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Forum Paper

Conservation Credits—Evolution of a Market-Oriented Approach to Recovery of Species of Concern on Private Land

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ABSTRACT

When species are listed as threatened or endangered under the Endangered Species Act, there are often real or perceived negative consequences for landowners that may produce perverse incentives and lead to the elimination rather than protection of habitat for the species on private land. In Texas, where approximately 95% of the land is privately owned, the listing of one species and the potential listing of another led to the creation of two innovative programs aimed at incentivizing landowners to protect and improve habitat for the two species: Recovery Credit System for the Golden-Cheeked Warbler and Conservation Recovery Award System for the Dunes Sagebrush Lizard. Both programs were based on multistakeholder collaborations that included federal and state agencies, nongovernmental organizations, and private landowners, and which resulted in quasimarket mechanisms for the voluntary protection of habitat by landowners for the species of concern. Key components of both programs included confidentiality of landowner conservation agreements with the state's wildlife management agency and the creation of not-for profit organizations to implement contracts with landowners and disseminate payments for habitat conservation actions to landowners. These two programs have also informed efforts to protect the Lesser Prairie-Chicken and Greater Sage-Grouse, which are under threat on private land in multiple states. Seven lessons learned from protection programs for the four species presented in this article provide useful guidelines for the conservation of other at-risk species on private land elsewhere.

Introduction

Biodiversity conservation in states such as Texas, where land is primarily privately owned, depends on the protection of wildlife habitats from deleterious land use change. This is especially critical for threatened and endangered species that occur mainly on private land. One increasingly common approach used to protect open landscapes from development is the selling or granting of a conservation easement by landowners (Rissman et al., 2007; Stroman and Kreuter, 2014, 2015). By selling or granting conservation easements, landowners voluntarily transfer their development rights to a land trust, such as The Nature Conservancy. Generally, these transfers of development rights are in perpetuity and become a deed restriction for current and future landowners. Landowners who are concerned about the dilution of their property rights are generally unwilling to sell or grant conservation easements on their land. This may be especially true in states where landowners tend to hold stronger private property rights orientations than in states with significant areas of public land (Jackson-Smith et al., 2005; Kreuter et al., 2006). Additionally, it may be unnecessary to protect in perpetuity all habitats for threatened and endangered species because the need for habitat protection may decline if populations of at-risk species recover and where sufficient habitat protections are in place to ensure long-term sustainability of this recovery. Texas has been the leader of programs that address the dual issues of landowner concerns about granting perpetual conservation easements and the potential short- to medium-term needs for habitat protection for threatened and endangered species (Sorice et al., 2012).

The Endangered Species Act (ESA) of 1973 forbids federal agencies from authorizing, funding, or carrying out actions that may "jeopardize the continued existence of" endangered or threatened species (Section 7[a] [2]) and it forbids any government agency, corporation, or citizen from taking endangered animals without written permission from the US Fish and Wildlife Service (USFWS). Once a species has been listed as endangered, the ESA requires that "critical habitat" for the species must be designated, including areas necessary to recover the species (Section 3[5] [A]), and federal agencies are forbidden from carrying out any action that "destroys or adversely modifies" such habitat (Section 7[a] [2]). The restrictive prescriptions of the ESA

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have impacted many private landowners whose properties incorporate endangered species habitat because there is no provision for compensation for the loss of use rights on land where such habitat occurs (Sugg, 1993). Accordingly, many landowners view the ESA as unfair and their efforts to protect endangered species habitat as unrecognized by society (Olive, 2016). Such negative attitudes can perversely incentivize landowners to eliminate rather than conserve endangered species habitat. Mechanisms that compensate landowners for conserving threatened or endangered species habitat could help overcome such perverse incentives (Sorice et al., 2012).

Central and western Texas are renowned for their scenic amenities and high potential for wildlife-related recreational opportunities. Central Texas is also home to Fort Hood, the nation's largest active duty armored post, and two endangered bird species, the Black-Capped Vireo *(Vireo atricapilla)* and Golden-Cheeked Warbler *(Setophaga chrysoparia)*, while western Texas and eastern New Mexico are home to another species that is under pressure, the Dunes Sagebrush Lizard *(Sceloporus arenicolus)* (DSL). Both central and western Texas are characterized by rapid development (urbanization and oil/gas extraction, respectively) and by landowners with strong private property rights orientations (Kreuter et al., 2006). This combination of characteristics has led to the development and evolution of an innovative and flexible market-oriented conservation approach that is providing valuable lessons for enhancing habitat for other at-risk species on private land in the United States, especially the Lesser Prairie-Chicken *(Tympanuchus pallidicinctus)* and the Greater Sage-Grouse *(Centrocercus urophasianus)*.

In this paper we address the evolutionary development of the market-oriented conservation credit approach in relation to four at-risk species in the western United States (Fig. 1). First, we provide information about the development of this market-oriented conservation approach in Texas. Second, we provide a description and evaluation of the Recovery Credit System for conserving Golden-Cheeked Warbler habitat and the Conservation Recovery Award System for protecting Dune Sage Brush Lizard habitat within Texas. Third, we discuss the potential usefulness of such market-based approaches for the recovery of two other species, the Lesser Prairie-Chicken (LPC) and the Greater Sage-Grouse (LSG), which occur on private land across multiple states.

Early Developments

Following the attack by Japan on Pearl Harbor in 1941, the United States established a new military base in the center of the country. This led to the expropriation and purchase of 217 337 acres of privately owned land near Killeen and Gatesville, Texas to create Fort Hood. The farmers and ranchers whose land was expropriated did not receive full compensation for their loss. In 1954, to offset the ensuing public relations problem, the Army began granting renewable grazing leases on the base to members of the Central Texas Cattlemen's Association (CTCA), which is composed of descendants of the original landowners of Fort Hood (Faulk and Faulk, 1990).

Since the late 1980s, the collaboration between Fort Hood and the CTCA has been affected by prescriptions of the ESA. The listing of the Black-Capped Vireo (BCV) and Golden-Cheeked Warbler (GCW) had immediate repercussions for Fort Hood and the CTCA. Tank maneuvers, the primary training activity at Fort Hood, can affect the habitat of these species through fire ignition by live ordnances. Livestock grazing can also affect them because cattle attract brown-headed cowbirds *(Molothrus ater)*, which parasitize the nests of songbirds and negatively affect songbird hatchlings, including the BCV and GCW. As a result, the USFWS required a study be conducted to determine the extent of impacts of fire and livestock grazing on the two endangered bird species

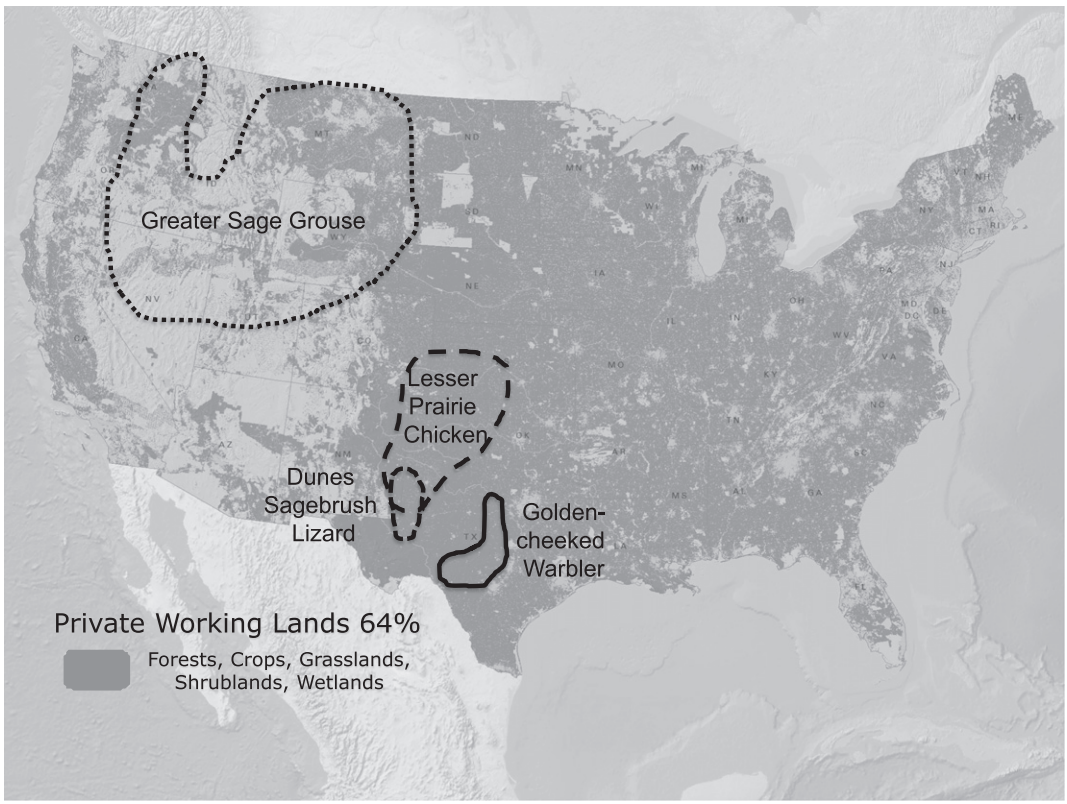

Figure 1. Approximate extent of range area of Golden-cheeked Warblers (Texas), Dunes Sagebrush Lizards (Texas and New Mexico), Lesser Prairie Chickens in (Colorado, Kansas, New Mexico, Texas and Oklahoma), and Great Sage Grouse (Washington, Oregon, California, Nevada, Idaho, Utah, Colorado, Wyoming, Montana, North Dakota an South Dakota); much of these range areas occur on private lands.

and, at the same time, demanded suspension of livestock grazing on 24 000 acres of the 196 000 acres available for grazing. The strong political connections of the CTCA resulted in political pressure from the governor's office to reduce the area of grazing exclusion and to place increased emphasis on cowbird trapping on Fort Hood. It also led to the Leon River Restoration Project (LRRP) that ran from 2002 to 2006.

The LRRP was established to encourage landowners in the Leon River watershed near Fort Hood to implement land management practices that improve forage supply, water quality, and BCV and GCW habitat in areas adjacent to Fort Hood. The primary approach to achieving these three objectives was the selective removal of invasive Ashe juniper (*Juniperus ashei* J. Buchholz). Increasing prevalence of juniper can lead to a decline in forage production, reduced water quality by impeding surface water infiltration and water filtration, and reduced the quality of GCW habitat by overwhelming other important plant species (Groce et al., 2010). Additional practices to improve herbaceous cover in some cases included seeding of perennial grasses and application of prescribed fire. A total of 51 landowners were enrolled in the project funded by several federal and state agencies. Through 5-yr contracts, the landowners received 85% cost-share incentives up to $15 000 to reduce juniper on their land and were required to apply grazing management practices that enhance watershed functions and provide adequate fine fuel loads for prescribed maintenance fire to suppress juniper regrowth. Participating landowners paid their 15% cost share into an escrow account and were refunded their contribution after all provisions of the contract had been met, less the cost of prescribed fires.

Four factors were identified for the success of the LRRP: 1) effective collaboration between key stakeholders, including members of CTCA and other nonaffiliated landowners who were community leaders; federal agencies (USFWS and NRCS); state agencies, notably Texas Parks and Wildlife Department (TPWD); and nongovernmental organizations (NGOs), such as the Environmental Defense Fund (EDF); 2) politically connected project leadership who catalyzed trust among community leaders and participating landowners and facilitated collaboration among participating federal and state agencies, NGOs, landowners, and researchers; 3) provision of technical and financial assistance to landowners to implement effective conservation measures, especially removal of invasive junipers, subject to the development of a Wildlife Management Plan approved by TPWD or a Resource Management Systems Conservation Plan approved by the NRCS; and 4) scientific credibility of the project due to participation of Texas A&M University researchers. However, the LRRP also had weaknesses, including lack of ongoing scientifically based monitoring of the accrued benefits of juniper removal for GCW and BCV and lack of effective provision of information about the program's results to the public.

Recovery Credit System for the Golden-Cheeked Warbler

It was anticipated that impacts on GCW habitat of increased military training beginning in the early 2000s at Fort Hood would primarily be temporary and that these areas would subsequently recover, an example being the use of GCW habitat areas by foot soldiers conducting training maneuvers. GCWs are neotropical insectivorous songbirds that spend the winter months in Mexico and Central America and breed in central Texas from March through July. The preferred habitat of GCWs consists of unfragmented mixed mature Ashe-juniper and oak woodlands (Coldren, 1998; Peak, 2007; Reidy et al., 2008). GCWs are endangered because of habitat loss (extensive clearing of mature juniper and oak woodlands), brood parasitism, and habitat fragmentation (USFWS, 1992; Locatelli et al., 2016).

Due to the success of the LRRP in promoting use of land management practices intended to benefit GCW on private land, the Texas Department of Agriculture organized a working group to establish a program in five counties surrounding the base to offset GCW impacts on Fort Hood (Hays, 2013). This program sought to turn a liability on Fort Hood—the presence of an endangered species—into an asset for private landowners, while helping GCW recovery. The ensuing mechanism, known as the Recovery Credit System (RCS), enabled the Department of Defense to offset debits to GCW habitat by procuring credits for conservation measures that benefited GCW (Wolfe et al., 2012). Under this mechanism, the beneficial effects of the credits and the adverse effects of the debiting actions needed to result in net benefits to the recovery of the species, as defined by the USFWS biological opinion for debiting (USFWS, 2009); permanent loss of habitat would be offset by the acquisition of permanent credits (e.g., perpetual conservation easements), while temporary habitat loss would be offset through the procurement of "term credits" (up to 25 yr). Additionally, compliance and effectiveness monitoring, as well as fund and credit accounting, were required throughout the life of the credit contracts. A comprehensive discussion of the components and principles of recovery credit systems are provided by Wilkins et al., (2009).

Credits were derived from conservation actions on private land and were determined by applying weighting criteria to each conservation unit (20 acres of suitable GCW habitat) accompanied by a wildlife management plan that specified management actions. The weighting criteria included 1) multiple conservation units on a property; 2) recovery regions (some being more critical); 3) proximity to known populations of GCW; and 4) extent of surrounding habitat. Landowners enrolled their properties through a bidding process. The competitive elements in this process included 1) contract term (the longer the better); 2) cost per recovery credit year (credits determined for the property multiplied by contract term); and 3) landowner's cost share for the land improvement actions (high landowner cost sharing was more competitive). In selecting bids, priority was given to landowners with credits that were part of a 250-acre or larger block of GCW habitat, of which at least 50 acres were under contract. Key elements and process flow of the RCS are shown in Figure 2 (Robertson and Rinker, 2010).

Private landowners who participated in the project were located mainly in Coryell and Bosque Counties, although some properties included portions of Bell or Hamilton County. Several organizations also played a role in credit accrual. Typically, the landowner contacted the program and then EDF biologists assessed the habitat, calculated credits, and prepared the GCW specific aspects of a wildlife management plan, after which the wildlife management plan was reviewed and approved by TPWD. Next, the Texas Watershed Management Foundation (TWMF) worked with the owner to prepare a bid proposal and evaluated the bids. Fort Hood selected and paid for the selected bids, and then TWMF managed contracts and supervised management practices. The relationships of the various parties are presented in Figure 3.

During the proof of concept period between 2006 and 2009, a total of 44 bids were received from landowners, of which 45% were successful leading to 20 contracts covering 13 782 acres (Robertson and Rinker, 2010). The selection of the bids occurred during eight bidding rounds at 3 − 6 mo intervals subject to funding availability. The total amount spent on the RCS program at the end of the 3-yr proof of concept was $3 442 074, of which the Department of Defense/US Army provided 87% and the NRCS and National Fish and Wildlife Foundation (NFWF) provided 13% in equal amounts. Of these funds, 57% ($1 954 666) was spent to improve and conserve 3 143 acres of occupied and potential GCW habitat, 28% on research and 15% on administration and program fees. Between 2006 and 2009 the cost per recovery credit declined from about $800 to $600 per credit, while the landowners' cost share of the contracted land management practices increased from 15% to 30% and the contract period increased from 10 to 25 yr (the maximum allowed under the program). The abundance of bids submitted and the increasing trend in contract length and cost share by landowners over the 3-yr period indicates the increasing popularity of this habitat improvement funding mechanism among landowners. As a result, the RCS provided a novel mechanism for more efficiently allocating resources among private land managers than other federally funded land improvement cost-sharing programs that do not incorporate economic competition among landowners for limited conservation resources.

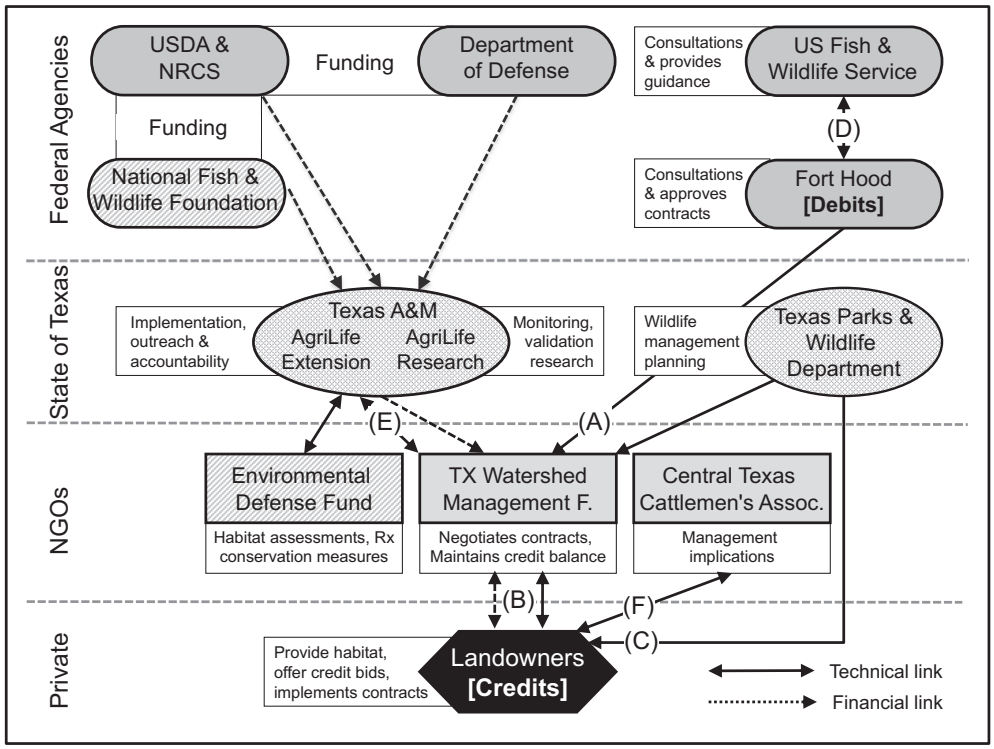

Figure 2. Interactions between key parties and funding channel in the RCS: (A) Texas Wildlife Management Foundation (TWMF) provides a conduit for Ft. Hood to obtain conservation credits to offset debits on the base; (B) Contractual linkage between TWMF and landowners enables landowners to receive payments for their credits; and (C) the legally binding confidentiality that Texas Parks and Wildlife Department provides when engaging with landowners on land management plans. Other links are: (D) between Ft. Hood and USFWS, which determines the GCW habitat debits created by training activities; (E) between Texas AgriLife Extension and TWMF to negotiate and facilitate contracts and maintain credit balance; and (F) between landowners and the Central Texas Cattlemen's Association, which aided in the creation of the RCS and has credibility with landowners.

Conservation Recovery Award System for the Dunes Sagebrush Lizard

The DSL is an insectivorous spiny lizard that inhabits blowouts in shinnery oak (*Quercus havardii* Rydb.) sand dune systems of southeast New Mexico and four adjacent Texas counties (Fitzgerald et al., 1997). Shinnery oak clearing for cattle grazing and oil and gas development in the highly productive Permian basin represent the main threat to the species (Smolensky and Fitzgerald, 2011; Leavitt and Fitzgerald, 2013).

Building on success of the RCS, the Texas legislature formed the Interagency Task Force of Economic Growth and Endangered Species in 2009 and involved multiple stakeholder groups and science, economic, and policy subcommittees to create a plan for a Candidate Conservation Agreement with Assurances (CCAA) (Hays, 2013). The CCAA outlines management practices that remove threats, restore habitat, augment populations, and otherwise benefit target species. Landowners and oil and gas firms can voluntarily participate in the Texas Conservation Plan (TCP) (the CCAA for the DSL) by signing a Certificate of Inclusion with the Comptroller's office and by agreeing to undertake conservation practices in exchange for assurances against additional measures should the species be listed as endangered. The TCP does not require permanent mitigation, which was deemed to be prohibitive in the Permian Basin, where consideration must be given to both surface and mineral rights of owners. Additional characteristics of the TCP that address the strong property rights orientations of landowners in Texas (Kreuter et al., 2006) are that agreements signed by participants are confidential under Texas law and, if the DSL were listed, the TCP would automatically turn into a Habitat Conservation Plan (HCP).

Oil and gas developers who participate in the TCP seek to minimize impacts on DSL habitat by using existing infrastructure or previously disturbed sites, locating new drilling sites in areas devoid of habitat, and restricting disturbance to the fall and winter when DSLs are less active. Participating agricultural producers reduce impacts by not placing fences through DSL habitat, restricting livestock access to DSL habitat, using NRCS grazing standards, removing invasive woody species, and controlling feral hog populations. Due to the TCP's comprehensive suite of impact avoidance, minimization and mitigation actions that benefit the recovery of the DSL, the USFWS decided to not list the DSL and removed it from the candidate list in 2012.

Under the TCP agreements, oil and gas and agricultural participants are obligated to pay $4 per enrolled acre per year. These fees are used to fund oversight, monitoring, and research activities. Texas A&M AgriLife Extension, which is responsible for the TCP's implementation and accountability, subcontracts with the Texas Habitat Conservation Foundation (THCF, analogous to the TWMF in the RCS) to negotiate landowner contracts, provide habitat assessments, monitor conservation practices, and oversee management plans. Texas A&M University conducts research to obtain data about potential impacts of habitat disturbance on behavioral, population, and community ecology of the DSL (Smolensky and Fitzgerald, 2011; Leavitt and Fitzgerald, 2013) and to inform adaptive management decisions to better manage the species.

So far, about 240 000 acres have been enrolled in the TCP in Texas representing about 60% of DSL habitat in the state. Most participating entities have voluntarily implemented impact avoidance and minimization measures. The TCP also has a Conservation Recovery Award System (CRAS), which, much like the RCS, enables landowners who voluntarily institute habitat conservation and recovery activities to earn credits for their efforts. These credits are certified and held by the THCF and can then be purchased by other entities that cannot avoid or minimize habitat impacts. As of March 2015, 1 854.5 credits had been generated; these are available for purchase

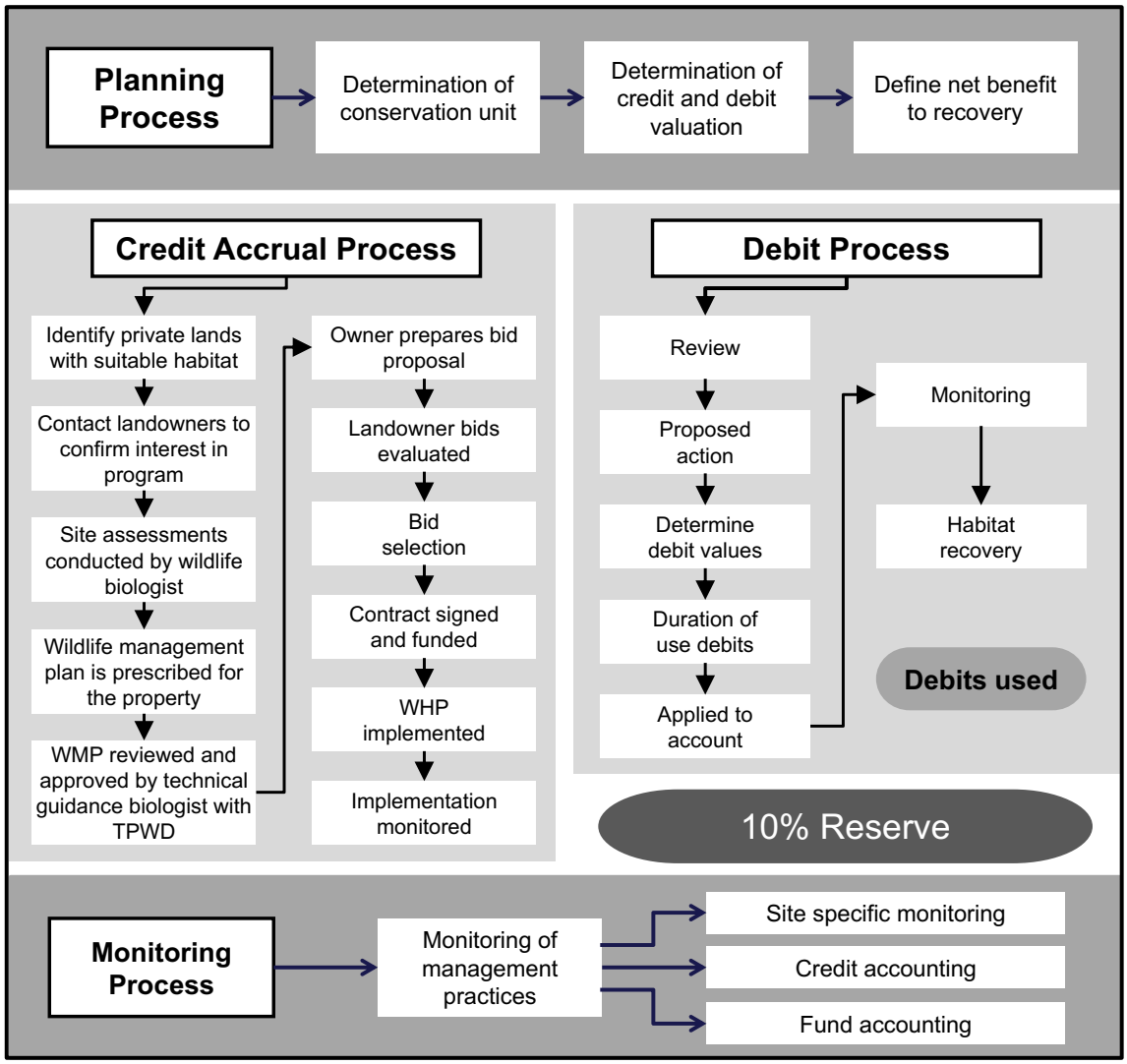

Figure 3. The four primary elements and process flow chart of the Recovery Credit System. The top panel represents planning activities, the left panel credit accumulation, the right panel debiting, and the bottom panel monitoring activities. In the RCS these phases occurred sequentially but in other applications, crediting and debiting may occur concurrently and continuously.

once oil and gas development in the Permian basin returns to a level that results in demand for mitigation.

Lesser Prairie-Chicken and Greater Sage Grouse Habitat Exchanges and Credit Systems

The LPC and GSG are two grouse species whose collective ranges cover much of the Great Plains and western United States. Their populations have declined substantially due to habitat loss and alteration. The LPC was listed as threatened on 27 March, 2014 (although that listing decision was vacated by a federal judge on 1 September, 2015) and a "not-warranted" decision was announced for the GSG on 22 September, 2015.

The LPC requires vast landscapes of native prairie habitat to survive and thrive. More than 90% of its range in the southern Great Plains occurs on private land; therefore, conserving landscapes required by the species necessitates the participation of numerous landowners. While oil and gas production has occurred in these landscapes for many decades, energy development accelerated in recent years and was identified as a key threat that led to the LPC's threatened designation.

Given the experience of the preceding credit-based habitat conservation systems, a committee of stakeholders (policy committee) representing agriculture, conservation, and oil and gas interests met in December 2012 to develop a similar system for the LPC. The policy committee assembled scientists with LPC expertise (science committee) to develop a habitat quantification tool (HQT) to define how credits were to be determined. HQTs are increasingly used in mitigation and conservation programs to measure gains or losses of benefits to a species. HQTs typically use habitat as a surrogate for species condition (although population or other measurable values may also be appropriate) to achieve more effective conservation and mitigation outcomes. HQTs generally include a set of metrics (i.e., measurements and methods) to evaluate habitat quantity and quality attributes over space and time; such attributes may include vegetation, anthropogenic features, and environmental conditions related to the species of interest. The output of an HQT is typically functional acres, the concept of which is described below (NNHPSETT, 2014).

The policy committee designed the LPC Habitat Exchange (Habitat Exchange) and drafted a supporting Habitat Exchange Agreement with USFWS. Like the RCS and CRAS, the purpose of the Habitat Exchange is to facilitate species recovery by creating a marketplace in which private landowners can earn income by restoring and conserving LPC habitat; income is earned through the competitive sale of conservation credits to oil and gas or other development interests that need to offset their impacts to habitat. Each transaction would include a net benefit contribution to the species.

Landowners interested in participating in the Habitat Exchange must be willing to enroll a minimum of 140 acres, which must be located within the estimated occupied range of the LPC (as determined by USFWS) and must have at least 50 functional acres at the time of enrollment. "Functional acres" refers to the size of a site (acres) multiplied by its "functionality" as habitat for the species of interest. A site's functionality represents its performance relative to optimal conditions and accounts for species-specific habitat attributes at multiple species-relevant scales, including quality and structure of vegetation and the degree of human disturbance on and surrounding the site. The functional acre approach uses the best available science to establish concept models and attribute scoring curves in order to create an ecologically based determination of habitat functionality. Concept models are graphic representations of the ecological conditions required to support various habitat types that comprise the life history needs of a species. They typically include landscape attributes (e.g., vegetation composition and structure, water regime, soil conditions, topography), how the attributes contribute to supporting the species, and conditions that affect the species use of a site. Attribute scoring curves represent the correlation between habitat attributes (over a range of values) and species fitness. Scoring curves can be converted to tables so that measured attributes can be readily converted to values that represent their contribution to habitat functionality. Concept models and attribute scoring curves provide an ecological basis for determining habitat value and can be readily adjusted as new scientific information becomes available. This is a significant improvement over the scoring approaches used in earlier credit systems.

Another notable innovation of the Habitat Exchange is the ability to achieve perpetual conservation through the dynamic permanent conservation option. Dynamic permanent conservation is essentially a continuous series of term agreements, which are funded and financially secured by a nonwasting endowment (similar to a typical conservation easement), but for which the site boundaries may shift over time. This new conservation tool is vitally important for several reasons: Split mineral estates make typical conservation easements susceptible to potential loss of conservation value if minerals are developed (as mineral rights are typically the dominant estate); climate change leading to species habitat shifts may necessitate adjustments in conservation priorities; and most rural landowners are unwilling to encumber their land with a conservation easement, but many will consider entering into less than permanent agreements.

The USFWS is currently reviewing documents supporting the Habitat Exchange, including the Habitat Exchange Agreement and HQT, and the Habitat Conservation Plan (Stakeholder Conservation Plan or SCP), which is part of a permit application submitted by the oil and gas and agricultural stakeholders. Next, these documents will be published in the Federal Register for public comment and then submitted for final approval by USFWS. Once approved, Habitat Exchange operations can begin.

The multistakeholder process used to develop the Habitat Exchange is similar to that used for the credit-based systems in Texas. This approach enables diverse stakeholders to provide input on all aspects of system design and operations and maximizes the likelihood of participation by all stakeholder groups. Improvements of the Habitat Exchange over previous credit-based systems include use of functional acres, establishment of a credit reserve to offset unanticipated losses, independent third-party verification of all credits generated, ability to permanently conserve habitat through dynamic permanent arrangements, increased accessibility to sites and information for USFWS, and web-based accessibility of transaction activity and conservation progress to the general public. For example, the Habitat Exchange Agreement for the LPC includes language indicating that USFWS has access to all landowner information within the office of the Exchange Administrator but may not copy or remove any of this information. In addition, USFWS may access any participating site on approval of the landowner. If the landowner does not approve, then the Exchange Administrator may contract with an independent accredited verifier to visit the site and assess compliance. USFWS will review the verifier's report and, if they deem that further action is necessary, then either 1) the landowner must allow access to USFWS to verify site conditions or 2) the landowner must agree to the buy-out conditions of their agreement (i.e., they must terminate their agreement with the Exchange).

A similar approach to development and implementation of habitat exchanges is currently under way for the GSG in several western states.

Discussion and Conclusion

The four case studies presented here show how conservation initiatives for species of concern on private land have evolved from single-state subsidized short-contract projects (LRRP) to federally funded competitive 25-yr conservation credit transfers (RCS) for GCWs, voluntary land management participation and credit transactions programs (CRAS) for DSLs, and a multistate Habitat Exchange program based on functional acres and an dynamic approach for achieving perpetual conservation of habitat for LPCs. These case studies provide important insights for the development of market-oriented mechanisms that may facilitate the recovery of threatened and endangered nongame species on private land in the United States, as well as other countries. Important characteristics that have contributed to their success include:

1. Involvement of diverse stakeholders and partners, including representatives from relevant state and federal agencies: This is critical to enhance trust, ensure buy-in from policy makers, federal and state agencies, private landowners, and environmental groups and reduce the risks of litigation by marginalized stakeholders.
2. Well-informed, multistakeholder science committees: This facilitates the development of biologically effective and scientifically credible conservation mechanisms, as well as measurable and verifiable conservation units, such as functional acres.
3. Flexible market-driven mechanisms: This provides incentives for landowners to protect habitat for species of concern and facilitates adaptation to different species requirements, as well as the concerns and interests of the suppliers (private landowners) and consumers (agencies/industry entities) of conservation credits.
4. Negotiable contract terms and new approaches such as dynamic permanent conservation: Perpetual arrangements that are fixed on the landscape (e.g., conservation easements) are a valuable tool for species recovery but have a number of limitations. These limitations include loss of conservation value as a result of split estates, mineral development, and climate change, as well as a lack of widespread acceptance from landowners.
5. An independent entity that negotiates contracts, serves as a bank for conservation credits, and disburses payments to credit suppliers over time (e.g., TWMF, THCF): This is especially important if credit consumers, such as state or federal agencies, are obligated to spend out their budgets annually; they cannot commit to payments for future management actions required to protect and improve habitats for species of concern.
6. Confidentiality of consultations and agreements with private landowners (e.g., landowner consultations with TPWD and TCP agreements signed by landowners): This is critical for building trust, especially in the context of the ESA, which many landowners view as threatening because the use of their land may be restricted without compensation when endangered species habitat occurs on their property. However, it is increasingly clear that making program results available to the USFWS and general public is vitally important to build and maintain credibility. The Habitat Exchanges for the grouse species will test new ways of achieving this transparency while still maintaining a degree of landowner confidentiality that affords strong participation.

7. An independent research component, funded in part by the program: This provides new knowledge that informs adaptive management and provides credibility for the program.

Given these characteristics, it is important to determine how other conservation programs aimed at protecting and restoring habitat for species of concern through voluntary landowner engagement compare in terms of flexibility, contractual terms, and confidence-building capacity. The comparison conducted by Robertson and Rinker (2010) is modified and presented in Table 1. It is evident from this comparison that the RCS, CRAS, and Habitat Exchange programs differ in two ways that facilitate the development of market-oriented conservation mechanisms: 1) the term of contracts is flexible and can be either temporally limited or (in the case of the Habitat Exchange) permanent static (i.e., using a typical conservation easement with site boundaries that are fixed in perpetuity) or permanent dynamic agreements to accommodate the habitat recovery needs; and 2) the three conservation credit-based programs create an opportunity to set up a competitive contracting environment that enables evolution of an efficient market.

The evolution of credit-based conservation mechanisms in Texas (RCS and CRAS) have provided important lessons for the development of market-oriented conservation initiatives for other species of concern that have well-defined habitat requirements, such as the LPC and GSG. The wide distribution of these two species creates both opportunities and challenges for market-based solutions for habitat conservation and restoration for them. The first benefit is that there are potentially many suppliers (private landowners) and consumers (federal agencies, energy companies, and developers) of habitat conservation credits, which may facilitate the establishment of competitive pricing for conservation credits. Second, the development of conservation credit markets that bridge state boundaries could create a more general market-oriented framework for the conservation of a broader suite of species that are under pressure, as well as other ecosystem services being provided by well-managed private rural properties (e.g., wildlife habitat, water filtration in catchments, soil carbon sequestration). Third, voluntary market-based payments for conservation credits could create a new revenue source for rural landowners that could reduce land fragmentation in rural areas due to forced land sales by landowners who are asset rich but cash poor, which have compromised the integrity of open spaces and ecosystems that provide beneficial services to society (Kjelland et al., 2007).

There are also numerous challenges to establishing such broad-scale conservation credit markets. First, developing a mechanism that requires approval of multiple federal and state agencies can be delayed or prevented by conflicting legislative prescriptions affecting conservation across state boundaries and, therefore, could hamper interstate trade of such credits. Second, the confidentiality mandated by Texas law regarding conservation agreements with private landowners and which increases landowner trust in entering into binding conservation agreements does not exist in many other states. Third, the number of stakeholders, especially state agencies, that participate in developing such market mechanisms increases with geographical scale; the larger the area, the greater the likelihood of stakeholder conflict (Ostrom, 2009). Table 2 shows stakeholders for the RCS, CRAS, and Habitat Exchange programs. Fourth, Texas and much of the eastern two-thirds of the country is well suited for the development of conservation credit markets involving private landowners because a large percentage of this part of the country is privately owned. In states with a greater proportion of public land there may still be opportunities for credit trading as vast areas of public land are leased by private individuals who may be able to generate and sell credits for benefits created above and beyond their lease obligations. In addition, there may be cases in which habitat impacts on public land are best offset with conservation credits on private lands (i.e., they result in a better outcome for the species). Fifth, there is a shift in landowner motivations across much of the western United States that impacts the management action that landowners may be willing to apply on their land to protect or improve habitat for species of concern and their willingness to engage in programs aimed at offsetting the cost of management actions that enhance ecosystem services, such as wildlife habitat (Olenick et al., 2005; Sorice et al., 2014).

In conclusion, for historical reasons, Texas has been a leader in the development of conservation credit markets for threatened and endangered species conservation on private land. The lessons from the case studies presented here indicate that such mechanisms may be useful

Table 1
Comparison of Recovery Credit System, Conservation Recovery Award System, Habitat Exchange, and other programs or strategies aimed at habitat conservation for species of concern on private land (modification of information provided by Robertson and Rinker, 2010)

Program or strategy	Purpose	Partners and benefits	Market feature	Credit timing
Recovery Credit System (Texas—Golden-Cheeked Warbler)	Preserve or enhance habitat for a net benefit to recovery	Private and nonfederal landowners	Incentives provided through a reverse auction and receipt of financial and technical assistance	Term contracts (10-25 yr)
Conservation Recovery Award System (Texas—Dunes Sagebrush Lizard)	Preserve or enhance habitat for a net benefit to recovery	Private and oil & gas landowners; landowners receive assurances against additional measures	Landowners are able to obtain tradable conservation credits for habitat protection measures	Term contracts (period not yet determined)
Habitat Exchange (Multistate—Lesser Prairie-Chicken)	Preserve, restore or enhance habitat for a net benefit to recovery	Partner with private and nonfederal landowners; landowners receive payments and technical assistance	Use of the functional acre approach for habitat generation and ability to establish dynamic permanent arrangements through sale of credits	Term contracts to perpetual static and dynamic agreements
Environmental Quality Incentives Program	Fund conservation practices on working agricultural land to achieve national priorities (e.g., threatened or endangered species)	Private landowners receive incentive payments and technical assistance	None, applications are scored based on state or local priority resource concerns	Term contracts: (2-10 yr)
Wildlife Habitat Incentives Program	Help participants develop habitat for threatened and endangered species (among others)	Private landowners receive financial and technical assistance	None, applications are scored according to each state's WHIP plan	Term contracts (5-15 yr)
Conservation banks (mitigation banking)	Offset impacts for no net loss, can include enhancement	Private commercial, public commercial, or single user	Price determined by demand	Permanent
Safe Harbor	Facilitate the conservation of listed species for a net conservation benefit	Multiple private landowners receive guarantee of no increased regulation; may include technical or financial assistance	None, applications are scored on basis of competitive ranking	Term agreements
Section 7 consultation	Collaboratively solve conservation challenges as long as species is not jeopardized	Consultation between federal agencies and USFWS	None	Term: levels of restriction vary by biological opinion

Table 2
Stakeholders of Recovery Credit System for the Golden-Cheek Warbler (RCS–GCW) and Conservation Recovery Award System for the Dunes Sagebrush Lizard (CRAS–DSL) and the Habitat Exchange for the Lesser Prairie-Chicken (HE–LPC)

	RCS–GCW	CRAS–DSL	HE-LPC
Federal			
US Fish & Wildlife Service	✔	✔	✔
US Department of Defense	✔		
USDA Natural Resources Conservation Service	✔		
USDA-ARS		✔	
State			
Colorado Parks and Wildlife			✔
Kansas Farm Bureau			✔
Oklahoma Farm Bureau			✔
Oklahoma State University			✔
Permian Basin Petroleum Association		✔	
Texas Comptroller of Public Accounts		✔	
Texas Parks and Wildlife Department	✔	✔	✔
Texas Farm Bureau	✔	✔	✔
Texas Dept. of Agriculture	✔		
Texas Dept. of Transportation	✔		
Texas A&M University	✔	✔	
Texas AgriLife Extension	✔	✔	
Texas Oil and Gas Association		✔	
Texas Royalties Council		✔	
University of Texas Lands		✔	
Nongovernmental Organization/Nonprofit			
Audubon Texas	✔		
Colorado Cattlemen's Association			✔
Environmental Defense Fund	✔		✔
National Fish and Wildlife Foundation	✔		
Plains Cotton Growers			✔
Texas & SW Cattle Raisers Association	✔	✔	✔
Texas Cattle Feeders Association			✔
Texas Wheat Growers Association			✔
The Nature Conservancy	✔		✔
Texas Watershed Management Foundation	✔		✔
Texas Habitat Conservation Foundation		✔	
Private			
Landowners	✔	✔	✔
Energy Companies		✔	✔

for conservation efforts for other species of concern in other areas. However, to successfully implement conservation credit markets, especially for species with geographically extensive ranges, policy makers and developers of such markets need to be inclusive of all relevant stakeholders to ensure buy-in and reduce the probability of federal listing of the species or litigation by excluded stakeholders. They also need to be both scientifically sound and procedurally flexible to effectively address habitat needs of various species and to develop programmatic contract terms and transaction mechanisms that are meaningful for habitat recovery and acceptable to private landowners. Finally they need to be sensitive to private landowners' (suppliers') privacy and property rights interests and concerns. They must also be sensitive to the interests of consumers of credits, which must meaningfully address conservation impacts that the consumers must mitigate in order to adhere to legal mandates or to avoid land use constraints that may arise as a result the federal listing of at risk species.

Management Implications

The ESA of 1973 has resulted in > 2 000 species being federally listed in the United States as threatened or endangered, with many more being considered for listing. Such listings often result in real or perceived negative consequences for private landowners, including restrictions on certain land uses. This can lead to perverse reactions including elimination of habitat for species of concern and refusal by landowners to cooperate with federal and state biologists to effectively protect habitat of species of concern. Moreover, individual species protection may work against large-scale land management for biodiversity conservation. To encourage landowners to protect habitats of at-risk species on their land for the benefit of current and future generations, positive incentive mechanisms that enhance voluntary landowner engagement in habitat conservation for such species are desperately needed. This is especially important in states with high proportions of private property and where landowners hold strong private property rights orientations.

Such positive measures include the conservation credit and habitat exchange programs initiated in Texas, which have resulted in considerable landowner participation in conservation measures aimed at protecting already listed species, such as the Golden-Cheeked Warbler, and at-risk species, such as the DSL. Such programs have been used to not only provide improved or additional habitat for species that have already been listed but also to remove from consideration other species that were targeted for listing. Similar programs are now being considered and developed for other species in other states. The expansion of programs that transform at-risk species from a liability to an asset for private landowners is likely to increase land management actions that benefit species whose populations are being threatened by anthropogenic or climate-related habitat changes.

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