Chapter 12
A Science-Based Approach to Regional Conservation Planning

Robert J. Steidl, William W. Shaw, and Paul Fromer

Abstract Although single-species approaches have played an important role in conservation in the United States, the Endangered Species Act provides a mechanism for conservation at larger scales through Habitat Conservation Plans (HCPs). HCPs not only offer the potential for comprehensive conservation planning for a wide range of species across broader geographic scales but also provide assurances that eliminate risks related to endangered species concerns for nonfederal landowners, developers, and planners. Given their benefits, dozens of municipalities have adopted HCPs to address planning issues related to rare and vulnerable species. The challenge, however, is to develop conservation plans that reliably meet broader-scale conservation and planning objectives while not increasing risks posed to vulnerable species. Consequently, we designed a science-based framework from which to develop regional conservation plans, including HCPs. We designed a rigorous process that classifies areas based on their relative conservation value as part of a conservation strategy for more than 20,000 km^2 of Sonoran desert in Pima County, Arizona. This chapter describes our approach including the fundamental planning elements selected, the process used to quantify the relative biological importance of each landscape unit, and how we assembled landscape elements into units that form the framework of the Sonoran Desert Conservation Plan.

Introduction

Conservation issues in the desert southwest generally reflect those in other parts of the United States, although several issues are unique to this arid region. First, large portions of the landscape remain undeveloped and in relatively natural condition with high levels of biological diversity. Second, during the last several decades, the human population has increased more in the southwest than in any other area of the

---

R.J. Steidl (✉)
School of Natural Resources, University of Arizona, Tucson, AZ 85721, USA
e-mail: steidl@ag.arizona.edu

A.X. Esparza, G. McPherson (eds.), *The Planner's Guide to Natural Resource Conservation*, DOI 10.1007/978-0-387-98167-3_12,

country, a pattern that is predicted to continue in the future (Benedict et al. 2005). Increases in the human population intensify development pressure that inevitably compromises the structure and function of natural landscapes. To minimize losses of biological diversity, strategies to constrain and direct the development footprint need to be enacted quickly as remaining opportunities for conserving large, contiguous natural areas will only decrease. Consequently, efficient strategies that identify areas of high conservation value enable regional planners to maximize the conservation benefits of planning while accommodating growth. Although site- and species-specific conservations surely have value, conservation will be most effective when implemented at larger geographic and ecological scales. The history and benefits of large-scale ecological conservation are discussed in Chapter 7.

Many regional-scale plans have been initiated in response to practical concerns related to species listed as threatened or endangered under the Endangered Species Act (ESA) of 1973. The effects of land-use change on listed species typically have been addressed on a single-species and single-parcel basis. This has led to considerable regulatory complexity and, more importantly, ineffective and fragmented conservation. The Habitat Conservation Planning (HCP) process was created to ensure that the impacts of development or other activities on listed species ("incidental take") are minimized and mitigated. In addition to providing relief from regulatory complexity, HCPs expand single-species protection provided by ESA to cover multiple species at broader geographic scales. For this process to be meaningful, however, HCPs must provide genuine conservation benefits that exceed the species-level protection provided by ESA (Kareiva et al. 1999).

Land-use planning at a broader geographic scale provides the opportunity to enact conservation measures that influence a wider range of organisms and landscapes and consolidate disparate planning guidelines under a common framework. Broad-scale land-use plans can promote long-term conservation strategies when they are designed carefully around contemporary scientific principles and implemented expeditiously. Although scientific principles central to the discipline of conservation biology should guide conservation planning, there are inevitable practical limitations that hamper application on lands that have already experienced some development. The degree to which these limitations impede effective conservation planning varies with the size of the development footprint and the compatibility of land uses with conservation goals. Given the pressures of an increasing human population on land and natural resources, there are few situations outside of national parks and reserves where lands can be managed primarily for conservation. Therefore, developing a conservation strategy as part of a comprehensive land-use plan requires balancing conservation ideals and practical realities.

This chapter describes a strategy that positions biological conservation at the center of future land-use decisions. The strategy ultimately defines a network of conservation lands across a large geographic area. We discuss a scientific framework that enhances the goals and objectives of regional-scale planning by identifying lands most suitable for conservation. These lands are found beyond the metropolitan fringe where there are significant opportunities for maintaining valuable biological diversity. Specifically, we describe the method or approach used to classify lands based on their potential conservation value. Based on our analyses, we then allocated lands to a conservation network around which other regional-planning elements were incorporated. Our overarching goal was to identify and establish an integrated system of conservation lands that support biodiversity while simultaneously providing a framework that guides future land use. This framework was the basis for a comprehensive regional-planning effort in Pima County, Arizona, called the Sonoran Desert Conservation Plan. In 2002, the SCDP received an "Outstanding Planning Award" by the American Planning Association, which recognized the long-term value of establishing the regional plan on a foundation designed to conserve biological diversity.

Sonoran Desert Conservation Plan

The conflict between land development and protection of listed species as mandated by federal law was the impetus for Pima County's land-use planning strategy. But over time, the Sonoran Desert Conservation Plan became a comprehensive framework designed to guide future land-use decisions by first ensuring conservation of natural and cultural resources important to the region. Development of the plan was a large, public process guided by a steering committee of about 80 citizens, 12 scientific advisory and other technical teams, dozens of working groups, and involvement of more than 150 scientists. One of these technical teams, the Science Technical Advisory Team, was responsible for establishing the network of conservation lands that are the foundation for all other elements in the plan. These additional elements, however, followed the identification of areas most important for conserving biological diversity. As such, conservation science guided the development of the entire land-use plan.

The SCDP (http://www.pima.gov/sdcp/) was guided by five goals: (1) define urban form to prevent urban sprawl and protect natural and cultural resources; (2) provide a natural resource-based framework for making regional land-use decisions; (3) protect habitat for and promote recovery of species listed under ESA; (4) obtain a Section 10 permit under ESA for a multispecies HCP; and (5) develop a system of conservation lands to ensure persistence of the full spectrum of indigenous plants and animals by maintaining or restoring the ecosystems on which they rely, thereby preventing the need for future listings. This set of interrelated goals was implemented through a series of specific objectives that promote recovery of listed and other vulnerable species, reduce threats caused by the introduction of nonnative species and other factors that compromise ecosystem structure and function, and foster long-term viability of species, physical environments, and biotic communities in the region.

This chapter describes the biological foundation of the plan. Discussion focuses on the metric developed to quantify the conservation value of each area in the region, the use of this metric as the primary means of identifying areas of high conservation value, and how we synthesized those areas and other conservation targets into a network of conservation lands that became the foundation for the comprehensive land-use plan. Lands within the network are managed principally for conservation of biological diversity. This has implications for all other types of land use as they will either be located outside the land conservation network or designed to be compatible with development guidelines within the network (described later in this chapter). We hope our case study provides a starting point for planners, local government officials, and land managers who seek to design plans using a scientific framework geared to conservation in exurban areas.

Planning Area

Pima County, Arizona, covers an area of approximately 23,786 km^2 (9,184 mi^2), slightly smaller than the state of New Hampshire. The entire county is characterized as basin and range topography with isolated mountain ranges surrounded by valleys, encompassing two somewhat distinct ecoregions (Omernik 1987) (Fig. 12.1). The central and western portions of the county are of lower elevation and characterized by Sonoran desert vegetation (Brown, Lowe and Pase 1980). The eastern portion of the county includes areas of much higher elevation, vegetated with coniferous forests and oak woodlands surrounded by either desert scrub or grasslands.

The region supports unusually high levels of biological diversity because of its geographic position between the subtropical and temperate climatic zones of North America that include two floristic realms, the Neotropic and Holarctic (Warshall 1995). Because the county is located at the edge of the tropics, many species occur

Fig. 12.1 Map of Pima County, Arizona. Source: Amanda Borens

at the northern limits of their geographic range. Further, the range of elevations (from about 300 to 2790 m) and strong regional gradients in precipitation across the region create a wide range of physiographic contrasts that provide conditions suitable for many species. Annual precipitation generally increases in amount from west to east and typically falls in a bimodal pattern with heavy “monsoonal” rains in summer and lighter rains in winter.

A Process for Large-Scale Conservation Planning

A plan’s geographic scale dictates the suitability of alternative metrics appropriate for biologically based planning. At small spatial scales, planning is ideally based on comprehensive field inventories of biological resources. At the largest scales, planning is only realistically based on broad regularities that reflect large-scale patterns and processes. At intermediate regional scales ($\sim$10,000–100,000 km^2), comprehensive inventories for many natural resources are likely impractical. Therefore, biological planning at this scale is usually accomplished through a combination of site-specific information and broad-scale patterns, with expert opinion used to meld these two disparate information sources. But planning efforts based on expert opinion are challenging because conclusions often reflect the knowledge and interests of any particular group of experts. Thus, pinning assessments to objective and explicit criteria is difficult at times. We therefore sought to develop a process that, although based in part on knowledge of local experts, is quantitative, explicit, and replicable and provides a rigorous foundation for exploring a range of planning alternatives that can be revised as additional information becomes available. This process is summarized in Fig. 12.2. Given the size of the planning area, analyses relied heavily on a geographic information system (GIS). Data resolution varied by source, but the highest resolution data available were used. In nearly all cases, the fundamental unit of analysis [approximately 300 × 300 m (9 ha)] was based on the digital elevation model used for analyses.

Landscape-level approaches based on strategies to conserve species assemblages, vegetation communities, and ecosystems are all useful in developing conservation programs (Noss and Cooperrider 1994). Although each of these targets can guide evaluation of an area’s potential conservation value, our approach began at the scale of individual species (see Fig. 12.2). Quantifying the conservation value of each landscape unit in the planning area required selecting a subset of species that represents well the range of structural and functional diversity in the region. In general, species are most valuable to this process when they use and inhabit the landscape (grain) across a range of spatial scales so that differences in the conservation value of alternative land allocations are maximized. Species provide less information if (1) they are either rare or very common because these traits provide the least discriminatory power at the landscape scale; (2) they occur only on lands that are already protected and will therefore be part of all alternative land allocations; and (3) there is limited biological information available about likely distributions and habitat requirements.

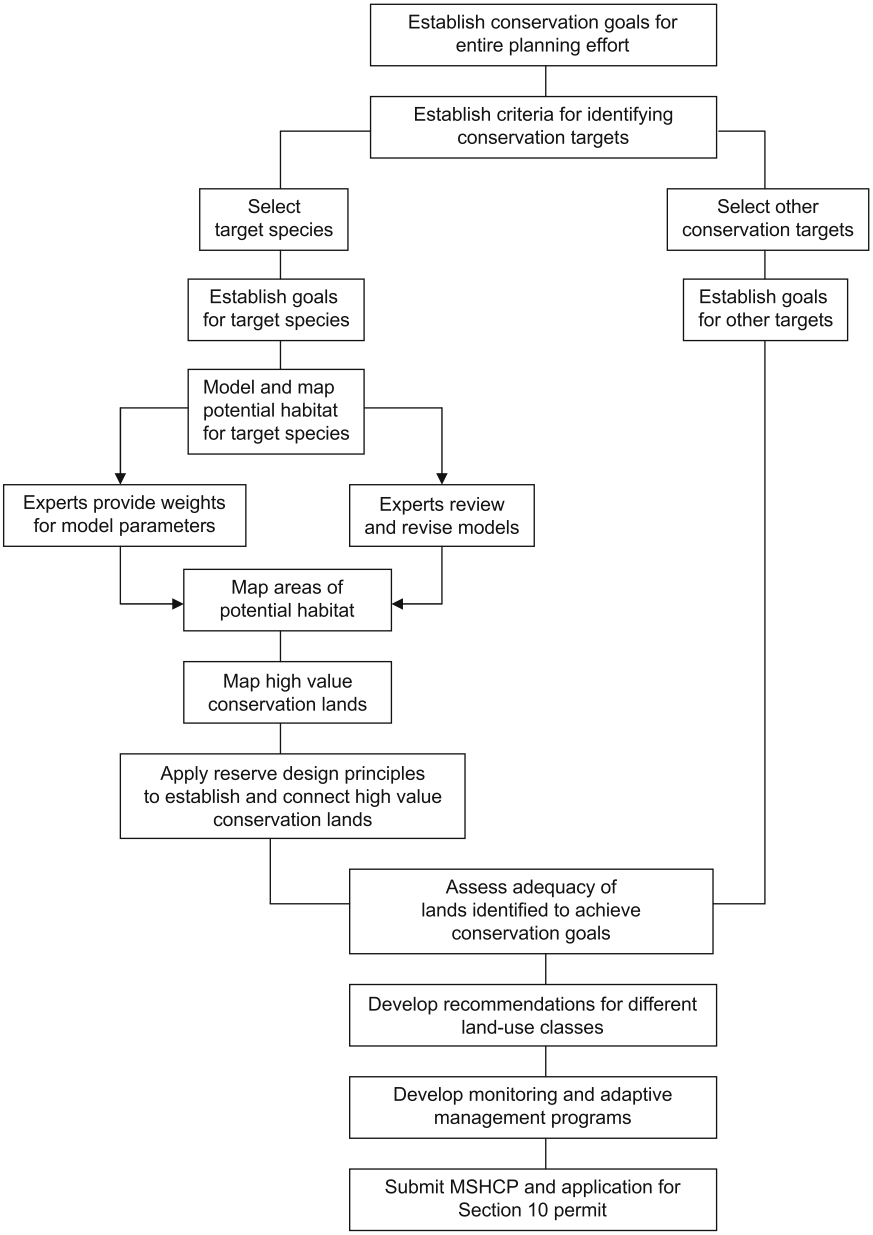


Fig. 12.2 A diagram of the process used to develop the SDCP. Source: Steidl, Shaw and Fromer

Provided that a large number of species inhabiting the full range of environments in a planning area are evaluated, the particular suite of species chosen should have little influence on the results of the analysis because a broad range of species should provide sufficient redundancy of environmental features needed to support biodiversity. In our process, a group of scientists with regional expertise in mammals, birds, fish, invertebrates, plants, reptiles, and amphibians identified species considered to be "vulnerable" in the region. Vulnerable species were defined as those thought to be declining throughout their range and where lands in the planning area were considered critical for their persistence. Scientists also considered species not thought to be at risk yet of considerable ecological or social importance to the region. Experts identified an initial group of 55 target species that was later reduced to 40 species as species with narrow distributions were eliminated. The final list included nine mammals, eight birds, seven reptiles, two frogs, six fish, and seven plants (see Table 12.1). More than 60% of target species were associated with riparian ecosystems, highlighting the importance of these environments to biodiversity in the desert southwest. A detailed account of each species was generated from the literature, including a description of its natural history, demography, taxonomy, geographic distribution, potential threats, and status as threatened or endangered. Most importantly, scientists identified each species' habitat requirements. This information was used for predicting landscape units that provide species habitat.

Table 12.1 Species used in development of the biological reserve. Species in bold face are federally listed as threatened or endangered

Group	Common name	Scientific name
Amphibians	**Chiricahua leopard frog**	*Rana chiricahuensis*
	Lowland leopard frog	*Rana yavapaiensis*
Birds	Abert's towhee	*Pipilo aberti*
	Bell's vireo	*Vireo bellii*
	Burrowing owl	*Athene cunicularia*
	Cactus ferruginous pygmy-owl	*Glaucidium brasilianum cactorum*
	Rufous-winged sparrow	*Aimophila carpalis*
	Southwestern willow flycatcher	*Empidonax traillii extimus*
	Swainson's Hawk	*Buteo swainsoni*
	Western yellow-billed cuckoo	*Coccyzus americanus*
Fish	Longfin dace	*Agosia chrysogaster*
	Desert sucker	*Pantosteus clarki*
	Sonora sucker	*Catostomus insignis*
	Desert pupfish	*Cyprinodon macularius*
	Gila chub	*Gila intermedia*
	Gila topminnow	*Poeciliopsis occidentalis occidentalis*
Mammals	Allen's big-eared bat	*Idionycteris phyllotis*
	Arizona shrew	*Sorex arizonae*
	California leaf-nosed bat	*Macrotus californicus*
	Lesser long-nosed bat	*Leptonycteris curasoae yerbabuena*
	Mexican long-tongued bat	*Choeronycteris mexicana*
	Merriam's mouse	*Peromyscus merriami*
	Pale Townsend's big-eared bat	*Plecotus townsendii pallescens*

Table 12.1 (continued)

Group	Common name	Scientific name
	Western yellow bat	*Lasiurus ega*
	Western red bat	*Lasiuris borealis*
Plants	Acuña cactus	*Neolloydia erectocentra. var. acuñensis*
	Gentry indigo bush	*Dalea tentaculoides*
	Huachuca water umbel	*Lilaeopsis schaffneriana recurva*
	Needle-spined pineapple cactus	*Echinomastus erectocentrus var. erectocentrus*
	Nichol's turk's head cactus	*Echinocactus horizonthalonius var. nicholii*
	Pima pineapple cactus	*Coryphantha scheeri var. robustispina*
	Tumamoc globeberry	*Tumamoca macdougalii*
Reptiles	Tucson shovel-nosed snake	*Chionactus occipitalis klauberi*
	Organ pipe shovel-nosed snake	*Chionactus palarostris*
	Giant spotted whiptail	*Cnemidophorus burti stictogrammus*
	Red-backed whiptail	*Cnemidophorus burti xanthonotus*
	Sonoran desert tortoise	*Gopherus agassizii*
	Ground snake	*Sonora semiannulata*
	Desert box turtle	*Terrapene ornata luteola*
	Mexican garter snake	*Thamnophis eques*

Goals and Guidelines

Conservation goals and objectives for regional planning should be established at levels needed to conserve identified targets, such as species or plant communities (Pressey, Cowling and Rouget 2003). This means that conservation objectives should be quantitative and based on the distribution and viability of targets, thereby providing an evidence-based approach to the planning process (Svancara et al. 2005). We sought to achieve our conservation goal at the landscape scale by identifying and establishing a network of conservation lands that provide the resources needed to maintain the collection of target species. The network incorporated additional areas known to support exceptional levels of plant and animal diversity, as well as protected areas that connect lands managed for their conservation value. To ensure achievement of these goals, we established several sets of specific objectives that provide a quantitative reference by which to compare alternative allocations of lands to the network of conservation lands.

The overarching goal of the planning process was to ensure persistence of the full spectrum of plants and animals in the region. Explicit conservation objectives were established for individual target species (fine-grain targets) and for conservation elements at larger ecological scales (coarse-grain targets) (see Fig. 12.2). Although these objectives were based on several different approaches, most were established in what has since been described as predefined analytical targets (Pressey, Cowling and Rouget 2003). Nearly all the objectives were set well above the targets established in other planning approaches that are policy driven (13%), conservation based (31%), or research based (42%) (Pressey, Cowling and Rouget 2003). For each target species, our goal was to make certain that adequate habitat is maintained in areas managed primarily for conservation to ensure long-term persistence of the species. Specifically, our objective was to ensure that between 75 and 100% of potential habitat for target species was classified as conservation land. The specific objective for each species varied with rarity and degree of endemism and by considering viability of individual potential populations and connectivity among areas thought to be inhabited by disparate populations. The objective for narrowly distributed endemics was established at 100% of potential habitat, and for more widely distributed species or those with significant populations outside the planning area, it was set at 75%. We also sought to ensure adequate representation of all plant communities and other important landscape features in the region in lands targeted for conservation (Table 12.2). This broader goal was established to complement the fine-filter approach of focusing on the conservation of individual target species (Haufler 1999).

Table 12.2 Plant communities, Brown, Lowe, and Pase (1980) classification, coverage in Pima County, and percentage of that area included within the Conservation Lands System (CLS). Other classification includes all plant communities that represent areas <5 km^2 combined

Plant community	Classification	Area in county (km^2)	Area included in CLS (%)
Pine forest	122.32	20.5	100.0
Pine	122.62	49.0	97.0
Oak–pine	123.3	24.9	100.0
Encinal	123.31	699.0	92.1
Oak–pine	123.32	111.6	81.0
Manzanita	133.32	61.4	36.0
Mixed sclerophyll	133.36	43.8	65.6
Scrub–grassland	143.1	545.5	96.9
Sacaton	143.14	11.1	100.0
Mixed grass–scrub	143.15	3950.5	93.4
Scrub disclimax	143.16	8.5	100.0
Creosote-tarbush	153.21	42.0	96.5
Chihuahuan mixed scrub	153.26	14.2	100.0
Sonoran desert scrub	154.1	513.6	78.1
Creosote bursage	154.11	3961.1	62.7
Paloverde-saguaro	154.12	12482.7	28.1
Saltbush	154.17	40.4	100.0
Interior riparian deciduous forest	223.2	23.6	100.0
Mesquite forest	224.52	107.2	92.5
Cottonwood-willow	224.53	13.7	99.1
Sonoran riparian scrub	234.7	28.5	93.8
Riparian scrub	234.71	25.4	36.0
Strand	254.7	21.2	88.3
Others		19.7	99.5

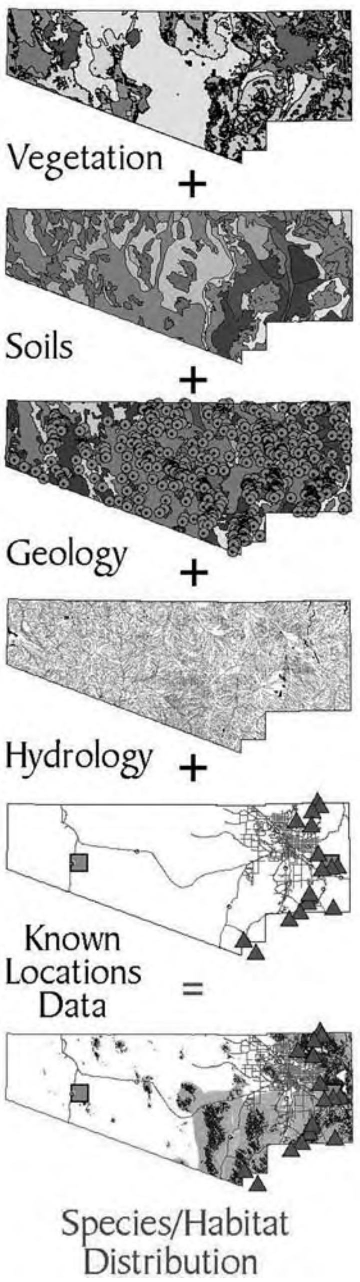
Modeling Potential Habitat

We explored several approaches to identify areas of high conservation value, all derived from geographic distributions of target species. We considered distributions based on the scientific literature, existing databases of documented locations (e.g., Natural Heritage Program databases), and expert opinion. Although aspects of each of these sources were incorporated in the design process, we relied primarily on models that predict the potential of each landscape unit to provide habitat for each target species. We chose to model potential habitat because it offered several distinct advantages over other alternatives. For example, published distributions are too general at and above the regional scale because they focus on the geographic limits of a species and typically include large areas that are uninhabitable by the species of interest. Documented locations are uneven in geographic coverage and are often biased toward areas commonly traveled and underrepresent remote areas. Expert opinion also has significant limitations because “on-the-ground” knowledge is rarely complete. Most species experts, however, know well the environmental features that provide habitat for a species. The last and perhaps most significant advantage of the approach is that habitat can be identified even if the species is currently absent from an area. This is especially likely for many jeopardized species. When populations are suppressed, there are almost certainly areas on the landscape that provide the full range of conditions necessary to function as habitat for a species, yet are currently unoccupied. Despite being unoccupied, these areas provide important targets for conservation because they identify areas in which threatened and endangered species might recover. Therefore, predicting the distribution of potential habitat for each species provided useful information and served as the foundation of the conservation plan.

We developed a spatially explicit model that predicts the distribution of potential habitat across the planning area for each target species, based on values established for four major categories of environmental features represented by 130 variables, each classified for every landscape unit. Environmental features included vegetation and land cover characteristics (60 variables, e.g., mixed broadleaf forest cover, agriculture), hydrology characteristics (11 variables, e.g., perennial stream width, groundwater depth), topographic and landform characteristics (45 variables, e.g., elevation, slope, aspect), and geologic characteristics (14 variables, e.g., soil type, presence of carbonates) (Fig. 12.3). Each feature was represented in a GIS layer.

Values used to represent the importance of each environmental feature to each species were based on expert opinion. We asked species experts to score the value of each environmental feature on the basis of its relative importance to habitat for each species, from unimportant (value = 0) to essential (value = 3). Experts were also asked to identify whether the absence of a specific feature kept an area from functioning as habitat for the species. For example, if elevation of a landscape unit was beyond the elevational limits of a species yet contained all other necessary habitat features, the unit was classified as having no potential as habitat. We then computed a simple sum of scores for the environmental features relevant to a species, thereby producing a suitability surface that represented the distribution of habitat

Fig. 12.3 Stylized illustration of several environmental features used for modeling the distribution of potential habitat for each species and the known locations and final model for one species. Source: Steidl, Shaw and Fromer



potential for each species on each landscape unit. The suitability surface was based on the presence of environmental features important to habitat for the species and classified as none, low, moderate, and high.

The modeling process was iterative (Fig. 12.2). Initial distributions of potential habitat were evaluated by experts and compared with a database of known locations; models were subsequently refined iteratively until experts thought the model provided a parsimonious representation of habitat potential for the species. This process resulted in a distribution of potential habitat for each target species across the planning area as predicted from biological and physical characteristics of each landscape unit (Fig. 12.3).

After exploring a series of alternatives, we reduced the range of scores for habitat potential for a species on each landscape unit into two classes: high potential and less than high potential. A GIS was then used to overlay areas of high potential habitat for all species to produce a map portraying species richness (i.e., number of species with high potential habitat value) for each geographic unit. This metric (species richness of target species) became the fundamental measure we used to classify the landscape into a collection of discrete polygons representing different levels of biological value on which we established the Conservation Lands System.

Conservation Lands System

After estimating the number of target species on each landscape unit—species richness—we evaluated the spatial arrangement, overall coverage, and success that different levels of species richness achieved toward meeting our conservation objectives (Fig. 12.4). Ultimately, areas with species richness of three or higher were

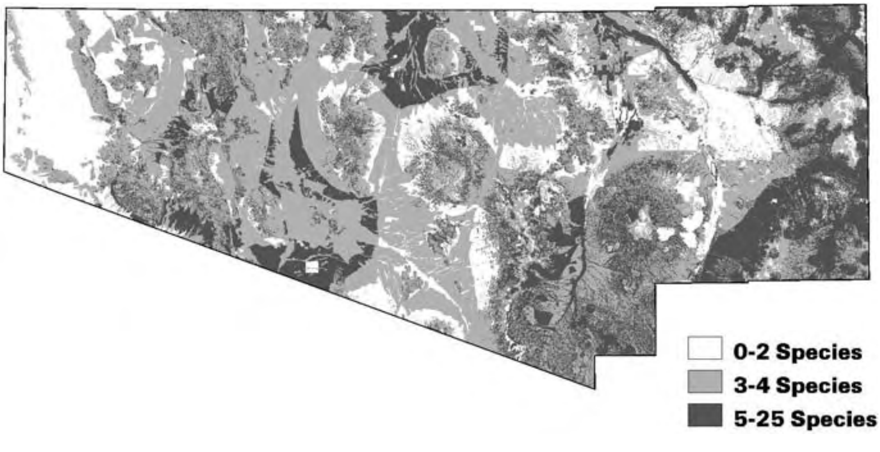


Fig. 12.4 Predicted richness of target species in Pima County. Areas with three or more species were considered to be of high conservation value and provided the starting point for the network of conservation lands. Source: Steidl, Shaw and Fromer

classified as lands with the highest conservation value. These lands were considered necessary components in all possible land allocation alternatives. Therefore, these areas became the starting point for the conservation plan, including the network of conservation lands called the Conservation Lands System (CLS). Lands with species richness of five or more were classified as areas of highest biological value. These lands were classified as the basis for establishing areas designated as "biological core" to represent their high conservation value. Lands with species richness of three or four were classified as areas of moderate to high biological value. These were identified as "multiple-use" lands, representing their importance for conservation, yet distinguishing them from lands classified as biological core.

The level of species richness used to distinguish lands of differing conservation value will be unique to each planning process and region. Ultimately, the decision will be the product of the number of target species used in a planning process, the range of environments in the target landscape, and the goals established for each plan. In our case, the levels of species richness identified a parsimonious network of lands that achieved the goals and objectives established for reserve design.

Each land classification within the CLS was associated with conservation targets that complement anticipated land-use change. The classifications ranged from 66.7 to 95%. Lands classified as "biological core" mandated a lower limit of 75% conservation (i.e., allow land-use change of 25% or less), "multiple-use" lands required a lower limit of 66.7% conservation, and "riparian areas" called for a lower limit of 95% conservation.

Setting boundaries for contiguous landscape units that share the same classification—called a "patch"—followed guidelines reported in the scientific literature on reserve design that maximizes conservation benefits in each patch and across the network of patches. For example, we sought to maximize the size of each patch, minimize distances between adjacent patches, maximize contiguity, and minimize fragmentation within and among patches. Additionally, we adjusted boundaries to better meet the conservation objectives established for target species and plant communities (see Table 12.3).

Ultimately, lands within the CLS covered 88% of the 13,723 km^2 planning area and are predicted to preserve an average of 75% of potential habitat (range = 28–100%) for the target species at build-out. Within the 12,073 km^2 CLS, 57% of the lands are federal, 24% state, 14% private, and 5% county/city. With a high percentage of land in public ownership, achieving the established conservation objectives for CLS lands seems tenable, although a portion of state-owned land remains open to development. Currently, about 4% of the CLS area is developed, with an additional 4% predicted to be developed in the future (ESI Corporation 2003). Although the quantity of development predicted at build-out will total <10% of the overall CLS, nearly all current and future developments are concentrated in the eastern portion of the county, which compromises the conservation value of these areas considerably (Fig. 12.5).

Table 12.3 Additional biological elements incorporated into the Conservation Lands System for the Sonoran Desert Conservation Plan

Group	Special element
Plant communities	Desert ironwood desert scrub (154.12 and 154.13)[a]
	Douglas fir-mixed conifer forests (122.61)
	Grasslands on unincised floodplains (143.1)
	Oak–scrub grassland ecotones (123.31 and 143.1)
	Sacton grasslands (143.14)
	Saltbush desert scrub (154.17)
	Upland grasslands, mixed grass–shrub (143.15)
Riparian areas	Cottonwood-willow forests (223.21 and 224.53)
	Mixed-broadleaf deciduous forests (223.22)
	Mesquite woodlands (224.52)
	Sonoran riparian scrub (234.71 and 154.1)
	Cattail (244.71)
Aquatic	Streams with perennial and intermittent flow
	Springs, cienegas, and other aquatic environments
Geologic and other	Caves, mine adits, and bridges occupied by bats
	Limestone outcrops
	Talus slopes

[a] Brown, Lowe, and Pase (1980) biotic community classification.

Riparian Areas as a Foundation for Connectivity

Riparian ecosystems typically support more and different species than adjacent upland systems in the southwest and are especially crucial to supporting biodiversity in desert biomes (Zaimes 2007). Riparian systems are also especially vulnerable to degradation imposed by development, as illustrated by the high loss of riparian plant communities compared to all other plant communities in the region (Baker et al. 2004). In addition to providing habitat for riparian species, riparian areas function as corridors for animal movements, especially across arid landscapes. These corridors form a natural network that links disconnected conservation lands (see Chapter 10 for a discussion of riparian conservation). Consequently, the conservation goals set for riparian areas are the highest among all lands (95%), in part because they foster connectivity across the landscape.

To enhance connectivity, landscape areas with current or anticipated barriers to animal movements were identified because they reduced the large-scale effectiveness of the CLS. We also recommended removal of, or modification to, existing barriers to facilitate movement and enhance connectivity among conservation lands, particularly those associated with major transportation corridors (see Chapter 5 for discussion of wildlife corridors and connectivity).

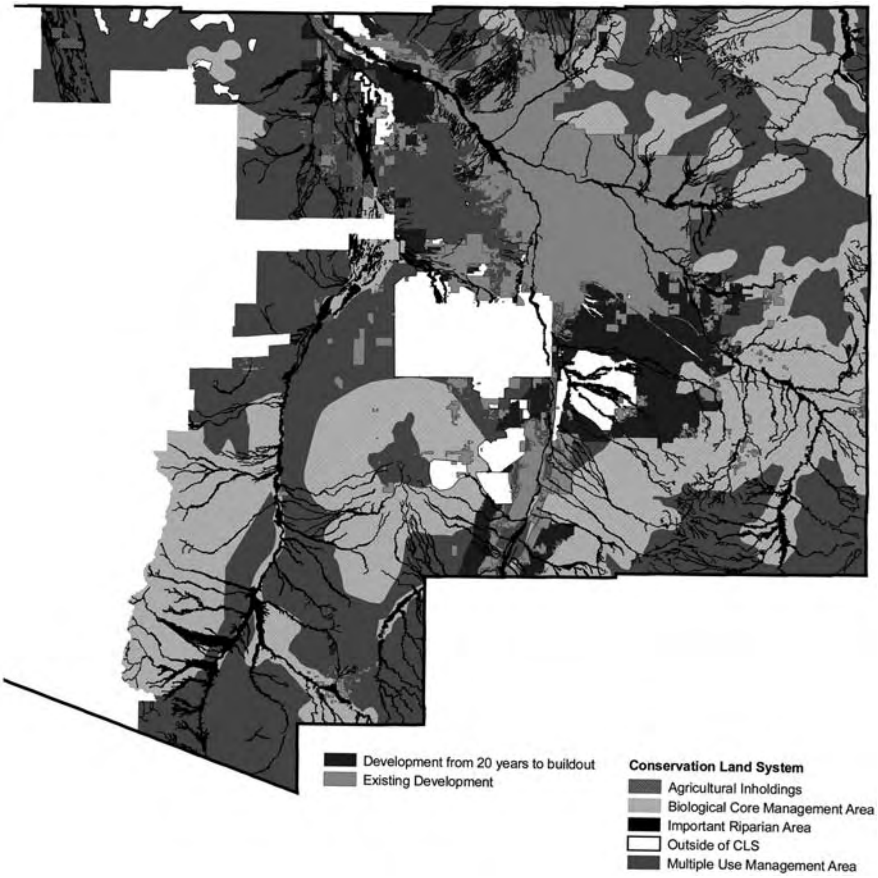


Fig. 12.5 Conservation Lands System and areas of existing and predicted future development in eastern Pima County. Source: Steidl, Shaw and Fromer

From Conservation Planning to Conservation Reality

No matter how carefully designed or how much biological potential they embody, conservation plans accomplish little unless land management reflects the plan. Without question, the majority of conservation plans have not realized their full potential because of the expense involved and/or the opportunity costs imposed by conservation rather than development. Nonetheless, many strategies foster the success of large-scale conservation plans, including conservation easements, transfer of development rights, incentives to private landowners, and the outright purchase of lands (see Chapter 13 for a discussion of land conservation devices). In Pima County, a range of alternatives have been employed, including ratification of a county-wide bond initiative in 2004 that provided $174.3 million for acquisition of high conservation value lands. Perhaps the most far-reaching and effective strategy, however, has been a change in planning guidelines at the county level that reflect CLS boundaries and the conservation goals set forth in the SCDP. In Pima County, land-use change must follow a series of guidelines that ensure that development does not exceed conservation targets established for all lands within the CLS.

Conclusion

A region-wide approach to conservation planning enables a framework that conserves biodiversity while minimizing the disjointed array of conservation lands that result from small-scale conservation driven primarily by opportunism. A synthetic approach to regional planning is more effective for conservation and reduces the need for future listings under ESA, hence minimizing the regulatory challenges faced by developers.

Ultimately, conservation-minded regional planning consists of a set of consequential experiments that respond to the uncertainty of large-scale efforts such as the SDCP. The effectiveness of ambitious plans, such as the SDCP (or any MSHCP), can be reliably established only by measuring temporal changes in the natural resources that plans seek to conserve. Plans, therefore, must be accompanied by a rigorous monitoring program designed to quantify changes in natural resources over time and measure responses to land management actions. Although HCPs require a monitoring plan, the strategies that accompany many HCPs have been criticized (Kareiva et al. 1999). The monitoring and adaptive management programs developed for the SCDP respond to these criticisms by moving beyond requirements for MSHCPs. This revised approach ensures persistence of all biodiversity in the region by moving from monitoring single species to a broader and more ambitious goal of monitoring aspects of ecosystem structure and function, as well as threats across planning areas.

Land-use plans must incorporate change by being sufficiently flexible. As lands transition to their future uses, the planning footprint will inevitably change in response to unforeseen social pressures, novel conservation opportunities, and new scientific information. Incorporating these changes requires that planning frameworks incorporate new knowledge and respond accordingly; this is the purview of adaptive management. Land-use plans are only the first step in developing responsible regional management and conservation plans that are ultimately refined as uncertainty is reduced through rigorous monitoring and adaptive management (Wilhere 2002). Although much effort is devoted to initial planning, monitoring and adaptive management receive far less attention, including fewer financial and intellectual resources. Until the effectiveness of plans is evaluated rigorously and new information is collected to refine land-use decisions, regional HCPs pose a risk to the species they are designed to protect.

References

Baker, M. B. Jr., Ffolliott, P. F., DeBano, L. F., and Neary, D. G. 2004. Riparian Areas of the Southwestern United States. Boca Raton, FL: Lewis Publishers/CRC Press.

Benedict, M., Drohan, J., and Gravely, J. 2005. Sonoran desert conservation plan, Pima County, Arizona. Green Infrastructure – Linking Lands for Nature and People: Case Study Series # 6. Arlington, VA: The Conservation Fund.

Brown, D. E., Lowe, C. H., and Pase, C. P. 1980. A Digitized Systematic Classification for Ecosystems with an Illustrated Summary of the Natural Vegetation of North America. USDA Forest Service General Technical Report RM-73. Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station.

ESI Corporation. 2003. Pima County Economic Analysis. Report to Pima County. Available at: http://www.pima.gov/cmo/sdcp/reports.html. Accessed November 10, 2008.

Haufler, J. B. 1999. Strategies for conserving terrestrial biological diversity. In Practical Approaches to Conservation of Biological Diversity, eds. R. Baydeck, H. Campa III, and J. B. Haufler, pp. 17–34. Washington, D.C: Island Press.

Kareiva P., Andelman, S., Doak, D., Elderd, B., Groom, M., Hoekstra, J., Hood, L., James, F., Lamoreux, J., LeBuhn, G., McCulloch, C., Regetz, J., Savage, L., Ruckelshaus, M., Skelly, D., Wilbur, H., Zamudio, K., and NCEAS HCP working group. 1999. Using Science in Habitat Conservation Plans. Santa Barbara, CA: National Center for Ecological Analysis and Synthesis, University of California, Santa Barbara.

Noss, R., and Cooperrider, A. 1994. Saving Nature’s Legacy: Protecting and Restoring Biodiversity. Washington, D.C.: Island Press.

Omernik, J. M. 1987. Ecoregions of the conterminous United States. Annals of the Association of American Geographers 77:118–125.

Pressey, R. L., Cowling, R. M., and Rouget, M. 2003. Formulating conservation targets for biodiversity pattern and process in the Cape Floristic Region, South Africa. Biological Conservation 112:99–127.

Svancara, L. K., Brannon, R., Scott, J. M., Groves, C. R., Noss, R. F., and Pressey, R. L. 2005. Policy-driven versus evidence-based conservation: A review of political targets and biological needs. BioScience 55:989–995.

Warshall, P. 1995. The Madrean sky island archipelago: a planetary overview. In Biodiversity and Management of the Madrean Archipelago: The Sky Islands of Southwestern United States and Northwestern Mexico, eds. L. F. DeBano, G. J. Gottfried, R. H. Hamre, C. B. Edminster, P. F. Ffoliott, and A. Ortega-Rubio, pp. 6–18. Fort Collins, CO: USDA Forest Service, Rocky Mountain Experimental Station General Technical Report RM-GTR-264.

Wilhere, G. F. 2002. Adaptive management in habitat conservation plans. Conservation Biology 16:20–29.

Zaimes G. N. 2007. Understanding Arizona’s Riparian Areas. Tucson, AZ: University of Arizona Cooperative Extension, Publication No. AZ1432.