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APPLIED CONSERVATION PLANNING AND IMPLEMENTATION IN THE US-MEXICO BORDERLANDS

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Abstract. The Nature Conservancy (TNC) and partners implement conservation strategies using an integrated framework with four components: setting goals and priorities, developing strategies, taking action, and measuring results. This framework, called Conservation by Design, is illustrated with specific examples that relate to US-Mexico borderland bird conservation, including the Chihuahuan Desert Ecoregional Plan, a conservation action planning process in this and surrounding regions, the acquisition of private lands, and the implementation of a comprehensive wintering grassland bird monitoring plan. For the specific purposes of long-term bird conservation, many of the elements of this process are captured by TNC's Prairie Wings project, an example of a large-scale conservation implementation plan.

Key Words: Conservation by Design, Chihuahuan Desert, The Nature Conservancy.

PLANEACIÓN PARA LA CONSERVACIÓN APLICADA Y SU IMPLEMENTACIÓN EN LA FRONTERA MÉXICO-EEUU

Resumen. The Nature Conservancy (TNC) y sus socios implementan estrategias de conservación usando un marco estratégico con cuatro elementos básicos: establecimiento de metas y prioridades, desarrollo de estrategias, toma de acciones, y medición de resultados. Este marco, se llama "Diseño para la Conservación", se ilustra con ejemplos que pertenecen a la conservación de las aves de la frontera México—EEUU. Los ejemplos incluyen el Plan Ecorregional del Desierto Chihuahuense, el proceso para Planeación para la Conservación de Areas como se ha sido implementado en esta ecorregión y sus alrededores, adquisición de tierras privadas, y el desarrollo de un plan de monitoreo para las aves de los pastizales del norte de México. Muchos de estos componentes de la conservación de aves para el largo plazo son parte del proyecto "Prairie Wings" de TNC, un ejemplo de un plan para la implementación de conservación de escala grande.

The long-term conservation of wide-ranging or migratory species requires coordination among conservation partners across numerous boundaries, both ecological and political. This need for coordination, coupled with widespread evidence of long-term declines in numerous taxa of migratory birds, has spawned efforts at conservation planning and, to some extent, implementation, across North America and at wider spatial scales (Brown et al. 2001, Kushlan et al. 2002, Rich et al. 2004, USDI Fish and Wildlife Service 2004). However, particularly when efforts must span complex ecological and political arenas, a strong need remains for a participatory and ecosystem-based regional conservation approach that can be facilitated by the non-governmental sector. This paper introduces the conservation approach applied by TNC to US-Mexico borderland birds as a means of addressing these needs.

TNC has used an integrated conservation framework called Conservation by Design since 1996 for all its activities (Baumgartner et al. 2006). This science-based conservation approach has four components: setting goals and priorities, developing strategies, taking action, and measuring results. Although TNC's broad conservation mission encompasses plants, animals, and ecological communities, specific bird conservation priorities have been incorporated throughout the Conservation by Design process. Given the current focus of modern conservation planning on ecosystem or ecoregional-based planning units, borderlands conservation projects provide a useful way of illustrating the application of these processes.

SETTING GOALS AND PRIORITIES

Goals and priorities are identified using a planning process applied at ecoregional scales and embedded within major habitat types. An example of this in the US-Mexico borderlands is the Chihuahuan Desert Ecoregional Plan (Cotera et al. 2004). This plan, a joint project of Pronatura Noreste, TNC, and World Wildlife Fund, identifies conservation priority sites with the aim of conserving biodiversity throughout the Chihuahuan Desert ecoregion (Fig. 1). This area encompasses a wide swath of the borderlands, including parts of the states of Texas and New Mexico in the US and Chihuahua, Coahuila, Durango, Zacatecas, San Luis Potosí, and Nuevo León in Mexico. The Chihuahuan Desert is known for its biological diversity,

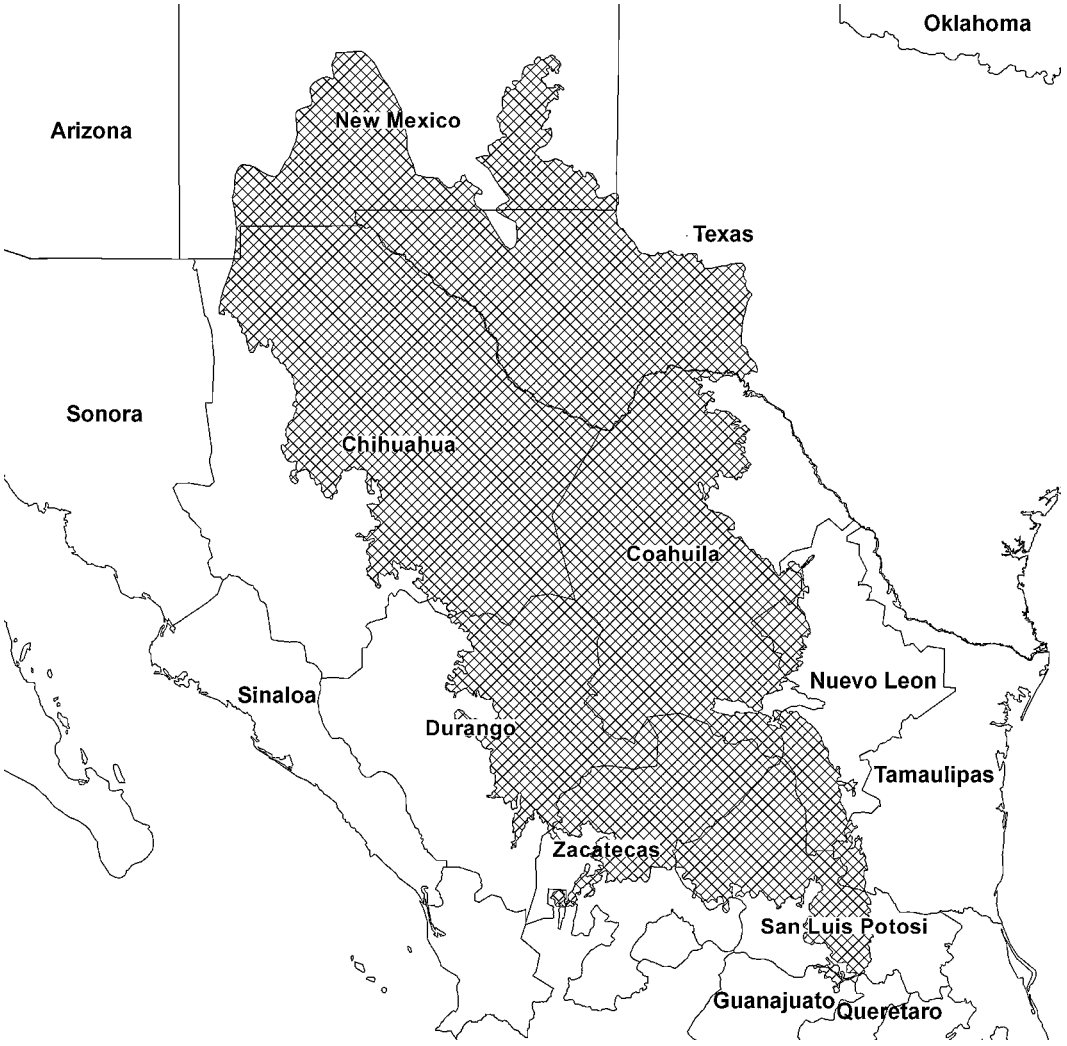

FIGURE 1. Map of the Chihuahuan Desert ecoregion, showing state boundaries in Mexico and the US (From Cotera et al. 2004).

particularly its endemic yuccas, cacti, and fish. In total, it supports more than 120 species of mammals, 300 species of birds, 110 species of fish, and more than 170 species of amphibians and reptiles (Cotera et al. 2004).

The goal of the ecoregional planning process is to generate a portfolio of areas that, if conserved, would protect the biodiversity of an ecoregion over the long-term. The process starts with identifying a broad suite of ecological targets of a variety of types (e.g., species or ecological systems) and a variety of geographic scales (Groves et al. 2000, Poiani et al. 2000). For the Chihuahuan Desert, initial lists of targets that met one or more of the following criteria were compiled:

1. Rare, having high global ranks (NatureServe 2007) or deemed rare by an expert.
2. Endemic to the Chihuahuan Desert.
3. Limited to two or three ecoregions including the Chihuahuan Desert.
4. Disjunct populations important for evolution.
5. Key indicators of quality habitat.
6. Keystone taxa, such as prairie dogs (*Cynomys* spp.)
7. Taxa for which the Chihuahuan Desert is key to the target's overall success, such as wintering migratory birds.
8. Taxa or plant communities for which there is evidence of serious immediate or impending decline.

9. Ecological systems that represent all naturally occurring plant communities in the ecoregion.

Initial lists of potential targets meeting these criteria were developed and reviewed by biologists and ecologists familiar with the Chihuahuan Desert and its flora and fauna. Of a grand total of 649 targets selected, 15 were birds (Table 1). Although birds appear at first glance to comprise only a small proportion of targets, a large number of additional bird taxa in the ecoregion were considered to be captured or subsumed by other targets at different scales, such as ecological systems. For example, the desert scrub ecological system was considered to include numerous shrubland birds, such as wintering Brewer's Sparrow (*Spizella breweri*), and the grassland ecological system to include Sprague's Pipit (*Anthus spragueii*).

To generate the actual portfolio of areas, known locations (occurrences) of all targets were plotted onto a planning grid of 2,000 ha hexagons across the entire ecoregion. Such locations were compiled from the literature, museum specimens, Natural Heritage Program databases, and scientists with knowledge of each taxon and the ecoregion. Goals were established for the number of occurrences of each target that needed to be captured in the final portfolio. Typically, the goal for any given target depended on its global rarity and the degree to which its distribution is confined to the ecoregion; rare species and those with restricted distributions had higher goals for the ecoregion than more common species with widespread distributions (Groves et al. 2000, Cotera et al. 2004). For many targets, goals were also specified for subregions or other strata within the ecoregion, to ensure appropriate spatial distribution of the target within the final portfolio (Groves 2003).

A map of the human impact on the Chihuahuan Desert ecoregion was developed, including relative area or density of urban areas, tilled agricultural lands, roads, railroads, powerlines, and protected areas. This map was used as a relative cost surface input to a software package (SITES; Davis et al. 2002) that helped design an efficient ecologically based portfolio of conservation areas that met the specified goals for each target while at the same time minimizing total area and cost from the human impact layer. The most efficient portfolio, as selected by the software package, was reviewed by biologists and staff from all institutions participating in the process to eliminate areas accidentally included, consolidate certain adjacent areas, and identify gaps in the resulting output. The final portfolio (Fig. 2) included 125 conservation areas which cover 24% of the entire ecoregion.

All of the 15 avian target taxa occurred within the final ecoregional portfolio (at least one site at which each taxon was known to occur was part of the portfolio). However, for only four of these taxa (27%) was the entire goal for that taxon completely captured within the portfolio. A primary cause for the failure to meet the entire goal for most taxa is the absence of accurate location data on the presence of viable occurrences. These data gaps are typical of planning for large ecoregions such as the Chihuahuan Desert and must be closed in future iterations of this planning process. The effort to make an efficient portfolio of the smallest total area probably also contributes to the failure to include more of the goal for each taxon, since single sites with one or a few total targets are unlikely to be included.

TABLE 1. AVIAN TAXA SELECTED AS CONSERVATION TARGETS IN CHIHUAHUAN DESERT ECOREGIONAL PLAN.

Species	Seasonal status	Reason for inclusion
Ferruginous Hawk (*Buteo regalis*)	wintering	Declining populations
Aplomado Falcon (*Falco femoralis*)	resident	Endemic subspecies
Snowy Plover (*Charadrius alexandrinus*)	breeding	High global rank, limited ecoregional distribution
Mountain Plover (*Charadrius montanus)*	breeding sites	High global rank, disjunct breeding population
Least Tern (*Sternula antillarum*)	breeding sites	Disjunct population
Burrowing Owl (*Athene cunicularia*)	resident	Declining populations
Spotted Owl (*Strix occidentalis*)	resident	High global rank
Willow Flycatcher (*Empidonax traillii*)	breeding	High global rank, US Endangered subspecies
Bell's Vireo (*Vireo bellii*)	breeding	Declining populations
Black-capped Vireo (*Vireo atricapilla*)	breeding	High global rank, limited ecoregional distribution; US Endangered
Gray Vireo (*Vireo vicinior*)	breeding	Disjunct population
Cave Swallow (*Petrochelidon fulva*)	breeding	Endemic subspecies
Colima Warbler (*Vermivora crissalis*)	breeding	Limited ecoregional distribution
Worthen's Sparrow (*Spizella wortheni*)	resident	Endemic
Baird's Sparrow (*Ammodramus bairdii*)	wintering	Limited ecoregional distribution

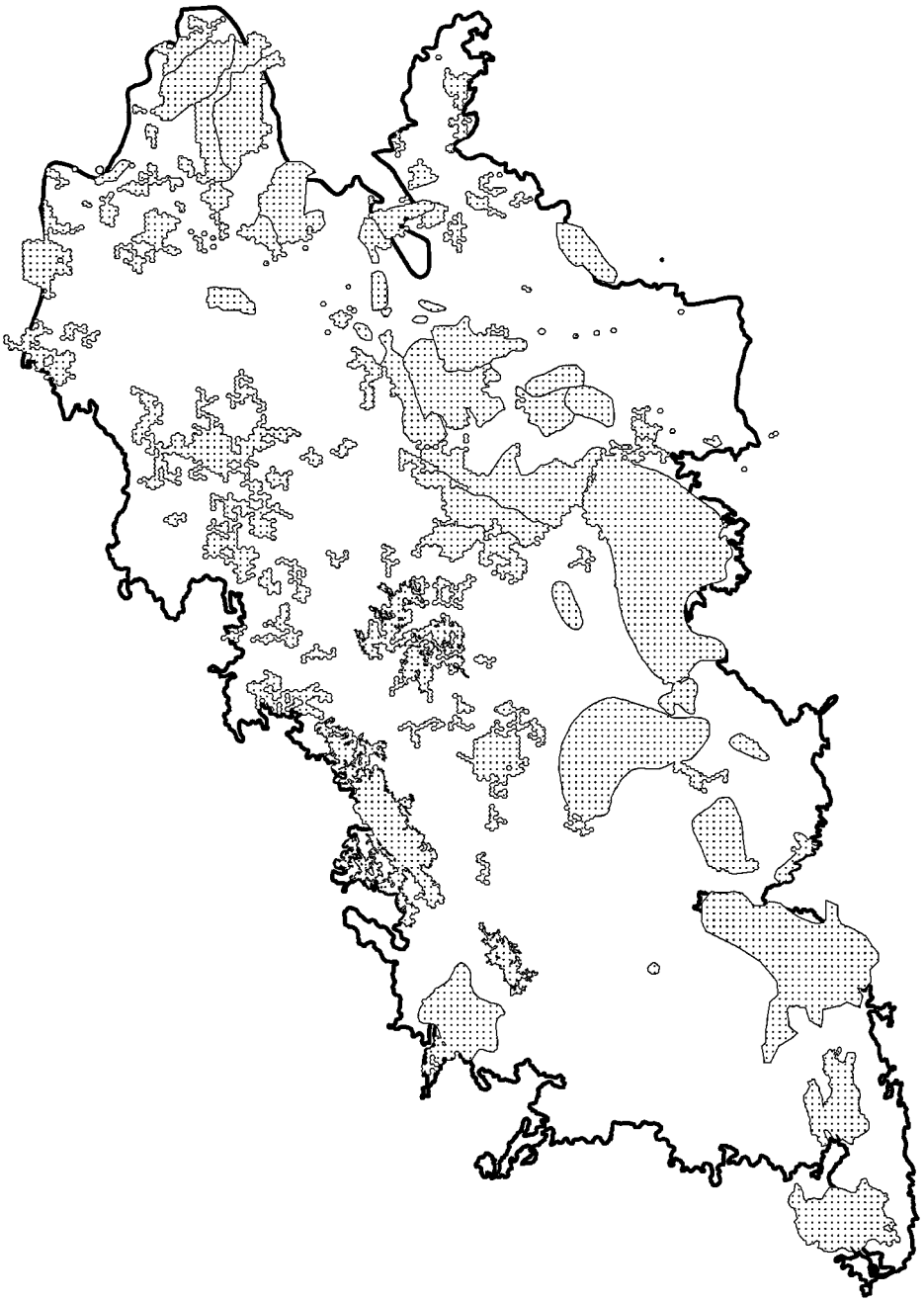

FIGURE 2. Chihuahuan Desert ecoregional portfolio of potential conservation areas (From Cotera et al. 2004). The heavy black line is the outline of the ecoregion, as in Fig. 1. The stippled areas are the portfolio sites, selected as described in the text.

DEVELOPING STRATEGIES

After conservation areas were identified through the ecoregional planning process, strategies and actions for the long-term conservation of biodiversity were developed. These strategies and actions were focused on abating the threats to one or more of the conservation targets at each area. In the borderlands region, this process was applied to a suite of conservation sites that shared common grassland bird species. Highly mobile conservation targets, such as birds, are often more easily dealt with in terms of suites of sites, because in addition to sharing targets, sites are likely to share threats and conservation strategies. A Conservation Action Planning process was carried out at five different conservation areas in the Chihuahuan Desert or adjacent ecoregions (The Nature Conservancy 2000). All were significantly important for shortgrass prairie and associated grassland birds and other taxa: Mescalero sandsheet, New Mexico; Marfa grasslands, Texas; San Pedro River, Sonora; Janos grasslands, Chihuahua; and Saltillo grasslands, Coahuila and Nuevo León. For each site, teams of experts first identified a small subset of conservation targets that represented the biodiversity at the site, reflected conservation goals for the respective ecoregion, and faced some level of threat. Next, threats that were known or highly suspected to impact each target were tabulated. Each threat was also ranked on a four-level scale (very high, high, medium, low) by assessing the severity and scope of its effect. The results were then rolled up across all sites into a combined analysis (Table 2). Although a total of 28 threats were identified across the five sites, only two were common across all or nearly all sites: grazing practices and conversion to agriculture. The remaining threats, though potentially of high priority at individual sites, are more idiosyncratic in their nature and vary in rank across the larger grassland landscape.

The causes or sources of these threats were then identified and also ranked by their degree of contribution to each threat and the irreversibility of the threat. For highly ranked causes of threat, site teams then developed conservation strategies that were designed to address the

TABLE 2. SUMMARY OF COMBINED THREATS TO CONSERVATION TARGETS AT FIVE SITES IN THE CHIHUAHUAN DESERT OR ADJACENT ECOREGIONS, WITH THREAT RANK AT EACH SITE INDIVIDUALLY AND COMBINED ACROSS ALL SITES INDICATED. THREAT RANKS: VH = VERY HIGH; H = HIGH; M = MEDIUM; L = LOW.

Threat	San Pedro River	Mescalero sandsheet	Marfa grasslands	Janos grasslands	Saltillo grasslands	All Sites
Grazing practices	H	H	H	VH	VH	VH
Conversion to agriculture	L	H	M	H	VH	VH
Development of roads or utilities	L	-	-	M	H	H
Inappropriate herbicide use	-	H	-	-	-	H
Oil or gas development	-	H	-	-	-	H
Poisoning	-	-	-	H	-	H
Invasive species	H	-	L	-	M	H
Excessive extraction of subterranean water	M	-	-	-	M	M
Policies and programs for incompatible development	-	-	-	-	H	H
Agricultural practices	-	-	-	-	H	H
Subdivision and development	-	-	H	-	-	H
Watershed management	-	-	H	-	-	H
Dairies and associated development	-	M	-	-	-	M
Perception of competition between livestock and prairie dogs	-	-	-	M	-	M
Incompatible pasture and boundary fences	-	-	M	-	-	M
Construction of ditches, dikes, drainage or diversion systems	M	-	M	-	-	M
Irrigated agriculture	-	M	-	-	-	M
Parasites/pathogens	M	-	-	-	-	M
Altered fire regime	M	L	M	-	-	M
Commercial and industrial development	L	-	L	-	-	L
Recreational use	-	-	-	-	L	L
Water treatment	L	-	-	-	-	L
Off road vehicles	-	L	-	-	-	L
Erosion	-	-	-	-	L	L
Hunting practices	-	L	-	-	L	L
Wind energy	-	L	-	-	-	L

cause and mitigate the threat. Generally, such strategies include activities such as the protection of legal interests in land or water, implementation of adaptive management on public or private lands, implementation of policy measures, or the initiation of compatible development activities (The Nature Conservancy 2000). For the Mescalero sandsheet, New Mexico site, three initial conservation strategies of high priority and high potential to abate important threats were identified: protection of ranches at risk of conversion to agriculture, implementation of best management practices for oil and gas leases on federal lands, and creation of areas of restricted use on federal lands.

TAKING ACTION

Once strategies have been identified and prioritized, implementation of on-the-ground conservation begins. In this phase, private or public conservation partners, either based in Mexico or the US, initiate a wide variety of conservation actions. These actions use all methods in the conservation toolbox, from land protection by acquisition or easements, to invasive species control, to public policy implementation. Ideally, TNC seeks to use its limited resources for conservation as efficiently as possible while at the same time achieving as much leverage as possible.

An illustrative example of conservation action in the borderlands region is the ongoing conservation initiative for the grasslands in the Janos Valley of northern Chihuahua, Mexico. The Janos Valley has been identified by numerous priority setting exercises at a variety of spatial scales as being a top priority for biodiversity conservation. Some of these exercises and organizations include the Chihuahuan Desert ecoregional plan (Cotera et al. 2004), World Wildlife Fund (Dinerstein et al. 2000), Important bird areas program (Arizmendi and Márquez 2000), and the Commission for Environmental Cooperation (Karl and Hoth 2005). These planning efforts, as well as conservation area planning exercises conducted by TNC and partners, have identified and ranked numerous conservation strategies in the area, including the identification and acquisition of key tracts of land, establishment of a protected area over much of the intact grassland, community-based conservation education and landowner outreach, coalition building, partner capacity building, acquisition of grazing rights, and grass-banking.

A critically important step in beginning the implementation of conservation strategies was the acquisition in 2005 of the 18,545 ha Rancho El Uno near the town of Janos by TNC and Pronatura Noreste (PNE). This acquisition immediately halted two high-level threats to this property (overgrazing and unsustainable agriculture practices) and provides a solid platform from which to base more efficient and leveraged strategies such as implementation of sustainable grazing practices on private and communal lands in the area, habitat restoration, black-tailed prairie dog (*Cynomys ludovicianus*) recolonization, education, and community outreach. Bird species of conservation concern that occur regularly in the Janos Valley and that will benefit from the acquisition of Rancho El Uno and the implementation of other conservation strategies include Ferruginous Hawk (*Buteo regalis*), Mountain Plover (*Charadrius montanus*), Long-billed Curlew (*Numenius americanus*), Burrowing Owl (*Athene cunicularia*), Sprague's Pipit, Brewer's Sparrow, Baird's Sparrow (*Ammodramus bairdii*), Chestnut-collared Longspur (*Calcarius ornatus*), and at least 200 other avian species (Dieni et al. 2003, Manzano-Fischer et al. 2006).

This acquisition, coupled with the implementation of other strategies such as the declaration of a biosphere reserve and other protected areas at federal and state levels, use of conservation easements, and payments for environmental services, will be used to protect other key parts of the Chihuahuan Desert. These protection strategies, combined with environmentally compatible economic development alternatives and sustainable land management efforts that can be tested at Rancho El Uno, give hope for significantly increased quantity and quality of grassland and other habitats for birds in the US-Mexico borderlands over the decades to come.

MEASURING RESULTS

The final step in closing the loop of Conservation by Design is to measure the success of conservation strategies as they are applied, in order to continually refine the entire process in an adaptive manner. Measuring success is still in its infancy, as techniques that can provide the desired information and that are cost-effective and take reasonable time are still under vigorous discussion and development. A consensus is emerging among numerous conservation organizations that it is appropriate to measure conservation effectiveness by assessing the combination of biodiversity viability, threat status, and conservation management status (Higgins et al. 2007). It is when all three of these factors (fully viable biodiversity, lowered or eliminated threats, and effective land management) have been achieved that we can fully

claim to have achieved conservation success. Such measures will have to be implemented at multiple spatial scales, such as the individual conservation site or project area, ecoregion, biome, or even the entire globe.

In many contexts, especially in the borderlands region, birds provide a valuable tool for monitoring conservation success, though undoubtedly many other techniques will have to be used. To test this hypothesis, TNC and Rocky Mountain Bird Observatory, in collaboration with numerous partners in Mexico, are implementing a large-scale initiative to monitor wintering grassland birds in northern Mexico (Panjabi 2007a). This project's immediate objectives are to gather better and more detailed data on the spatial, temporal, and habitat distribution of wintering grassland birds across the Chihuahuan Desert in Mexico. Efforts will be concentrated in several conservation areas identified through the above-mentioned planning processes and focused on avian priority conservation targets as selected by the ecoregional and conservation action planning processes. As this project continues over time, we expect to be able to measure the success of the variety of conservation strategies being implemented in this region, as well as to expand the project to cover a wider spatial scale.

Preliminary results from the first season of monitoring, in which a line-transect bird survey methodology was implemented at randomly points within randomly chosen 10 km × 10 km blocks overlapping previously identified conservation priority areas (Panjabi 2007b), reported a total of 131 species. Of this total, sample sizes sufficient for further analysis were obtained for 41 species (31%), of which nine are considered conservation priorities by one or more national initiatives. These species are Scaled Quail (*Callipepla squamata*), Northern Harrier (*Circus cyaneus*), Long-billed Curlew, Burrowing Owl, Loggerhead Shrike (*Lanius ludovicianus*), Sprague's Pipit, Brewer's Sparrow, Grasshopper Sparrow (*Ammodramus savannarum*), and Chestnut-collared Longspur. Several high priority birds, such as Mountain Plover, Cassin's Sparrow (*Aimophila cassinii*), and Baird's Sparrow were not found in numbers sufficient for analysis. These results suggest that implementation of broad scale surveys will yield useful data for conservation monitoring on many species of interest. However, a comprehensive survey effort will require additional, specialized surveys for certain species that are rare, difficult to find, or hard to identify.

CONCLUSION

The Conservation by Design framework is a useful process for achieving conservation success. Although implemented primarily by TNC, many of its components have been and can be used by other parties to achieve their particular conservation goals. Avian conservation has proved difficult to achieve for a variety of reasons, not the least of which are the broad spatial scale that many migratory birds traverse during their life cycles, the numerous threats they face, and the strategies that must be applied to address these threats. For these reasons, TNC and partners have developed large-scale conservation programs responsible for implementing the steps in the framework described in this paper. An example of these large-scale programs, applicable to many borderland bird species, is the Prairie Wings project (McCready et al. 2005). Such a fully integrated set of conservation planning tools and techniques, committed partners, and a framework to guide them are necessary to accomplish the long-term conservation of US-Mexico borderlands birds and other avian communities elsewhere.