat diversity of conservation banks did not differ significantly between regions ($P = 0.15$). Ecological values varied greatly within the Sacramento Region and the South Coast. In the Sacramento Region, Orchard Creek ranked highest in overall ecological metric value (EVM = 13) and Jenny Farms ranked lowest (EVM = 4). Ecological Value Metric scores for the other 8 sites in the region ranged from 7 to 11. The high-performing Orchard Creek is 632 acres (approx. 256 ha), with 80% edge connectivity and has 4 vegetation communities and a riparian corridor winding through the property. The low-scoring Jenny Farms is 406 acres (approx. 164 ha), with 13% connectivity, and is a monoculture of alfalfa without riparian or wetland habitat. There are 10 banks in Southern California. Cajon Creek is a wash flowing out of the San Gabriel Mountains and the other 9 sites are between Orange and San Diego counties. The high-performing banks are Daley Ranch and Cornerstone Lands, both with EVM Scores of 15. The 2 sites are 2,600–3,058 acres (approx. 1,052–1,238 ha), with connectivity of

100% and 80%, and 4–5 natural communities with riparian habitats. Manchester, scoring the lowest in Southern California (EVM = 7), is 123 acres (approx. 50 ha), with 29% connectivity and 3 vegetation communities. In the East Bay Hills, Ohlone Preserve and Pleasanton Ridge had similar EVM scores of 14 and 13, respectively. Both are large properties, at 640 acres and 654 acres (approx. 259–265 ha), respectively, with 100% connectivity and 4 or 5 habitat types. Four sites on the Santa Rosa Plain have similar ecological values, all scoring either a 6 or 7. All sites are small in size (8–38 acres; approx. 3.2–15 ha), have connectivity between 15% and 47%, and have 2 vegetation communities of vernal pools and non-native grassy uplands. Two of 3 sites in the Southern San Joaquin Valley are unusual in that they are large working landscapes with major non-agricultural industrial activities. Coles Levee Ecosystem Preserve is 6,059 acres (approx. 2,452 ha) of 6 degraded vegetation communities fragmented by oil facilities and service roads. The Kern Water Bank is 3 nearly adjacent large parcels totaling 3,267 acres (approx. 1,322 hectares) of 5 vegetation communities, fragmented by water canals and reservoirs and service roads. Palo Prieto consisted of 2 closely situated parcels totaling 2,226 acres (approx. 901 ha) of primarily rolling non-native grasslands on the west side of the valley, with 100% connectivity.

Eleven of 29 sites have some habitat creation or restoration components. The remaining banks manage existing habitat of working landscapes. Bank credits are typically sold at an exchange ratio of one-to-one for mitigation of project impacts.

DISCUSSION

Our review of conservation banks across California has revealed that comparison of conservation banks within a region is valuable for assessing the ecological value of individual banks; it also showed that, as practiced currently, conservation banking has limited usefulness for protecting some species and natural communities. Consistent with regional analyses of Forman (1995*b*), we confirmed that it is not meaningful to compare or prioritize conservation banks across regions because of differences in natural communities, land-use patterns, extent of converted lands, and habitat fragmentation.

Site selection for conservation banks would be improved if standardized criteria for site size, connectivity, and habitat diversity was used in initial assessments. Our EVM, which combines these 3 conservation criteria, is designed for initially ranking the ecological value of sites within a region. However, larger landscape-scale analyses may indicate that a specific site has greater regional conservation value than the EVM score indicates. A broader understanding of habitat connectivity in the region may show that a site with low or average percent-edge connectivity is critical for regional connectivity. The EVM values all wetlands and riparian habitats equally and does not differentiate between degraded and high-quality habitat. A site with a rich riparian habitat, or known to provide important ecosystem services, may warrant added value that this metric would fail to recognize. The EVM also values each vegetation community equally. Sites with particularly rare natural communities should be given higher consideration than is indicated by the metric score. For example, a site with low habitat diversity could provide preferred habitat for a rare species. In this case, the EVM would undervalue the site.

Site assessments, as required by the conservation banking program, only provided a portion of the information necessary to fully evaluate the conservation value of a particular property. Only regional conservation planning that assesses and prioritizes lands provides the set of ecological information necessary to fully evaluate potential bank sites. Relative size of properties must be evaluated against other large blocks of open lands in the region. A thorough evaluation of connectivity requires evaluating potential networks of habitat at the regional scale and mobility of diverse species of concern. Biodiversity (or habitat diversity) is a more relevant concept at the regional scale. Although a site may have little habitat heterogeneity at the 1,000-acre (approx. 405 ha) scale, it may preserve an important part of a habitat mosaic and contribute to biodiversity at the regional level. A site with low heterogeneity and biodiversity (based on the few annual surveys typically available to bank site evaluators) may contribute to biodiversity of adjacent lands by providing the corridor between the 2 habitats or by providing forage for keystone species in the region, thereby benefitting many species. This may be the case, for example, for lands set aside to protect annual grassland corridors for the kit fox (*Vulpes macrotis*) or to protect alfalfa fields for foraging Swainson's hawk (*Buteo swainsoni*). Prioritizing representative natural communities for conservation requires gap analyses at the regional and eco-regional level. Once such regional analyses are conducted, the value of natural communities can be compared among potential bank sites.

Our EVM is a credible starting point for evaluating the ecological value of potential conservation banks sites within a region. Once potential bank sites or reserves are scored and ranked, emphasis should be on making the case that a proposed site is of lower or higher value than indicated by the EVM score as compared with other potential sites in a region. In this study, use of the EVM quickly revealed that sites on the Santa Rosa Plain were of similar ecological value, while sites in the Central Valley had wide-ranging ecological values. After repeated use of the EVM metric, minimum guidelines could be established for regional EVM scores. Ideally, completion of regional planning for conservation banks would provide information needed to create a more comprehensive ecological value metric for ranking bank sites within a region.

We hypothesized that approved conservation bank sites would generally have high ecological values for their region. In reality, some approved banks had much higher ecological values than other banks targeting the same species within the same region. For example, EVM scores for banks in the Sacramento Region varied from 4 to 13. Lower scoring banks might not have been selected or approved if standardized criteria, such as the EVM, had been used to prioritize

potential sites. Ideally, regional conservation planning, which should be the basis for designating priority areas for reserves and corridors, should be completed before conservation bank sites are established. Our analysis showed that only 8 of 29 banks benefited from regional conservation planning. Regional planning is especially critical for selecting bank sites or reserves if 1) species of concern are wide-ranging; 2) target species rely on habitat connectivity; 3) threat levels to target species across the region are highly varied; and 4) landscapes have numerous land parcels where a bank could be established, such as in an agricultural landscape. Based on these 4 criteria, areas such as the Sacramento Region (and more broadly the Central Valley) are where regional planning is most urgently needed for evaluation of proposed conservation bank sites.

Our analysis shows the limits of conservation banking as a mechanism for conserving species and natural communities. Location and size of conservation banks and species they cover are constrained by the market for mitigation credits. Conservation banks are clustered where rapid development affects similar habitats and species across a region or subregion. Under these circumstances, only a bank covering commonly impacted species and habitat is likely to sell credits to developers. Not surprisingly, all 5 bank regions are in areas of rapid growth across similar habitats: the Santa Rosa Plain, the Central Valley from Los Banos to Sacramento, the East Bay Hills, the San Joaquin Valley, and the South Coast. In many parts of the state, conservation banks are just not financially viable because there is no market for development mitigation credits. This explains why approved conservation banks protect only a few dozen covered species among 2,515 taxa of concern throughout the state and are found in less than one-third of the state's 19 eco-subregions (CDFG 2003).

Although conservation banks are designed to offset development impacts, they may not provide appropriate mitigation for species threatened by a combination of stressors other than development. Water diversions, spread of invasive species, habitat degradation due to off-road vehicles, and numerous other stressors may cause declines (Bunn et al. 2007). Such stressors on wildlife usually do not generate a need for mitigation land credits, nor does conserving land directly mitigate them.

By primarily focusing on benefiting a few species, rather than on conserving natural communities and ecosystems as regional habitat conservation plans do, conservation banks are less likely to support high biodiversity or contribute to regional connectivity (Fleischer and Fox 2008). For example, Jenny Farms Conservation Bank was established to protect foraging habitat for Swainson's hawk. The bank is an alfalfa field without any trees for perching. Although the Swainson's hawk does not require perches near foraging grounds, the kestrel (*Falco sparverius*) and northern harrier (*Circus cyaneus*) do. An alfalfa field in the same area as Jenny Farms with a riparian strip would not only better support Swainson's hawk (both foraging and nesting), but it would better serve other raptors and numerous other species that use riparian habitat.

The world over, habitat destruction is the dominant threat to the survival of natural communities (King 1998, Wilcove et al. 1998). In face of this threat, conserving representative natural communities protects biodiversity and thus has long been a priority of conservation (Margules and Usher 1981). This conservation principle is particularly relevant to California, which has the most diverse plant communities in North America with high endemism. The California Department of Fish and Wildlife has classified 135 of the state's 280 plant communities as rare and warranting special protection. There are fewer than 2,000 acres (approx. 809 ha) of habitat for $\geq$50 of these rare ecological communities (Sawyer and Keeler-Wolf 1995). The loss of any of these habitats means the loss of a suite of species associated with them. As currently designed, the conservation banking program is not suited to protect rare natural communities from development. Also, the one-to-one mitigation credit ratio typical of conservation banks is likely to lead to unacceptable losses of rare natural communities if used as a principal conservation tool. To make conservation banking useful for protecting rare natural communities, conservation banking programs need to have the flexibility to mitigate development impacts on lower priority habitats by protecting higher priority sites that have rare natural communities or greater biodiversity. Although conserving out-of-kind lands of higher ecological value has been possible under the NCCP framework, such flexibility is not afforded to the siting of stand-alone conservation banks. However, regional planning is also needed to ensure that out-of-kind mitigation protects the most critical lands, without unintended consequences.

"No net loss" of endangered species habitat is not a declared goal of state or federal conservation banking programs, as it is for wetlands mitigation policy under the Clean Water Act (Wheeler and Strock 1995, USFWS 2003). Among the 29 conservation banks approved by the California Department of Fish and Wildlife, most banks restore or conserve existing habitat that may or may not be imminently threatened by development. Five of the 29 banks created habitat, such as the Pope Valley Conservation Bank (Fig. 2). In these cases, the sale of credits may have achieved 'no net loss' of habitat for the species of concern. But generally, there is a net loss of habitat for endangered species and species of concern when credits are purchased in conservation banks that protect intact open space. Thus, the establishment of stand-alone banks is not an appropriate approach to protecting species that cannot afford to lose much of their remaining habitat. Furthermore, expanding conservation banking may fail to conserve sensitive species as long as net losses of habitat continue under the program.

Conservation banks to mitigate for industrial activities are different from other banks in that their location is dictated by existing industrial lands rather than by a comparison of possible sites in a region. The decision to approve an industrial site conservation bank is made on the basis of whether the onsite bank is of more value than one offsite. The 3 industrial conservation banks in the California program compare well with the 26 non-industrial bank sites. For example, the average size of industrial bank sites is nearly

Figure 2. Pope Valley Conservation Bank, established under the California Program (USA) in 2001, created giant garter snake (*Thamnophis gigas*) habitat on former agricultural land. Left: Agricultural land before habitat creation. Right: Pope Valley Conservation Bank after habitat creation completed.

5 times larger than the nonindustrial sites, averaging 3,298 versus 702 acres (approx. 1,335 ha vs. 284 ha) for nonindustrial sites. Based on the annual reports (required to be submitted by conservation bank management to the Department of Fish and Wildlife), conservation management and monitoring on industrial sites is more thorough. Because these are working sites, they receive daily supervision and enforcement to prevent damage by activities such as off-road vehicle use and dumping.

Stand-alone conservation banks, without regional connectivity, are too small to conserve wide-ranging species, such as the kit fox, which have home ranges far greater than the size of most bank properties (Bonnie and Wilcove 2008). If connectivity is not conserved as part of a regional reserve network, it is likely development will eventually isolate the bank sites. In this case, the site's ecological value is limited to the habitat and species that are viable in isolation. In this study, the selection of bank sites for the wide-ranging kit fox was partly influenced by the USFWS Recovery Plan that indicated the need for large areas that were important for connectivity between basins or sub-regions. To meet this need, stand-alone banks were established on the remaining areas of kit fox habitat that connect the Central Valley to the Santa Clara Valley. However, these stand-alone sites are likely to eventually be isolated because their selection was not part of a regional plan that provides a mechanism for linking sites to complete habitat connections.

MANAGEMENT IMPLICATIONS

Each year more conservation banks are being planned and approved to mitigate development impacts on species of concern. Conservation bankers and wildlife agency biologists must work together to evaluate and negotiate the conservation value of potential new bank sites. This paper provides guidance for evaluating and prioritizing new bank sites and for determining when a conservation bank may not be an appropriate mitigation mechanism. Nationwide, most conservation banks are likely to be established as stand-alone banks without regional planning. It is therefore important that standardized criteria be used to prioritize and select new bank sites with the best ecological values to mitigate development impacts on species of concern. Ranking sites by their EVM scores, which is based on information available to state and federal wildlife staff, provides a framework for evaluating banks where regional planning is lacking. The limited state and federal funding for regional conservation planning should be applied to regions where species of concern are wide-ranging; there is high variability of biodiversity across the landscape; threats to species of concern are highly varied; and there are many potential conservation bank sites, such as in agricultural regions.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher's web-site.

Appendix I. California (USA) conservation banks ($n = 29$)—level of ecological assessment completed on species and habitats covered by the conservation bank prior to approval of the conservation bank.

Appendix II. California (USA) conservation banks ($n = 29$)—year of approval, covered species, acres, connectivity, habitat diversity, and Ecological Value Metric (EVM).