GEOSPATIAL SYNTHESIS OF GRASSLANDS CONSERVATION INFORMATION

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BIRD CONSERVANCY OF THE ROCKIES

Mission: conserving birds and their habitats through science, education and land stewardship

Bird Conservancy of the Rockies conserves birds and their habitats through an integrated approach of science, education and land stewardship. Our work radiates from the Rockies to the Great Plains, Mexico and beyond. Our mission is advanced through sound science, achieved through empowering people, realized through stewardship and sustained through partnerships. Together, we are improving native bird populations, the land and the lives of people.

Goals

1. Guide conservation action where it is needed most by conducting scientifically rigorous monitoring and research on birds and their habitats within the context of their full annual cycle
2. Inspire conservation action in people by developing relationships through community outreach and science-based, experiential education programs
3. Contribute to bird population viability and help sustain working lands by partnering with landowners and managers to enhance wildlife habitat
4. Promote conservation and inform land management decisions by disseminating scientific knowledge and developing tools and recommendations.

Bird Conservancy accomplishes its mission by:

Monitoring long-term bird population trends to provide a scientific foundation for conservation action

Researching bird ecology and population response to anthropogenic and natural processes to evaluate and adjust management and conservation strategies using the best available science

Educating people of all ages through active, experiential programs that create an awareness of and appreciation for birds

Partnering with state and federal natural resource agencies, private citizens, schools, universities and other non-governmental organizations to build synergy and consensus for bird conservation

Fostering good stewardship on private and public lands through voluntary, cooperative partnerships that create win-win situations for wildlife and people

Sharing the latest information on bird populations, land management and conservation practices to create informed publics

Delivering bird conservation at biologically relevant scales by working across political and jurisdictional boundaries in western North America and beyond

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

EXECUTIVE SUMMARY

1. We develop a map in the Desert LCC's Conservation Planning Atlas (CPA) showcasing land cover datasets classifying grassland areas within the Desert LCC. We provide direct links to these resources as well as all spatially explicit resources related to grasslands within the Desert LCC through this report.

2. We catalogue data resources (including primary literature, grassland management plans, other grey literature, and spatial data) related to grasslands in the United States in ScienceBase and provide direct links to these resources through this medium. We also provide links in the CPA to all grassland resources through the External Resources tab in the Grasslands gallery. We describe and use a tagging system with this data inventory to facilitate searching for specific resources by outside users. Each ScienceBase entry includes a spatial representation of the resource's footprint for query and use.

3. We produce a map of natural resource plans potentially affecting grassland areas within the Desert LCC, and provide a table with a unique url to each plan.

4. We review data resources (including primary literature, grassland management plans, and spatial data) related to Mexican grasslands through a subcontract to Adrián Quero at Colegio de Postgraduados – SAGARPA. We summarize this Spanish-language review in English and provide links to these resources in ScienceBase.

5. We catalogue Mexican grasslands stakeholders through a structured interview process through a subcontract to Adrián Quero at Colegio de Postgraduados – SAGARPA. We also present results from an ongoing stakeholder assessment effort subcontracted through Southwest Decision Recsources which will continue following the timeline for the Landscape Conservation Planning and Design effort.

6. We use a subset of this collated data to create a spatially-explicit map of current risk of agricultural conversion in Mexican grasslands within the Desert LCC geography. We use the Instituto Nacional de Estadística y Geografía (INEGI) spatial layers to define current agriculture and grassland boundaries, and use expert opinion and local knowledge within Bird Conservancy of the Rockies and Invesitigación Majeno Conservacion de Vida Silvestre (IMC) to delineate current high-growth farming communities. We use remotely-sensed ecological cutoffs to further define areas of threat in these grassland communities. These mapped indices of threat are available in map form in this report, and in raster format for eventual distribution in the DLCC's Conservation Atlas.

ACKNOWLEDGEMENTS

We would like to thank IMC Vida Silvestre AC, Irene Ruvalcaba, and Rodrigo Sierra Corona for providing expert opinion that fueled the conversion risk analysis included in this report. We thank Duane Pool for developing the grant that funded this work, and Sally Holl for early input in the deliverables for this grant. We also thank the many data contributors that this draft summarizes for allowing public access and posting of their data in the CPA.

INTRODUCTION

Grassland ecosystems are declining faster than any other ecosystem in North America. These areas provide critical habitat to grassland-specialist wildlife species, provide essential livestock grazing and ranching areas, and act as significant carbon sinks for grassland landscapes. Grassland areas within the geography of the Desert Landscape Conservation Cooperative (LCC) face multiple future stressors, including the effects of climate change (through drought and increasing temperatures), conversion to agriculture, and overgrazing. Information about these essential and threatened grassland resources, however, is dispersed across websites, reports, management plans, and the peer-reviewed literature, and no centralized database has been developed to catalogue 1) the data resources available to inform conservation and management of grassland across the bi-national geography of the Desert LCC, or 2) the main stakeholders for grassland ecosystem within this same geography. Knowledge of Mexican data resources and stakeholders within the Desert LCC's coverage area is particularly sparse.

This grant was established before the development and implementation of the larger Landscape Conservation Planning and Design (LCPD) effort through the Desert LCC. Many of the deliverables for this grassland-specific grant are now covered under the LCPD ongoing agreement between Bird Conservancy of the Rockies and the Desert LCC. We therefore report on a subset of the deliverables for the original grant related to spatial data synthesis of grasslands, and include an additional analysis of conversion risk to grasslands within the Mexican portion of the Desert LCC. The majority of the stakeholder-based deliverables has been moved to the timeline of the LCPD agreement, and will be reported on in the structure and timeline for that agreement. Details on this deliverable switch-out can be found in Appendix 1.

Objectives

In this report, we address the following objectives for synthesizing Geographic Information System (GIS) resources related to grasslands within the Desert LCC:

1) Identify existing spatially explicit information that identifies and classifies grasslands throughout the region.
2) Identify active partners in Mexico and map their area of interest, activity, or program.
3) Provide a literature review and annotated bibliography of regional plans and assessments that contain information that can be defined spatially.
4) Develop a table that provides a spatial link to spatial elements of the annotated bibliography.
5) Review existing conservation and management plans of desert grasslands for the US and Mexico and map these program footprints with agency or program contacts.
6) Map current risk of agricultural conversion in Mexican grasslands based on proximity to agriculture and farming communities within currently delineated grasslands.

In this report we addressed Objective 1 by creating a living map in the Conservation Planning Atlas (CPA) of all land cover datasets classifying grasslands within the Desert LCC. These land-cover datasets also have individual ScienceBase Entries in the Desert LCC data inventory. We addressed Objective 2 through a stakeholder interview effort within Mexico led by Adrian Quero. We also report results from a stakeholder mapping effort through a workshop in Aguascalientes, Mexico in 2014. We addressed Objective 3 by reviewing spatial resources related to grasslands and adding all applicable resources to the Desert LCC SB data inventory, currently totaling 204 records. To further review Mexican-specific grassland resources, we provide a Spanish language literature review of resources in the Desert LCC in Mexico, including a table of spatial data resources. We addressed Objective 4 as part of our resource cataloguing process within SB – all records include a link to the original data source. Additionally, we provide a table of spatial data records with active urls. We address Objective 5 by reviewing all catalogued resources categorized as "plans" and mapping their footprints within the Desert LCC. We also provide a table of live urls for each plan mapped. Finally, we address Objective 6 by creating a map of conversion risk to agriculture across the Desert LCC using the collated spatial data layers as described in Appendix 1.

PART 1: DATA RESOURCES FOR GRASSLAND ECOSTEMS

Landscape-scale grassland classifications

Land cover datasets allow users to map and analyze landscapes using predefined sets of classes to categorize areas based on ecological groupings. Land-cover datasets vary in resolution (pixel size), geographic scope, and geopolitical boundaries, and can be created through satellite imagery analysis, ground-based data collection, or a combination of these two methods. Each land cover dataset therefore has inherent strengths and weaknesses, resulting in the production of many landscape-scale layers classifying grasslands within our area of interest.

We identified 15 landscape-scale grassland classifications within the Desert LCC (Table 1). We added a ScienceBase entry of each of these resources, as well as created a map of the combined datasets in the Desert LCC CPA (Figure 1). This map is accessible at:

https://dlcc.databasin.org/maps/06c74822a8934d2abc00c7a2af4b325a/active

Review and inventory of grassland data resources

Methods

We searched for GIS datasets, web maps, conservation assessments, conservation plans, conservation programs, and organizations involved in conservation and land management within the DLCC's geography. We used Google Search to search for "GIS" and "management plan" in combination with "CONANP", "NPS", "DoD", "USFWS", "BLM", "USFS", "Tribe", and included management plans for properties greater than 100,000 acres in size that mentioned native grasslands. We searched for additional institutions known to have useful resources such as "INEGI", "CONABIO", "NatureServe", "CEC", "USGS", "WWF", "GAP", "LANDFIRE", "Sky Island Alliance", "Sonoran Joint Venture", "Rio Grande Joint Venture", "ecoregional assessment" and "State Wildlife Action Plan" and explored resources on each website. We searched for "GIS" in combination with specific threats (e.g. "solar", "renewable", "wind", "invasive", "mining", "oil", "fragmentation", "development", etc.). We also searched for "grassland", "desert", "arid", "conservation", "restoration", "plan", "project", "program" and Spanish equivalents in various combinations. Many searches yielded non-target results that prompted further searches, and many resources referenced other resources that also prompted to additional searches. We looked at maps to determine which resources fell at least partly within DLCC boundaries to include just those relevant resources. We also included some resources compiled by subcontractor Adrian Quero.

In the event that a resource had a previous ScienceBase entry, we created a new entry to allow tagging of this resource within our organizational scheme. All records were manually entered at https://www.sciencebase.gov/catalog/folder/54fa3835e4b02419550da3a8. We respected the following methods when creating ScienceBase entries in each field:

Table 1. Land cover datasets delineating grassland features within the Desert Landscape Conservation Cooperative geography.

dataset	**extent**	**originator**	**date of imagery**	**publication date**
2010 Land Cover of North America at 250 meters	Canada, USA, Mexico	Canada Centre for Remote Sensing (CCRS), Earth Sciences Sector, Natural Resources Canada, Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO), Comisión Nacional Forestal (CONAFOR), Instituto Nacional de Estadística y Geografía (INEGI), U.S. Geological Survey (USGS)	2010	2014
A Synthesis of Vegetation Maps for Nevada	Nevada plus 25 km buffer of surrounding states	Nevada Natural Heritage Program	various, up to winter 2007/08	2008
Arizona grasslands	Apache Highlands Ecoregion	The Nature Conservancy of Arizona	2002	2008
Brown and Lowe's Biotic Communities of the Southwest	-114.815995^0 W to -109.045173^0 W, 37.003895^0 N to 31.332110^0 N	The Nature Conservancy of Arizona	1981	2004
Cartografía de Uso de Suelo y Vegetación del Estado de Chihuahua	Chihuahua	Gobierno del Estado de Chihuahua, Secretaría de Desarrollo Rural, Dirección de Desarrollo Forestal	1996-2010	2013
Central Mojave Vegetation Map	Eastern Mojave of California	U.S. Geological Survey (USGS) Forest and Rangeland Ecosystem Science Center (FRESC)	1994	2002
Land Cover/Natural Vegetation Communities, DRECP	Desert Renewable Energy Conservation Plan (DRECP) boundaries	Aerial Information Systems, California Dept. of Fish and Game	2010-2014	2014
LANDFIRE Existing Vegetation Type 1.3.0	USA	USGS EROS, Rocky Mountain Research Station	2010-2012	2014
National Land Cover Datasets (NLCD)	USA	Multi-Resolution Land Characteristics (MRLC) consortium	2011	2014

New Mexico Rangeland Ecological Assessment (REA)	Rangeland in southern New Mexico, including but not limited to BLM's Carlsbad, Las Cruces, Roswell and Socorro field offices' lands	The Nature Conservancy (TNC) New Mexico Chapter	NS[1]	2008
Terrestrial Ecological Systems of the United States	USA	NatureServe	NS	2014
Texas Ecological Systems Map	Texas	TPWD, Missouri Resource Assessment Partnership (MoRAP)	2005-2007	2014
Transboundary land cover dataset for the Sky Islands Ecoregion	Sky Islands ecoregion	Conservation Science Partners, Inc.	2011	2016
U.S. Geological Survey Gap Analysis Program- Land Cover Data v2.2	USA	U.S. Geological Survey Gap Analysis Program	1999-2001	2011
Uso del Suelo y Vegetación Serie V	Mexico	Instituto Nacional de Estadística y Geografía (INEGI)	2011	2013

[1] NS = not stated

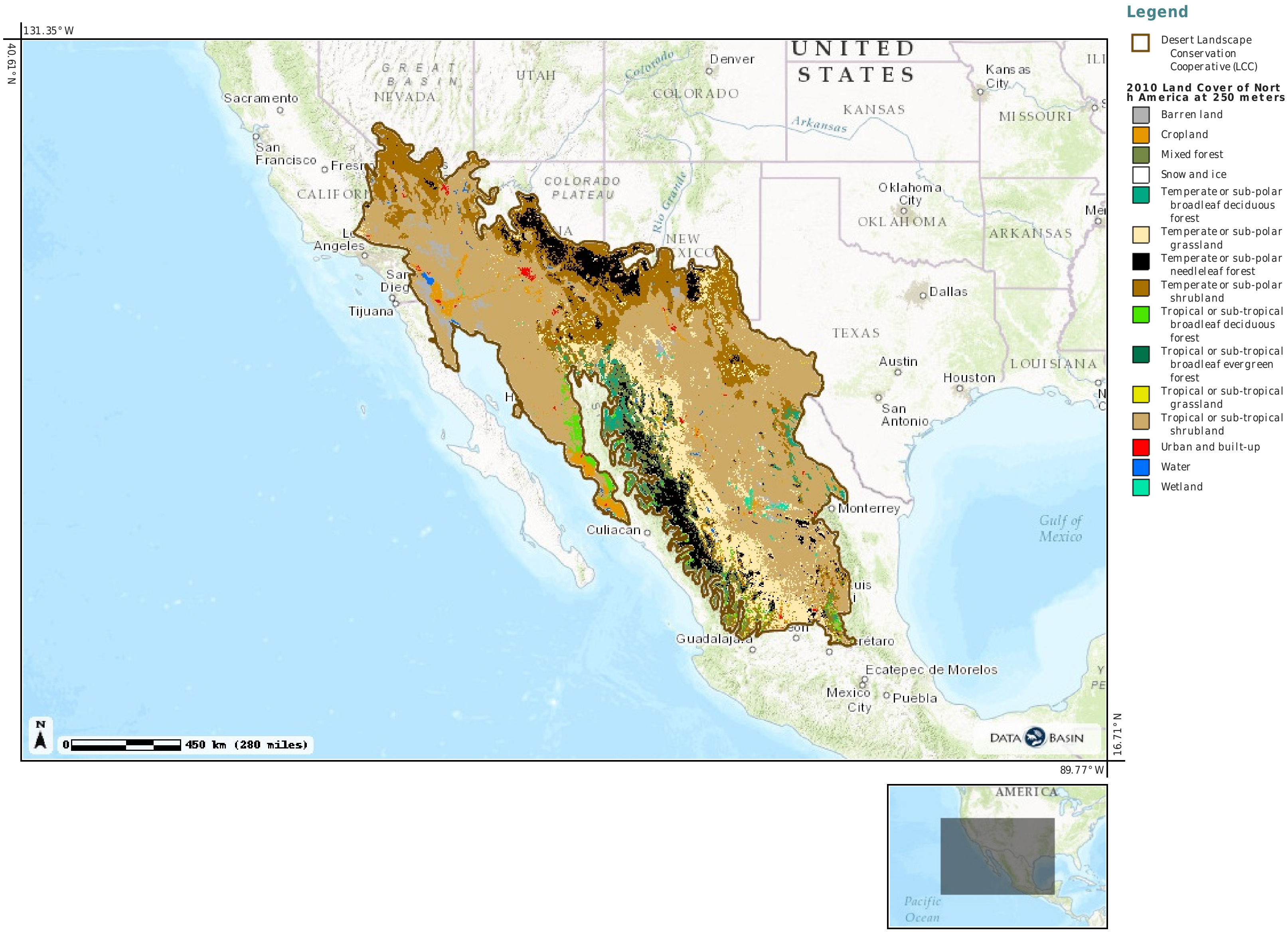

Figure 1. Exported map of a landcover dataset (Land Cover of North America) from the "Land Cover Datasets in the Desert LCC" map included in the Desert Landscape Conservation Cooperative Conservation Planning Atlas.

“What”:
Title: title of resource

Subtitle: subtitle of resource if applicable

Body: We entered the resources’ “introduction”, “about”, “summary” or “description” or other general information paragraphs, using discretion about which paragraphs worth including (e.g. description of field trips at a conference not relevant to proceedings). For publications, we used the abstract (if not from a peer-reviewed journal) or if the research was funded by tax dollars and therefore is in the public domain. In some cases, no such description wass available to copy, so the field was left blank.

Citation: ScienceBase switched from housing citations under “Extension” tab to also include them under the “What” tab mid-way through our cataloguing effort. In this case of, the system often auto populates incomplete citations from the “Extension” field from my older records. We only entered citation if specified.

Purpose: If available, we entered any separate statement of purpose that was not mixed in with the general info copied into the Body section. If it was mixed in with other information, we included this in the “Body” section.

Rights: We left this section blank for most records due to it not being specified in the resource. If disclaimer/use constraints were available on separate web page, we copied its url, otherwise usually copied actual text.

Alternate Titles & Identifiers: left blank.

“Who”:
We added contacts for all organizations listed unless specified that their only role was as funder.

Contact: We included the name of organization to minimize the number of contacts; multiple authors often work for same organization and all authors appear in citation information.

Type: If it was clear which partner was the lead organization, we included “Lead Organization”, otherwise we used “Cooperator/Partner”. In one case where the data owner was not the lead organization, “Data Owner” category was used. For peer-reviewed publications, we used “Author” or “Editor”.

Person/organization dropdown: We used “organization” unless the author was completely unaffiliated.

E-Mail: We entered this information if available.

Organization’s Person: We listed the first contact for each organization.

We left all other fields blank.

“When”:
We added dates as “Publication Date” when available, with the exception of conferences with dates specified. In this case we added “Start Date” and “End Date”, since this was the best indicator of timeliness of proceedings. For a conference that only specified the year it was held, we used “Assessment Date”.

“Where”:
Most often resources were limited to given state(s) or countries. Where the resource was limited to a predefined geographic context and shapefiles and web services were not available, we reconstructed footprints from HUC’s, ecoregions, or agency districts. When a resource was small enough in scope, we manually digitized the resources’ geography to create an accurate footprint. In the few cases when none of these methods applied to the SB resource, we selected all the states that the resource overlapped as that resource’s footprint. When the resource was global in scale, we omitted the footprint altogether.

“How”:
We left this blank for most resources. If instructions for viewing or downloading data were available and brief, we copied them into this field. If instructions were prohibitively long, we copied url of instructions page.

“Tags”:
The three tag vocabularies we created are housed at https://www.sciencebase.gov/vocab/category/555cea37e4b0811b6a5d3837, developed with input from Duane Pool and Sally Hull. We generally assigned each record one Resource Type tag that best described the resource, as many Location tags as needed (ecoregion, state(s), country, or continent) to describe the geographical area to which the resource applied, and many Keyword tags. We used the keyword “Spanish” for all records that contained at least some content in Spanish. For clearinghouses of publications too numerous to review or for extremely long documents, we searched for each keyword from the keyword vocabulary and added that keyword to the record if the search yielded any results. For other resources that were feasible to examine more closely, we chose the keywords that best encapsulated the themes that the resource covered.

“Files”:
The records we created include links to datasets already published elsewhere so that as resources are updated by their creators, entries are linked to the current version.

“Extensions”:
For records that include web services (Add ArcGIS REST Service, Add OGC Web Service) we entered the REST Service url or Capabilities URL respectively .

As previously mentioned, the creators of ScienceBase added a “citations” field mid-way through our literature review. This resulted in citation information added before this change incompletely auto populated added to the citations field. In the event that incompletely information displays in the citations field, users should scroll to the bottom of the record to see the full citation.

Language: English or Spanish.

<u>"External Sources":</u>
Type:

- Original Metadata—when metadata available on separate webpage
- PDF Download—when link is just a download site for PDF
- Download—when link is just a download site for other files
- Web Link—when link is none of the above

Url: We added a live url for each resource.

Title: We added title of web page or downloadable document.

Results

We identified and catalogued in SB a total of 204 resources related to grasslands within the Desert LCC geography. This Grasslands Data Inventory folder can be found at (https://www.sciencebase.gov/catalog/item/5531336ce4b0b22a158062a8). Of those resources, 98 were spatially explicit. A full table of all spatially explicit resources with urls for each resource can be found in Appendix 2.

Of the grassland resources catalogued, we identified 60 resources as either conservation or management plans. We reviewed and summarized these plans by directly mapping the footprints of these resources (Figure 2). Because of the number of plans mapped, the map legend is included as a separate document from the actual map. The direct urls for each plan are included in Appendix 2.

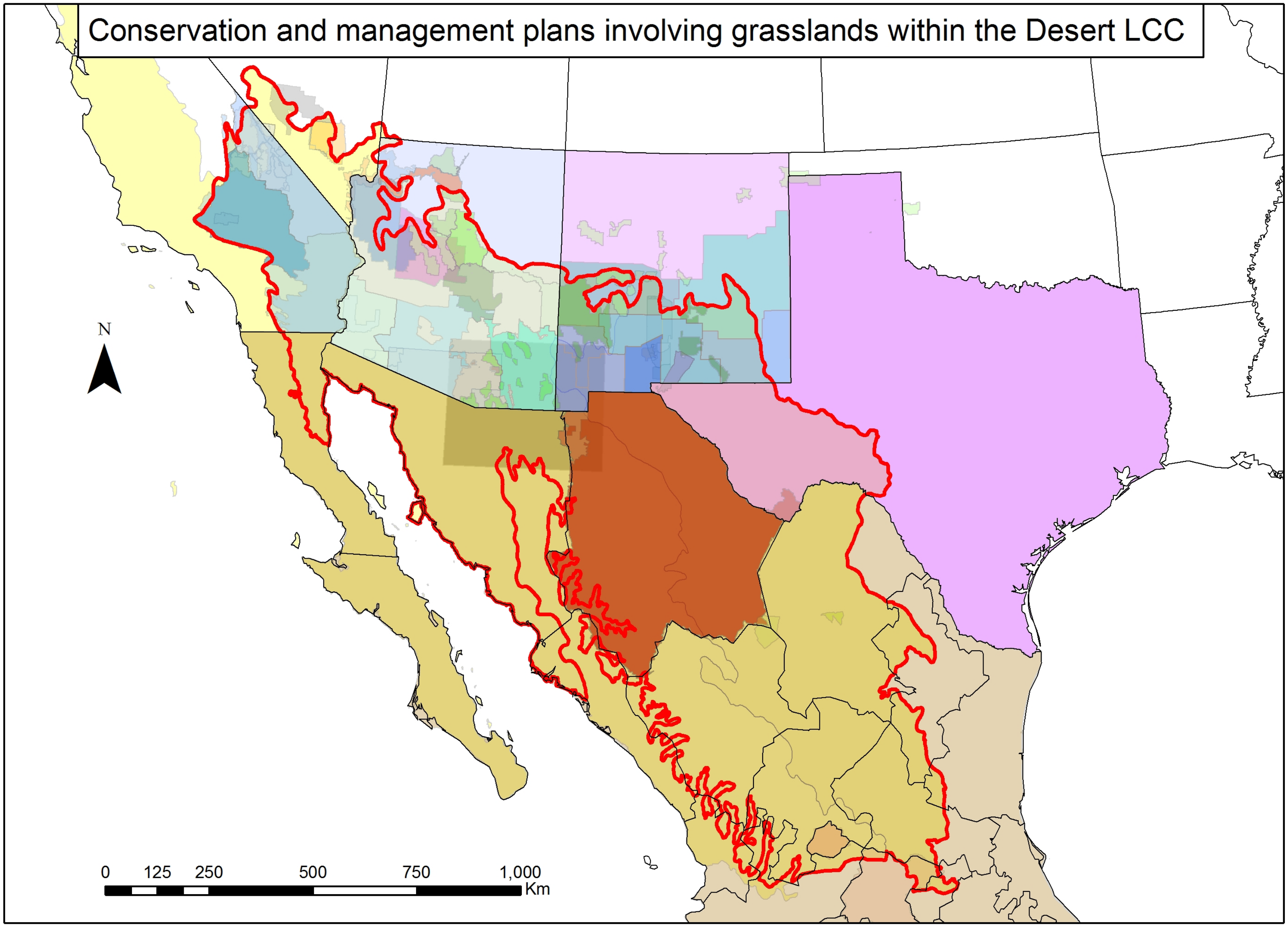

Figure 2a. Mapped footprints of management and conservation plans affecting grassland ecosystems within the Desert Landscape Conservation Cooperative geography.

Legend

- Desert LCC
- Land Management Plan for the Apache-Sitgreaves National Forests
- Cibola National Forest Mountain Ranger Districts Plan
- Land and Resource Management Plan for the Coconino National Forest
- Coronado National Forest Land and Resource Management Plan
- Gila National Forest Plan
- Lincoln National Forest Land and Resource Management Plan
- Land and Resource Management Plan for the Kaibab National Forest
- Land and Resource Management Plan for the Prescott National Forest
- Tonto National Forest Plan
- BLM Yuma Field Office Resource Management Plan
- BLM White Sands Resource Area Resource Management Plan
- BLM Safford District Resource Management Plan
- BLM Roswell Resource Area Resource Management Plan
- BLM Socorro Field Office Resource Management Plan
- BLM Restoration Design Energy Project Resource Management Plan Amendments
- BLM Lower Sonoran Resource Management Plan
- BLM Ironwood Forest National Monument Resource Management Plan
- BLM Carlsbad Resource Management Plan & Amendment
- BLM West Mojave Plan Amendment
- BLM Northern and Eastern Mojave Desert Management Plan Amendment
- BLM California Desert Conservation Area Plan
- BLM Mimbres Resource Management Plan
- BLM TriCounty Resource Management Plan
- Kingman Resource Area Resource Management Plan
- Grand Canyon-Parashant National Monument Resource Management Plan
- Death Valley National Park Wilderness and Backcountry Stewardship Plan
- Lake Mead NRA Exotic Plant Management Plan
- Grand Canyon National Park Fire Management Plan
- Grand Canyon National Park Backcountry Management Plan
- Big Bend National Park Fire Management Plan
- Saguaro National Park Restoration Management Plan
- Cabeza Prieta National Wildlife Refuge Comprehensive Conservation Plan
- Sevilleta National Wildlife Refuge Comprehensive Conservation Plan
- Desert National Wildlife Refuge Complex Comprehensive Conservation Plan
- U.S. Army Yuma Proving Ground Integrated Natural Resources Management Plan
- Integrated Natural Resources Management Plan For Edwards Air Force Base
- White Sands Missile Range Integrated Natural Resource Management Plan
- Fort Bliss Integrated Natural Resources Management Plan
- Nellis Air Force Base Integrated Natural Resources Management Plan
- Desert Renewable Energy Conservation Plan
- Central Arizona Grassland Conservation Strategy
- Arizona's State Wildlife Action Plan
- Comprehensive Wildlife Conservation Strategy For New Mexico
- Texas Conservation Action Plan
- Pima County Sonoran Desert Conservation Plan
- USDA-ARS Jornada Experimental Range Project Plan
- Estrategia del área focal de degradación de tierras
- Programa de Manejo Reserva de la Biosfera Janos
- Programa de Conservación y Manejo Reserva de la Biosfera Mapimí
- Programa de Manejo del Area de Proteccion de Flora y Fauna Cuatrocienegas
- Estrategia para la conservación y el uso sustentable de la biodiversidad del estado de Guanajuato
- Estrategia para la Conservación y Uso Sustentable de la Biodiversidad del Estado de Aguascalientes
- Estrategia para la conservación y el uso sustentable de la biodiversidad del estado de Chihuahua
- Plan De Acción Para La Conservación Y Recuperación De Especies De Fauna Silvestre Prioritaria En El Estado De Chihuahua
- Plan de Acción para la Conservación y Uso Sustentable de los Pastizales del Estado de Chihuahua 2011-2016
- Estrategia para la Conservación de los Pastizales del Desierto Chihuahuense (ECOPAD)
- Plan Maestro de la Alianza Regional para la Conservación de los Pastizales del Desierto Chihuahuense 2011-2016
- Sonoran Joint Venture Bird Conservation Plan
- Chihuahuan Desert Bird Conservation Plan
- Business Plan for the Sky Island Grasslands

Figure 2b. Legend for Figure 2a - mapped footprints of management and conservation plans affecting grassland ecosystems within the Desert Landscape Conservation Cooperative geography.

PART 2: SYNTHESIS OF MEXICO-SPECIFIC GRASSLAND RESOURCES

Introduction

In our inventory of grassland resources we encountered a dearth of information on the landscape south of the US/Mexico border. To improve knowledge of Mexico-specific resources, we subcontracted Adrián Quero from Colegio de Postgraduados – SAGARPA to review and synthesize resources specific to Mexican grasslands. This review was conducted and reported in Spanish. We provide a translation of the executive summary of the literature review in English below. A Spanish language version of the executive summary is also included in Appendix 2. Both the Spanish and English versions of this literature review can be found at: https://www.sciencebase.gov/catalog/item/57e42b85e4b0908250060f03. Additionally, a table including url links to each identified resource can be found at the same url.

Value, Condition, and Alternatives for Improvement of Grasslands in Mexico

Literature review executive summary

Arid and semiarid zones make up half of Mexico's national territory, the reason for their importance, and are fragile ecosystems due to slow biological dynamics, a result of the low precipitation rates characteristic to these regions. Similarly, it is a biome important at the continental level, and its conservation and ecological function depend on well-structured international collaboration, both in terms of ideas and funding.

Mexican arid and semiarid grasslands represent an environmental resource undervalued in Mexico by predominantly urban civil society, and similarly by decision makers unaware of its value. Conversely, the desert is widely recognized by specialists of diverse fields for its diversity, importance, but have not been able to obtain the political power needed to achieve recovery plans, conservation, and sustainable use of grassland resources.

The best agricultural soils in these regions were grasslands in recent history and hosted large populations of humans, animals, microorganisms, and plants (from a diversity of families but especially the grass family), which all evolved excellent functional relationships until about 300 years ago. Currently many of them are at high risk of extinction.

The approach for production in these regions must always adapt to the conditions that determine its potential: scarcity of moisture and contrasting temperature extremes in summer and winter. The precipitation in arid zones is scarce and poorly distributed, with few pulses that exceed 25 mm, midsummer drought normally lasting 3-4 weeks but up to 6 weeks. This complicates many activities, such as grassland restoration. However, more databases from more rainfall stations are needed to achieve certainty for timely declaration of droughts and better prediction of opportunities for successful plantings.

Currently in Mexican arid regions, high pressure is applied to natural resources for their utilization, principally in the form of: uncontrolled grazing omnipresent in every corner accessible to cattle, opening high risk lands up for crop production, overexploitation of aquifers, discharge of contaminated waters, riparian areas drying up, exploration and uncontrolled exploitation of natural goods: flora, fauna, oil, gas, etc., without promotion of participatory activities for resource conservation and improvement among users, which results in a poor understanding of the precarious condition of the grassland environment.

Landowners think that the frequency and devastating effects of drought, dust bowls, low primary productivity, erosion, and run-off are "natural; many lack the concept of ecological conditions of 25, 50, 75, 100 or 300 years ago beyond what they know from oral history. Constant deterioration in grassland regions makes landowner interests highly susceptible to climate change (anthropogenic droughts), given the predicted increased frequency of extreme weather events: droughts, isolated torrential rains, mean summer and winter temperatures, among others, and the precarious condition of grasslands' ecological function. This poor condition causes poor harvests of crops and other natural resources (cattle, honey, flora, fauna) in the absence of production infrastructure like irrigation systems.

There is a glaring absence of a culture of valuing the biotic and abiotic components of grasslands, which is an indicator of the predominance of interest in resource extraction without a counterbalancing resource conservation view among landowners, due to lack of interest or awareness or that they don't see the need for mechanisms to improve grassland ecological function.

Grazing *per se* is naturally positive for the condition, stability, and function of grasslands, as well as promoting plant diversity. Overgrazing, however, is a problem, given that to maintain ecological stability, planned activities are required to balance two contrasting and dynamic aspects: (use vs. rest) which implies goal-oriented efficiency planning to dynamically maintain the correct grazing intensity. This balanced relationship is difficult to achieve under an extractive model that is not based on conservation and maintaining the quality of the components needed for healthy grassland ecological function.

Due to this grassland condition, 1/20 of potential primary productivity is harvested, and with this reduction, genetic resources (fauna, flora, microorganisms) and abiotic resources (soil, nutrient cycling, and low salinity) valuable for society's wellbeing are lost. Combined with the increased exploitation pressure on grassland resources, the achieved harvest of renewable resources is inefficient: poor herd parameters, poor harvests of honey and wild flora and fauna, poor soil infiltration, etc. Therefore commercial goods are produced at the cost of grassland deterioration, which jeopardizes the production of goods as a whole for future generations. Grassland management in Mexico is an open system that doesn't receive positive feedback (i.e. adaptive management) to elevate its function, a clear example of the tragedy of the commons as proposed by Hardin.

Work is needed to produce grasslands managers trained to develop production technologies with a balance between extraction and fostering natural resources, the latter via social strategies for participatory action. Certainly there are technological problems for achieving grassland function, but the principal problem is social through the lack of users with a good balance between extraction and fostering of natural resources. As far as animal production, the model of Livestock Groups for Technology Transfer and Validation (GAVATT) has clearly shown its value, in spite of lacking legal protections. This model hasn't reached full coverage of the population of production centers (ranches or other livestock owners), so they should develop other social strategies for technological empowerment of grassland landowners. If educational activities promoting sustainable production are not initiated, the ecological costs of the purely extractive vision will rise until the economic costs for the recuperation of grassland function will be beyond the national economy's reach, given that this situation has already continued for the past several decades.

Protecting soil via promoting greater vegetation basal cover is of great importance for diverse aspects of grassland ecological function and similarly for extending the longevity of rainwater capture and erosion control systems, given the direct relationship with these projects' longevity. The promotion of greater vegetation cover can be the first objective of any serious program of grassland restoration.

Developing pilot ejidos where the advantages of professional grassland management are highlighted would be a good opportunity to demonstrate the potential of well-planned activities to improve grasslands' sustained productivity. These ejidos can be focused on diverse activities: ranching, wildlife management, ecotourism, water retention, carbon sequestration, or a combination thereof.

Grasslands contain genetic resources (alleles) of many native and endemic species of plants, wildlife, and microorganisms, which contain the genetic information (most of which is still unexplored) needed to respond both to production demands in support of good grassland function, and to climate change. Similarly, this provides the opportunity to achieve international commitments for the reduction of greenhouse gases, e.g. feedstocks for bioethanol as well as carbon sequestration. For the density and capacity of grassland restoration, 1 kilogram of seed can contain more than 4 million seeds for some species, and 90 days post-emergence can withstand drought and winter temperatures; grasses are huge allies in improving vegetation cover, so we should take advantage of their attributes to quickly achieve greater basal cover of the soil.

Mexico stands out in terms of the need for the creation of laws and regulations for the beneficial flow of goods and services to and from grasslands, addressing international commitments and local needs, as well as promoting incentives for grassland production and conservation. However, it lacks the links to and follow-up by the experts that have consistently characterized grasslands. Similarly, it should focus on linking government programs for landowners to the achievement participatory activities to take ownership of the conservation and sustainable use of grassland resources, which has not yet occurred. This could be achieved by establishing specific or mixed and matched pilot modules according to the ecological opportunities of each region.

Legislation should focus on facilitating empowerment of landowners for the conservation yet profitable use of grasslands in response to dynamic global economic models, *i.e*. respond to the needs of a larger economy and current conditions: ten times more inhabitants than in 1917, greater technology, greater communication and training capabilities, the need for carbon credits, payments for ecosystem services, regulated hunting of profitable species attractive to the market of hunters, ecotourism with sufficient amenities, the popularity of bird-watching and cowboy culture, among others. Examples of proactive legislation that benefits both the profitability and condition of small grassland areas have recently occurred, and this vision should be replicated not just for wildlife as noted for bighorn sheep and mule deer; instead it should be generalized and flexible to improve the whole arid and semiarid ecosystem's function.

The good news about the Mexican population boom is that it can be taken advantage of for the work of restoring grassland function. In this document, information developed principally in Mexico is compiled and analyzed that accounts for the condition of grasslands in Mexico, concluding with their importance and alternatives for improving the productivity and condition in these regions.

PART 3: STAKEHOLDER ASSESSMENT FOR MEXICAN GRASSLANDS

In our inventory of grassland resources we found a dearth of information on stakeholders south of the US/Mexico border. To improve knowledge of Mexico-specific stakeholders, we subcontracted Adrián Quero from Colegio de Postgraduados – SAGARPA to identify and interview grassland area stakeholders in Mexico to improve knowledge of these parties within the Desert LCC partners. This review and stakeholder assessment was conducted and reported in Spanish. We provide a translation of the report in English, below. A full list of the participating stakeholder groups can be found in Appendix 4. A Spanish language version of the report is available at: https://www.sciencebase.gov/catalog/item/57eef6afe4b00abc114867b6.

Perceptions of the condition of semiarid grasslands under grazing regimes in Mexico

Abstract
A succession of questions was developed and applied to different stakeholders immersed in knowledge of the condition and the use of grazing of grasslands. One hundred people were surveyed amongst livestock producers (both from private ranches and from communal ejidos), and students and researchers at regional institutions involved in agricultural sciences in different states of Mexico: Coahuila, Durango, San Luis Potosí, and Jalisco. The objective of the survey was to determine aspects of stakeholders' interpretation of the condition of grasslands in their region under conditions of extensive grazing, such as soil condition, harvest efficiency, vegetation condition, openness to community organizing of grazing, capacity for technological innovation, openness to innovations, among the most important aspects. This information was analyzed using a chi-squared test. The group interviewed did not influence the answers received, given that they were independent ($p<0.05$). Regardless of the representative interviewed, the ideas that grasslands are in poor condition, that cattle yields are low, that soil erosion vulnerability is high, were predominant, and similarly that communal landowners currently barely participate in organizing or promoting rules for grazing, but that their active participation is necessary for decision-making to coordinate grazing. The representatives interviewed are aware of the importance of technological innovation for the most efficient balance of grassland use vs. conservation. The information gathered strengthens the importance of working on human dimensions to achieve the empowerment of producers to promote conservation-oriented use of grasslands and the even distribution of grasslands' renewable resources regardless of users' access to tools; examples of proactive public policies have demonstrated the effectiveness of participation and continuous information about natural resource dynamics, achieving participatory conservation. Grasslands represent a renewable source of income for many families and their ecological importance is even greater for society in general, so we must work for their conservation and wise use.

Introduction
Cattle permeate practically every corner of the nation with their free-ranging search for food, except for steep mountain peaks, deserts with water scarcity (either natural or anthropogenic) and steep river canyons and ravines, so there is practically no area free of the herbivory of domesticated ruminants. Mexico has around 1,140,000 livestock production units, with an average of 21 head of cattle, and the vast majority is for subsistence with difficult access to markets, with a large polarization where few ranchers have many cattle and vice versa (Cavalloti,

2014). Similarly, financial investment comes in greater quantity to those ranchers with more cattle who belong to systems with access to trade and technology (Robles, 2013), which is an indication of the economic importance of this sector and its disparities. It has been said that in Mexico grazing is the most common activity in rural environments and is practiced without exception in all agricultural regions, even under adverse climate conditions (Mora et al., 2013). Grazing has been and will continue to be the principal tool for changes in ecosystem function in arid zones of Mexico. Currently, the most important impact on vegetation and habitat fragmentation is attributed to activities like extraction of wild flora and fauna, mineral extraction, exploitation of aquifers, hydrocarbon exploration and extraction, however none of these has the vast reach of grazing.

Since the domestication of the first ruminants around 5000 AD, their production via grazing has been converted into an activity inherent to human culture (Humphreys, 2003) and will continue being part of our culture for a long time. The type of grazing dominant in Asian and African grasslands, in some cases for thousands of years, differs little from nomadic grazing of wild ungulates (Walker & Janssen, 2002), in contrast to what happens in Mexico. Due to constant economic pressure; in general, livestock owners in Mexico don't stop to evaluate their production system regularly, much less the effect of grazing on the long-term functionality of the system, and don't establish or respect rules of vegetation usage, nor do they understand the effects and importance of grazing pressure with respect to the flow of energy: periods of intense grazing and periods of total rest from grazing (Quero et al., 2007).

In Mexico, principally in communal lands, it's obvious the absence of regulatory authority that would ensure better functional condition of the ecosystem, which creates problems of the loss of productive goods: soil, flora, fauna, etc. for future generations, as well as permeating all types of lands, to date, there is no glimpse of a proactive intervention of the authorities in this. For this reason, we experts who recognize the tendency toward deterioration of this resource's condition need to document the situation. Cavalotti (2014), indicates that the tenacity and economic necessities of ranchers is what keeps them prevailing in this activity, however this tenacity and meeting their economic needs, when it comes to extensive grazing, is based on the detriment of grassland function from excessive grazing.

Grazing is the principal tool that modifies arid and semiarid ecosystem function by acting as a selective force on plant communities and affecting the dynamics of other biotic (fauna, flora, etc.) and abiotic resources (soil, water infiltration, soil biological activity, organic matter, etc.; Gonzalez & Fierro, 1985), i.e. livestock owners through this mechanism are the agents directly responsible for vegetation condition and ecosystem function components in the absence of other historic disturbances. The wise use of grazing increases plant diversity and helps control greenhouse gases by promoting their capture and sequestration (Follett & Schuman, 2005).
In large regions of Mexico the production via extensive grazing together with the harvest of wild flora and fauna represent the only renewable source of income for residents (Echavarría et al., 2006; Quero et al., 2013); as such, there will be extensive grazing for many years faced with the impossibility of providing infrastructure for intensive agricultural production: irrigation, greenhouses, electric fencing, wells tapping aquifers, equipment, electricity, among others, therefore it is recommended to promote greater productivity and ecological stability there for diverse reasons (Quero, 2013a):

1) Arid zones contain the populations most economically, socially, and educationally neglected other than indigenous populations

2) By surface area, these areas have the greatest impact. There are one million square kilometers of arid land in Mexico.

3) They are far from the biological limits of production, in addition to not requiring large investments beyond planning efforts

4) Therefore they offer the opportunity for greatest impact with the least economic investment. The first investment required for grazing (communal or private) is for organizing and respecting basic rules for vegetation utilization.

Economically, the efficiency of the cow-calf system predominant in extensive grazing of arid zones is based on increasing the percentage of calves weaned at healthy weights that increase consistently until put into the corral for finishing and supplying to the market. This becomes more important when the rate of return for the producer in the finishing corral is lower each year and the cost of feed for finishing is higher, affecting the profitability of the system of finishing cattle in corrals (Carrera & Bustamante, 2013), increasing the ecological costs of production with finishing in corrals. The cow-calf system used in extensive grazing continues to be the most profitable with respect to finishing in corrals.

The geographical importance of grazing domesticated livestock and the range of technology for livestock production now developed and available are well known, however this technology does not reach producers for various reasons: available infrastructure, lack of technical support from specialists, producers' low capacity for risk to try innovations (if they don't work, they don't eat), among others. There is a small impact of each individual decision of grazing management on communal rangelands on ecosystem condition (Hardin, 1968). This places producers and their decisions at the heart of changing the condition of ecosystem components for the better (Quero & Miranda, 2013).

There are few studies that address the interpretation of rangeland stakeholders in terms of their influence on vegetation condition, components of grassland function, and grazing management as a whole, with the reasons for these. The goal of this work is to establish stakeholders' interpretations of the effects of grazing and grazing decisions, so surveys were developed and administered to address this goal. Therefore the objective of this work was to get to know the interpretation of stakeholders, directly or indirectly involved in the use or study of grazing in arid zones, of diverse aspects of production.

Materials & Methods

A set of questions was prepared and used to define the current situation, productivity, and openness of grassland stakeholders to conservation and grassland improvement (Appendix 5). The set consisted of 45 multiple choice questions to select from. The non-probabilistic casual method was used for the surveys (Pimienta, 2000). The survey was given in cattlemen's associations to those who responded to the survey announcement and those members who were visiting each association office to fill out paperwork during the two days when surveys were being carried out, in a variety of states known to have extensive livestock grazing in arid zones. Those interviewed included agricultural sciences researchers with more than five years working in the region where they were interviewed, and agricultural sciences students from families involved in both communal and private ranching operations, and livestock producers from communal and private ranches. The survey was given verbally rather than letting them fill it out alone, so that questions could be explained if necessary.

The survey consisted of questions that identified activities and 1) how long they have been interested in grazing management and their knowledge of it, 2) their consideration of current condition and trends in grassland vegetation, soil, and organic matter, 3) the importance and proclivity of people to develop strategies for grazing management improvements for the benefit of grassland condition in their area, 4) their perception of who is directly responsible, via grazing, for grassland condition, 5) the importance and frequency of extension agent visits and the effect on adherence to programs, ideas, and teachings about the importance of conserving grasslands in good condition, 6) the knowledge acquired about forage species, cattle races, herd parameters for grazing management in grasslands, 7) interest in and capacity for community organizing for grassland conservation, 8) requirements and impediments to tackle, in their situation, grassland degradation through collective action, 9) how the community is organized for grassland vegetation utilization via grazing, 10) historic and current levels of productivity, 11) their interest in adopting the technology necessary to restore grasslands and the benefits of good grassland condition.

We obtained 100 surveys in diverse arid regions of the Chihuahuan Desert: Jalisco (Ojuelos), Durango (Mezquital), Hidalgo (Mezquital), San Luís Potosí (SLP) y Coahuila (Zaragoza). The interviewees consisted of 20% students of agricultural sciences and veterinary medicine (Universidad Politécnica de Francisco I. Madero, Universidad Autónoma de San Luis Potosí, y Universidad Juárez del Estado de Durango), 10% agricultural sciences researchers (INIFAP, Colegio de Postgraduados, Universidad Juárez del Estado de Durango, y Universidad Autónoma de San Luis Potosí), and 70% livestock producers (of which 29% were from private ranches and 71% from ejidos).

Results & Discussion

Stakeholders' interpretation of grassland condition was explored. Ample knowledge of the precarious condition of grasslands and recognition of the goals that should cover the strategies to improve it were both detected (Table 2). The questions that were analyzed were just those that were interpreted as informative about grassland condition, how grasslands are used, and the openness of producers to improve grassland condition with the goal of conservation and improved productivity. The stakeholder groups' answers were evaluated using the χ^2 test, which suggested that the answers and opinions were independent for each group ($p<0.05$). The majority (85%) of stakeholders are aware of the precarious condition of grasslands and consider grassland condition to be generally bad or in the process of degradation. Only 10% thought the grassland condition has improved, and they seem to be influenced by short memories (wet years recently), some positive event (sale of their cattle, good price for their cattle, among others), and/or by the lack of photos or data for comparison of historic vs. current grassland condition. Similarly, a low percentage of stakeholders consider that the soil is protected from the forces of erosion and the majority (63%) think that it is exposed to the forces of degradation, among all interviewees, 20% think that the soil is very exposed to these forces.

Table 2. Perceptions of Mexican stakeholders about grassland condition and goals that should cover the strategies for grassland conservation.

Concept:				
Current grassland condition	Worsening 52%	Normal (bad) 33%	Improving 10%	Don't know 5%
Exposure of soil to erosion	Very exposed 20%	Exposed 43%	Regular 31%	Protected 6%
Causes of current grassland condition	Overgrazing 64%	Poor coordination 17%	Don't know 14%	Poor technology 5%

The opinions cross-tabulated with the stakeholder group interviewees belong to show that the population immersed in the knowledge and use of grasslands via extensive grazing know about the degradation of their grasslands and/or think that it is normal, due to being unaware of the historic condition of rangelands. Few interviewees indicated that they don't know whether the situation was improving or not, and a similar proportion of agricultural science students and grassland landowners think that grasslands are improving with time and utilization (Fig. 1, $p<0.05$). This is informative about perceptions of degradation of rangelands among stakeholders immersed in the knowledge of the condition of vegetation and grazing.

Therefore there is a predicted receptiveness to community activities for the improvement of grasslands and empowerment for the propriety, conservation, and improvement of biotic and abiotic grasslands components. This could be possible with proactive planned interventions of local authorities for this goal, both via the linking of government support programs with activities that improve grassland condition and via promoting community activities for the restoration of grasslands: resting and controlled grazing of rangelands, proportional (fair) distribution of the benefits of grassland resources, empowerment for a vision of balance between conservation and extractive use of grassland resources (Fig. 1).

The majority (64%) of stakeholders know the importance of grazing and consider that grassland degradation occurs as a result of the abuse of grassland resources via grazing (Table 2). This has been extensively documented by diverse studies, and recently in Tamaulipan scrub it was shown that poorly coordinated grazing was the 2nd factor that influenced rangeland condition (Mora et al., 2013). On the other hand, a fairly large percentage of interviewees don't know what causes current grassland condition, and a small proportion think that the lack of technology is responsible. Overgrazing, poor coordination of grazing, and low availability of technology combined as community organization plus technology sum to 86% of responses as aspects that determine grassland condition, that is stakeholders are aware of the high degree of the need for grassland protection (Table 2).

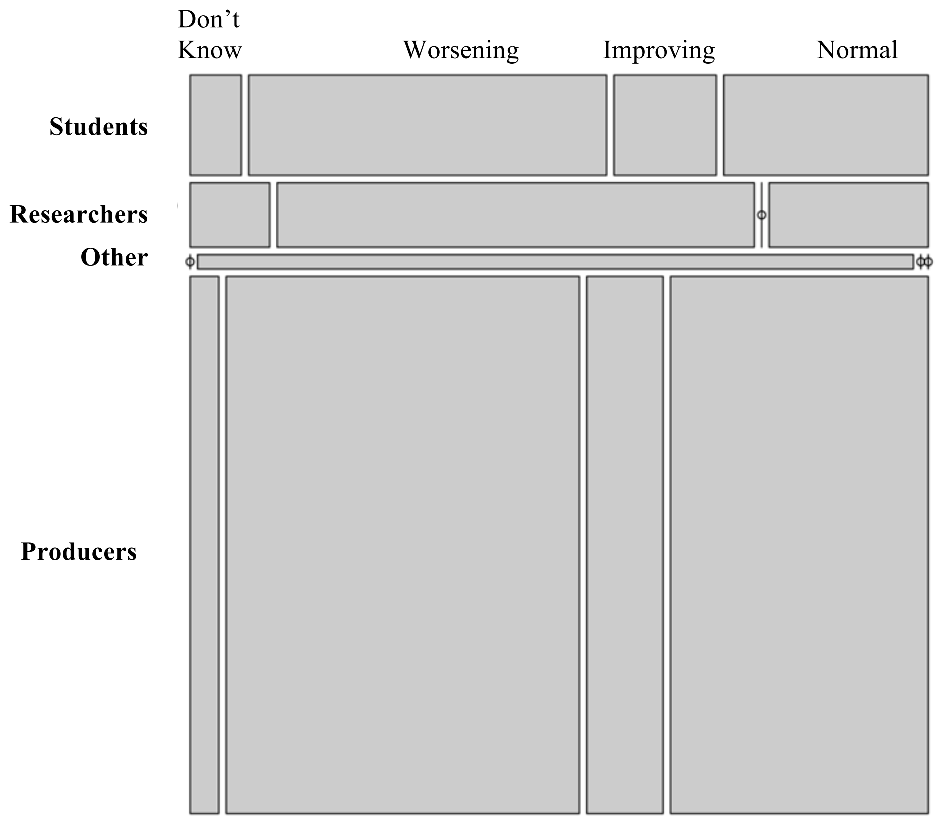

Figure 3. Perceptions of grassland condition by Mexican stakeholders immersed in the use and study of grasslands

Organizing grazing production is of the utmost importance, and requires overcoming barriers, idiosyncrasies (sometimes needed based on infrastructure) and vested interests to achieve needed modifications, adaptations, and variations within and between communities. However the stakeholders interviewed recognize the importance of technology (85%; Table 3), hold in high esteem their possible impact to achieve a better condition of pasture vegetation, recognize that productivity or the harvest of commercial goods (cattle) is currently mediocre to bad (69%), which indicates that productivity is recognized as precarious. The efficiency of herd parameters are traditionally poor, which has been shown in diverse studies (Ramírez y González, 2010; González et al., 2010). The decisions about methods of grazing are barely modified; there is no dynamic approach nor empowerment for the regulation of grazing, following traditional customs and accepting without thinking current grazing methods, according to 87% of stakeholders interviewed, is the factor with the greatest influence on decisions about grazing methods (Table 3). Communal producers are not empowered to protect shared vegetation, given that they don't perceive themselves as its owners. Similarly, they don't perceive themselves as the recipients of the damage caused by those users that take unfair advantage of grassland resources. There are few studies that indicate sufficiently if livestock grazed in diverse communities are distributed proportionately among landowners or if there is a concentration of livestock among just a few owners, which is difficult to answer given the sensitivity of the subject.

Table 3. Perceptions of the importance of technology, grazing management and current production among stakeholders of pasturelands in arid zones of Mexico.

Is technology important for good pasture?	Always	Often	Sometimes	No
	53%	32%	14%	1%
Why do you graze land the way you do?	Tradition	No one discusses it	The area is negotiated	No one is in charge
	38%	34%	15%	15%
Current livestock production is:	Excellent	Good	Mediocre	Bad
	4%	26%	61%	8%
Would you track production data for your cattle?	Yes	Maybe	No	
	75%	18%	4%	
Are extension agents' visits helpful for your pasture?	Always	Often	Sometimes	Never
	18%	42%	27%	8%
Do you plan your sales of cattle?	Always	Sometimes	Never	
	41%	41%	15%	

Ninety-three percent of stakeholders show interest in recording information about their cattle, although some would want information on the reasons or benefits of doing so first, given that they perceive its importance but not decisively. Similarly 60% see the benefit of extension agent visits and less than 10% think that these visits are never good. More than half of producers don't have a plan for selling their cattle, indicating that they see cattle as a means of getting cash at the opportunistically when a necessity arises, not based on a business plan (Table 3). Cuevas *et al.* (2013), evaluated surveys of producers advised under the methods of the GGAVATT (groups of ranchers for validation and transfer of technology) model and indicated that close communication with extension offices made them more receptive to innovation, however, this innovation may be a result of increased frequency of technical support visits given greater accessibility of certain livestock production units. The survey is valuable given that it detected similarities and differences between producer groups with herd size being the factor directly related to the capacity for technological innovation. The greater profit in extensive grazing systems in Australia has reached ranchers who are efficiently informed, tripling their income over those who don't use innovations under the direction and support of extension agents, based on data over a 200 year period (Walker & Janssen, 2002). That shows the importance of technical support and the application of technology for grazing production. The same as in Australia, in Mexico economic and conservation success from the diversified used of grasslands is starting to be documented, especially with game species attractive to hunters from sectors of society that appreciate a diversity of grassland components, which has been achieved in conjunction with changing laws in Mexico (Tapia, 2013).

Evaluating with surveys stratified by number of cattle, in Durango the condition of grasslands were sampled in San Luís del Cordero, an ejido surrounded by the neighboring ejidos Nazas, San Pedro el Gallo, and Rodeo, and it was reported that in spite of the human population decreasing by 66% from that measured in 1970, the grasslands showed a clear deterioration. The landowners work 98% in agriculture, combining grazing with rain-fed agriculture, and 14%

gather oregano from the forest. Those with less than 20 heads of cattle have more than double the rates of illiteracy and depend on other activities to make ends meet for their families more than those with more than 20 head of cattle. Similarly, 41% of the cash remittances sent home by family members living away from the ejido (either in the USA or elsewhere in Mexico) were spent on supplemental forage to maintain the herd. In this ejido, the rangelands are utilized from June to December, and the rest of the year the cattle graze croplands and receive supplements of alfalfa, milled corn, chicken manure, salt, cattle feed, and as local products, producers with less than 20 head of cattle use crop residues, prickly pear, or palma plants, vs. those with more cattle don't use prickly pear or palma (Orona et al., 2009). These authors mention that just 48% of the producers belong to the local cattlemen's association, and that those who do don't receive any benefits of membership. They report an absence of organizational leadership and of collective benefits from interest in and structure of an appropriate grazing system promoting balance between conservation and resource exploitation. Their grazing management would seem appropriate in this system of resting pastures over certain times of year and during periods of meager precipitation and low temperatures that limit the vigor of vegetation regrowth, which would affect its recuperation from grazing. Similarly, high levels of livestock and habitual overgrazing, not mentioned by the authors, and the constant tendency to increase the number of livestock cause a lack of forage for the livestock.

With respect to the possibility that the community or landowner organize grazing methods, 91% of the stakeholders we interviewed said that it is necessary to organize grazing to regulate better the use of pastures for grazing, but regarding this, the majority (84%; Table 4) see it as very difficult to organize grazing in practice in their community. The grazing exploitation in floodplains in Brazil has been documented with systematic evaluation of forage for harvest and the constant presence of extension agents to support decision-making of communal landowners (Sabourin y Djama, 2003), which has had good results in terms of productivity and product diversification in a complex framework of harvest of crops, fish, and livestock sustainable over the long term. That shows again the importance of technical assistance for good decision-making.

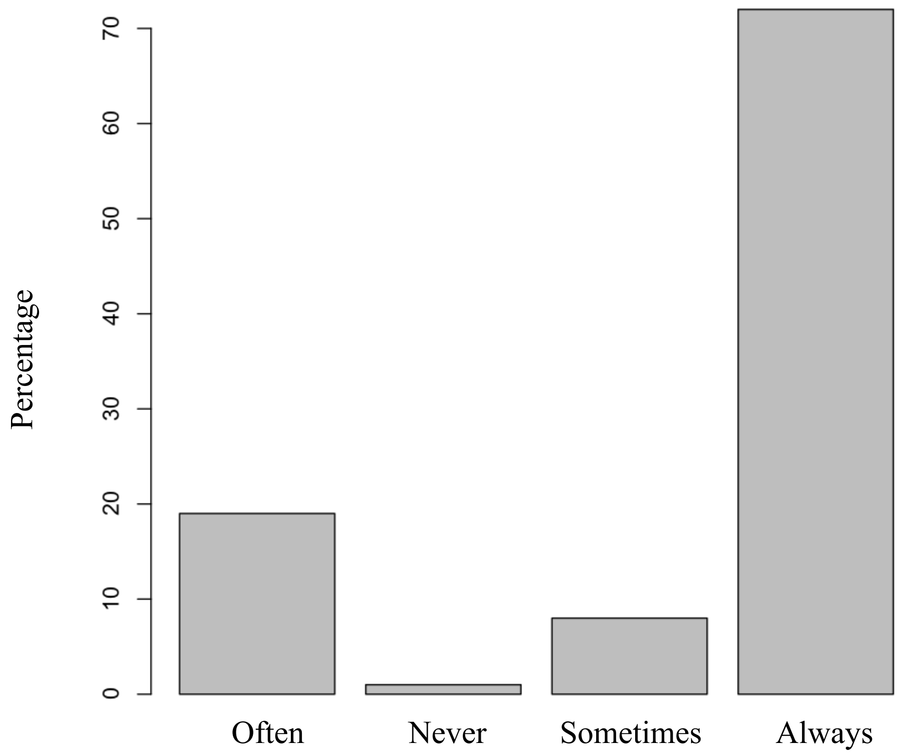

Figure 4. Evaluation of the importance of organized grazing to achieve best use of grassland via extensive grazing on communal lands in Mexico.

Sixty percent of interviewees had received an official invitation for organizing grazing, however this type of initiative can't be accomplished because they aren't led by a member of the community; no one takes the lead to consolidate a plan for grazing use of pasture (72%), and they see the absence of a leader with organization and proposals for strategies for organizing as the principal problem for achieving a plan for appropriate pasture utilization, in spite of the fact that community members had proposed organizing from within the community (43%). Experience has shown that participation and communication between communal landowners to discuss and intervene in the process of assigning the right to graze or harvest other common goods of grasslands (honey, wood, firewood, vegetation, etc.) result in better managed grasslands than in the absence of participation (personal opinion) where there is reduced collaboration and empowerment in decisions about the balance between harvesting pressure and what promotes the common good (Ostrom et al., 1994). This magnifies the importance of promoting empowerment and participation of communal landowners in decision-making regarding common resources, which results in the search for alternatives to not just achieve balance between the exploitation and the betterment of common resources but will also promote alternatives that improve the distribution of wealth among communal landowners who don't have all the tools needed for harvest.

Table 4. Perceptions of the necessity and probability of organizing grazing among stakeholders in arid zones of Mexico.

Should the community organize for the best use of pasturelands?	Always	Often	Sometimes	Never
	72%	19%	8%	1%
It is possible to organize your community with respect to grazing?	Yes, easily	With effort, yes	Maybe, but I doubt it	Never
	16	55%	28%	1%
Have government authorities invited you to organize grazing?	Always	Often	Sometimes	Never
	16%	16%	44%	15%
Have members of your community proposed organizing?	No	Yes	don´t know	
	34%	43%	14%	
Principal obstacle for organizing	Fear of proposing it	No one proposes it	No one actually organizes	The rich
	9%	23%	49%	14%
Would the community participate in a grazing plan?	Easily	With effort	I doubt it	Never
	23%	46%	19%	2%

In Mexico there are no laws for monitoring, and the challenge of regulatory authority of grazing, though absent in Mexico, is to achieve a policy that balances necessities and the importance of learning to prevent excessive degradation of this resource as Walker & Janssen (2002), have mentioned as a fundamental factor to achieve stability of grazed areas.

The interpretation of interviewees on the reasons for overgrazing and the lack of balance between conservation and utilization of arid grassland in Mexico show that 84% conceptualize that tradition and the lack of participation in decisions about grazing promote the current excessively extractive management of grassland vegetation for grazing. The current harvest of male calves for sale is bad to mediocre for 70% of interviewees, which is reflective of the production parameters monitored in diverse studies (Hernández et al., 2010; Ibarra et al., 2010), and few cattle ranches have the outstanding parameters reported by experimental livestock programs (Garcia, 2006). Among producers, more than 93% were open to recording information on the productivity of their cattle herd, of which 18% would need to understand the reasons for taking this information and would do so once convinced. Sixty six percent of producers do not consistently plan the sale of their cattle, which is an indication that their decision is not a function of the energy flows that determine forage production, but rather that grassland users consider cattle as a form of security, like a piggy bank, to use for unforeseen large expenses and have not developed the vision of entrepreneurial efficiencies of cattle grazing of grasslands as has been recommended (Quero, 2014).

Conclusions

The stakeholders absorbed in the knowledge of management and use of grasslands agree upon their degraded condition, recognize the necessity and importance of participation in decisions about organizing grazing, and recognize the precarious harvest of cattle due to limited access to technology. Producers are interested in active participation in obtaining information and improvements in grassland condition and productivity parameters.

Stakeholder mapping; Aguascalientes, Mexico 2014 partner meeting

As part of the beginning implementation of the Desert LCC's LCPD effort, stakeholder and partners from a total of 40 projects/programs (63 unique partners) attended the LCPD Aguascalientes workshop in 2014. Attending partners belonged to federal, state and local governments, NGOs, universities and private/landowners. Each party (Appendix 4) was asked to draw an area of interest on a desert LCC geography map (Fig. 5). We subcontracted Southwest Decision Resources, a professional facilitation organization specialized in natural resource planning, to collect and digitize these stakeholder geographies. This stakeholder assessment is part of the larger LCPD effort through the Desert LCC, and efforts similar to these will continue as part of that process. A full list of participating organizations is included in Appendix 5.

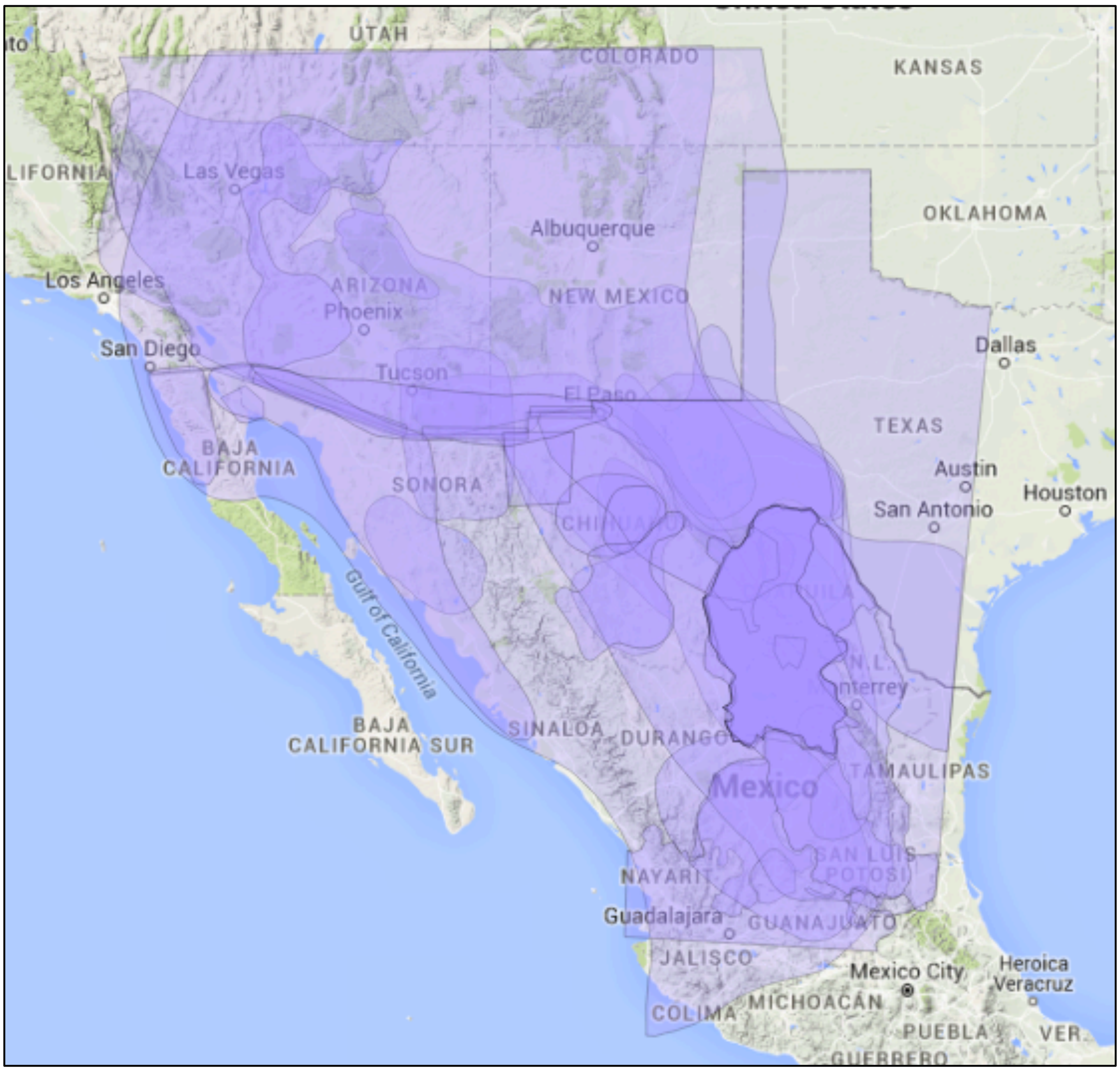

Figure 5. Mapped partner interest areas at Desert Landscape Conservation Cooperative meeting in Aguascalientes, Mexico. Each polygon represents a partner area of interest mapped during the meeting.

PART 3: MAPPING CONVERSION RISK OF MEXICAN GRASSLANDS

Introduction

Grassland areas are shrinking globally due to numerous stressors, however conversion to agriculture is the leading cause of grassland loss in the Chihuahuan and Sonoran deserts of Mexico (Pool et al. 2014). Exploring A) the ecological characteristics of converted agriculture and B) estimating the current risk of conversion to grasslands in Mexico is integral to conservation planning for grassland landscapes, especially within Mexico's geography.

We used available regional datasets to conduct a risk analysis of grassland area conversion to agriculture within Mexican grasslands in the Desert LCC geography. We present a map of conversion risk applicable to this geography, and discuss next steps in honing this geospatial layer for eventual use in conservation planning.

Methods

We used five criteria to define conversion risk within the Desert LCC in Mexico:

1) Grassland classification
2) Ecological suitability for agricultural development
3) Proximity to urban centers
4) Proximity to existing agriculture
5) Water availability

All analyses were completed in ESRI's ArcGIS 10.3. The resulting spatial layer has a pixel size of 30 x 30 m.

Grassland classification

We used land cover classification developed by the Instituto Nacional de Estadística y Geografía (INEGI 2013) to define grassland areas in our study area. Areas not defined as grasslands were excluded from further analysis.

Ecological suitability for grassland development

We used a Digital Elevation Model (DEM, CGIAR-CSI 2008) to calculate slope for our study area. We then used the INEGI land cover classification for agricultural development (INEGI 2013) to calculate the 95% quantile (5.88°) for slope threshold within these delineated areas. We used this threshold to isolate areas of slope equal to or less than the slope threshold value. We excluded areas with a slope greater than 5.88° from further analysis. Areas less than the threshold were assigned a linear increasing risk value with decreasing slope value, ranging from 1 (no increased risk) to 2 (maximum risk due to slope value).

Proximity to urban centers

We used a layer produced by INEGI's Polígonos de Localidades Urbanas Geoestadísticas (INEGI 2011) to define urban centers in our study area. We created a point feature at the geometric center of each urban polygon and measured Euclidean distance (straight-line distance) from each urban center across the study landscape. We then used the INEGI layer classifying current agriculture to measure distance to nearest agricultural development to each urban center. We used the 99% quantile (30.74 km) for distance to nearest agriculture for each urban center as a threshold after which no increased risk would be assigned to the study area. Areas less than the threshold were assigned a linear increasing risk value with decreasing distance, ranging from 1 (no increased risk) to 4 (maximum risk due to proximity to urban center).

Proximity to agriculture

We used the agriculture layer previously described to assess proximity to agriculture in our study area. We measured Euclidean distance from each agriculture polygon across the study landscape. We used 4 km as a threshold (personal communication, G. Levandoski and A.O. Panjabi) for distance to nearest agriculture for each urban center as a threshold after which no increased risk would be assigned to the study area. Areas less than the threshold were assigned a linear increasing risk value with decreasing distance, ranging from 1 (no increased risk) to 4 (maximum risk due to proximity to agriculture).

Water availability

We used the aquifer water availability from Comisión Nacional del Agua (CONAGUA 2014) to define water availability across the landscape. This layer approximates water availability by watershed due to knowledge of existing aquifers within each watershed. These watersheds are split into four categories of water availability. We reclassified these categories and assigned risk to each category to describe relative risk of conversion due to water availability across the study area. Watersheds labeled as having a "deficit" of water we assigned a value of 1 (no additional risk). Watersheds labeled as "equilibrium" with aquifer sources were assigned a value of 2 (increased risk). Watersheds labeled as either "available water" or "abundance of water" were assigned a value of 4 (highest risk).

Analysis

Once each of these risks were assessed individually, we multiplied these risks together (Fig. 6, full model structure in Appendix 7) and rescaled to a scale of 0:1 to create a spatially explicit representation of risk of conversion to agriculture ranking from low to high risk (Figure 7). All models were constructed in ESRI's model builder. We used delineation of Grassland Priority Conservation Areas (GPCAs, Pool and Panjabi 2011) to calculate summary statistics for each GPCA unit within our study area.

Results

We found concentrations of high-risk grassland areas in low slope areas directly abutting the Sierra Madres Occidental (Figure 7). This is due to high water availability in this area combined with close proximity to agriculture and urban centers. Lower-risk grassland areas occurred in large areas within the state of Chihuahua. We also found highest average risk of grasslands in the Cuatro Cienegas, Malpais, and Cuchillas de la Zarca GPCA (Table 5).

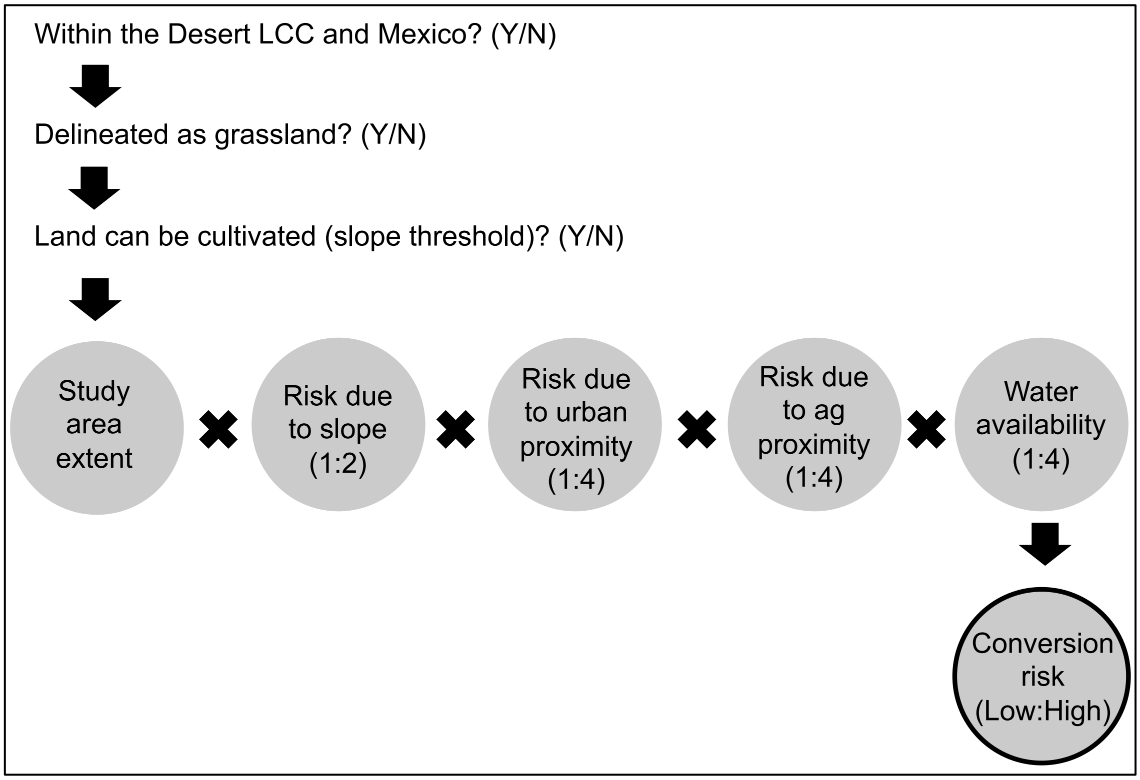

Figure 6. Concept diagram showing analysis steps for conversion to agriculture risk in grasslands of Mexico within the Desert Landscape Conservation Cooperative geography.

Table 5. Summary statistics of grassland conversion risk due to agriculture within Grassland Conservation Prioritization Area (GPCA).

	relative risk values				
GPCA	**minimum**	**maximum**	**range**	**mean**	**standard deviation**
Cuatro Cienegas	0.08	0.87	0.79	0.25	0.16
Malpais	0.01	0.91	0.90	0.25	0.18
Cuchillas de la Zarca	0.00	0.97	0.97	0.22	0.18
Alto Conchos	0.00	0.93	0.93	0.15	0.16
El Tokio	0.00	0.98	0.98	0.08	0.09
Lagunas del Este	0.00	0.32	0.32	0.06	0.04
Mapimi	0.00	0.34	0.34	0.06	0.05
Valles Centrales	0.00	0.97	0.97	0.05	0.06
Llano Las Amapolas	0.00	0.31	0.31	0.05	0.02
Janos	0.00	0.39	0.39	0.04	0.04
Valle Colombia	0.00	0.06	0.06	0.03	0.02

Discussion and Next Steps

This analysis is the first of many steps in developing a regional prioritization scheme for grassland areas. This product is meant to be a "living" spatial layer that can be vetted and updated to adaptively incorporate suggestions from other experts in the field. The model structure presented here is easily changed to incorporate additional spatial input layers or adjust risk values. One addition to the existing model structure of particular import is incorporation of the spatial layer we used for water availability. This watershed-scale layer is very course; incorporation of water availability at this scale likely oversimplifies this complex issue. We recommend incorporation of finer-scale water availability information into further analysis based on the structure we present here.

We also suggest the limited distribution of this preliminary product to the grasslands resource team within the Desert LCC for full vetting and potential updating under the umbrella of the LCPD process. Further, the majority of grasslands in Mexico fall within the Transboundary Madrean and Dos Ríos pilot areas. In-depth analysis of these two smaller geographies incorporating cultural variation in agriculturalists, additional data on available water sources, and protected area geography will yield finer-scale results potentially usable on the ground. Additionally, after internal vetting of this product we suspect this model underestimates relative risk in the Janos and Valles Centrales GPCAs due to long-established and rapidly growing agricultural communities (e.g. Mennonites) specifically in the state of Chihuahua. We recommend use of cultural community mapping (Bird Conservancy of the Rockies, unpublished data) in a state-specific analysis of conversion risk prioritizing proximity to Mennonite communities.

Finally, we encourage grassland conservationists to incorporate this spatial layer as part of a larger analysis that also incorporates climate change projections of grassland loss as well as measured grassland conversion rates through analysis of satellite imagery to further hone the models presented here. Although agricultural development is a leading risk for grassland loss in the short-term, changing climate involving lowered precipitation and higher temperatures will likely drive rising rates of grassland conversion into the future (Cang et al 2016).

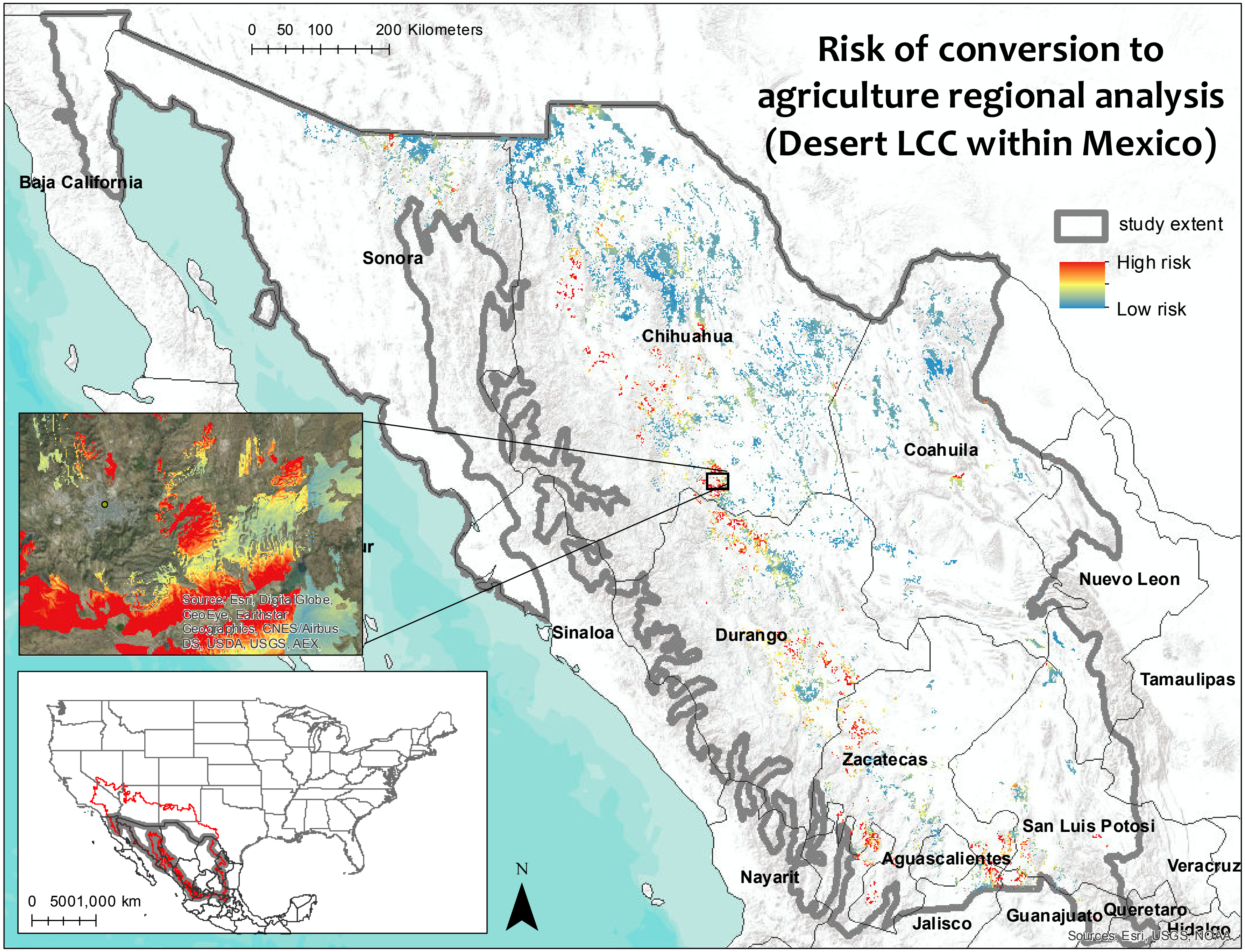

Figure 7. Regional conversion risk of grasslands to agriculture within the Mexican Desert Landscape Conservation Cooperative geography

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APPENDICES

Appendix 1. Deliverable text and documentation for grassland conversion analysis

Proposed Deliverable Conversion: Critical Management Question 3
Bird Conservancy of the Rockies
April 21, 2016

The Critical Management Question 3 (CMQ3) grant awarded to Bird Conservancy of the Rockies (2014) has several overlapping deliverable items with the newer Landscape Conservation Planning and Design (LCPD) grant awarded in 2015:

Goal 3, Objective 5: Survey desert stakeholders and review the literature for existing threat and vulnerability assessments. Provide a spatially linked annotated summary of these reports

Goal 3, Objective 6: Conduct a session during a round table to articulate threats and threat locations. Map the outcomes of the session for inclusion in Atlas products

Goal 4 Objective 8: Survey stakeholders and conduct a round table session to map existing programs, areas of interest, extant resources, desired program areas and need. Provide a data layer with this information to the Atlas.

Goal 5 Objective 9: Follow up the round table with a WebEx with stakeholders where data from (Goals) 1-4 are available. Have the stakeholders and CMQ3 members review the outputs and displayed information from the process in (Goals) 1-4 and provide input on gaps, data quality, and needs for informed grassland conservation.

These deliverables will all be met with the implementation of the LCPD pilot area workshops and webinars September 2016 – April 2017. Due to this extended timeline and the impending deadline for the CMQ3 grant deliverables (8/31/16), we propose the replacement of these deliverables with the following proposed spatial analysis, which meets Goals 3 and 4 on the timeline of the CMQ3 grant.

We propose a spatial analysis of current risk of agricultural conversion in Mexican grasslands based on proximity to center pivot and other agriculture and actively-growing farming communities within currently delineated grasslands. We will use the Instituto Nacional de Estadística y Geografía (INEGI) spatial layers to define current agriculture and grassland boundaries, and use expert opinion and local knowledge within Bird Conservancy of the Rockies and Invesitigación Majeno Conservacion de Vida Silvestre (IMC) to delineate current high-growth farming communities. We will use remotely-sensed ecological cutoffs to further define areas of threat in these grassland communities. This analysis will provide an end deliverable of a mapped index of threat based on these criteria both in map and GIS format, for inclusion in the Conservation Atlas.

Appendix 2. Spatially-explicit resources with associated urls catalogued in the Grasslands Data Inventory in the Deset Landscape Conservation Cooperative's ScienceBase records.

Title	Contacts	URL
The GIS Inventory	National States Geographic Information Council (NSGIC) (info@nsgic.org)	https://www.sciencebase.gov/catalog/item/5547991de4b0a658d794c724
Integrated Landscape Assessment Project	Janine Salwasser (janine.salwasser@oregonstate.edu) Jamie Barbour Steve Tesch	https://www.sciencebase.gov/catalog/item/5511a5e4e4b02e76d75b5185
SIATL: Simulador de Flujos de Agua de Cuencas Hidrográficas	Instituto Nacional de Estadistica y Geografia (INEGI)	https://www.sciencebase.gov/catalog/item/551323b3e4b02e76d75c093a
Sevilleta GIS Vector Datasets	John Mulhouse (mulhouse@sevilleta.unm.edu)	https://www.sciencebase.gov/catalog/item/551978bde4b0323842783142
New Mexico Resource Geographic Information System (RGIS)	Earth Data Analysis Center (EDAC), University of New Mexico (UNM) (clearinghouse@edac.unm.edu) Bureau of Business and Economic Research (BBER), University of New Mexico (UNM)	https://www.sciencebase.gov/catalog/item/555cc85ae4b0a92fa7eb8169
Atlas Nacional Interactivo de Mexico	Instituto Nacional de Estadística, Geografía e Informática (INEGI) Comisión Nacional de Áreas Naturales Protegidas (CONANP) Instituto Nacional de Salud Pública (INSP) Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT)	https://www.sciencebase.gov/catalog/item/5512ff4be4b02e76d75be58e
PimaMaps	Pima County, Arizona (PimaMaps@pima.gov)	https://www.sciencebase.gov/catalog/item/55149b05e4b032384276cb14
Portal de Geoinformación	Comisión Nacional Para el Conocimiento y Uso de la Biodiversidad (CONABIO) (ssig@conabio.gob.mx)	https://www.sciencebase.gov/catalog/item/553029ace4b0b22a15803480
Bureau of Land Management California GeoSpatial Data Downloads	Department of the Interior (DOI) Bureau of Land Management (BLM) California	https://www.sciencebase.gov/catalog/item/55442208e4b0a658d794781b
Biotic Communities of the Southwest GIS Layer	Mike List (mlist@tnc.org)	https://www.sciencebase.gov/catalog/item/5519c1fae4b0323842783386
Off-Highway Vehicle Use	Dave Theobald (davet@csp-inc.org)	https://www.sciencebase.gov/catalog/item/5508b8eae4b02e76d757c5b5

Actions Likely to Increase Plant and Animal Resilience to Climate Change	Kirk Klausmeyer (kklausmeyer@tnc.org) Rebecca Shaw Jason MacKenzie	https://www.sciencebase.gov/catalog/item/551f298ce4b027f0aee3bab7
USDA Forest Service Pacific Southwest Region Geospatial Data	United States Department of Agriculture (USDA) Forest Service (USFS) Region 5 (r5geospatialdatamanager@fs.fed.us)	https://www.sciencebase.gov/catalog/item/574f6c20e4b0ee97d51abfa9
A Synthesis of Vegetation Maps for Nevada	Nevada Natural Heritage Program	https://www.sciencebase.gov/catalog/item/57d841cce4b090824ff9ac4a
HabiMap™ Arizona	Arizona Game and Fish Department (AZGFD) (webgis@azgfd.gov)	https://www.sciencebase.gov/catalog/item/5500b218e4b0241955100737
Información Geoespacial	Servicio de Información Agroalimentaria y Pesquera (SIAP), Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (SAGARPA) (contacto.siap@siap.gob.mx)	https://www.sciencebase.gov/catalog/item/563d24bde4b0831b7d623bc8
Mine claim activity on Federal lands for the period 1976 through 2010	Peter Schweitzer (pschweitzer@usgs.gov)	https://www.sciencebase.gov/catalog/item/551efd87e4b027f0aee3ba64
Transboundary land cover dataset for the Sky Islands Ecoregion	David M Theobald (davet@csp-inc.org)	https://www.sciencebase.gov/catalog/item/57d9b376e4b090824ffb0f8c
Mapping Groundwater Dependent Ecosystems in California	Kirk Klausmeyer (kklausmeyer@tnc.org)	https://www.sciencebase.gov/catalog/item/552fe8d0e4b0b22a158032f7
Malpai Borderlands Portal	Darren James (dkj2@nmsu.edu) Malpai Borderlands Group (malpaigroup@gmail.com)	https://www.sciencebase.gov/catalog/item/5511e35ae4b02e76d75b5270
Espacio y Datos de Mexico	Instituto Nacional de Estadistica y Geografia (INEGI) (atencion.usuarios@inegi.org.mx)	https://www.sciencebase.gov/catalog/item/55132eb1e4b02e76d75c0964
Geografia	Instituto Nacional de Estadistica y Geografia (INEGI) (atencion.usuarios@inegi.org.mx)	https://www.sciencebase.gov/catalog/item/55134090e4b02e76d75c09b9
Opportunities for Near-Term Geothermal Development on Public Lands in the Western United States	Donna Heimiller	https://www.sciencebase.gov/catalog/item/551ef798e4b027f0aee3ba62
Servicio Web de información geográfica	Instituto Nacional de Estadistica y Geografia (INEGI) (atencion.usuarios@inegi.org.mx)	https://www.sciencebase.gov/catalog/item/5512f0bae4b02e76d75bd67e
Uso de suelo y vegetación	Instituto Nacional de Estadística y Geografía (INEGI)	https://www.sciencebase.gov/catalog/item/57d9de8de4b090824ffb1051

Madrean Archipelago Rapid Ecoregional Assessment (REA)	Megan Walz (mwalz@blm.gov) Patrick Crist	https://www.sciencebase.gov/catalog/item/5568f4a4e4b0d9246a9f63ad
Invasive Plant Mapping	California Invasive Plant Council (Cal-IPC) (info@cal-ipc.org)	https://www.sciencebase.gov/catalog/item/57dca185e4b090824ffe1744
Areas of Conservation Emphasis (ACE II)	California Department of Fish and Wildlife (CDFW) Sandra Summers (ssummers@dfg.ca.gov)	https://www.sciencebase.gov/catalog/item/54ff4884e4b02419550dec71
Mapa Digital de Mexico	Instituto Nacional de Estadistica y Geografia (INEGI) (atencion.usuarios@inegi.org.mx)	https://www.sciencebase.gov/catalog/item/55132817e4b02e76d75c094a
Sonoran Desert Rapid Ecoregional Assessment (REA)	Megan Walz (mwalz@blm.gov)	https://www.sciencebase.gov/catalog/item/550a0699e4b02e76d759081d
Desert Landscape Conservation Cooperative Conservation Planning Atlas	Genevieve Johnson (gjohnson@usbr.gov) Data Basin (databasin@consbio.org)	https://www.sciencebase.gov/catalog/item/551b2a22e4b03238427839f2
National Gap Analysis Program (GAP)	Dr. Kevin Gergely (gergely@usgs.gov)	https://www.sciencebase.gov/catalog/item/57e306d9e4b0908250046785
Southwest Regional Gap Analysis Project	Julie Prior-Magee (jpmagee@nmsu.edu) Ken Boykin (kboykin@nmsu.edu) Doug Ramsey (doug@nr.usu.edu) Collin Homer (homer@edcmail.cr.usgs.gov) Kathryn Thomas (Kathryn_A_Thomas@usgs.gov) Don Schrupp (hqwris@lamar.colostate.edu) Dianne Osborne (Dianne_Osborne@blm.gov) David Bradford (bradford.david@epa.gov)	https://www.sciencebase.gov/catalog/item/55109762e4b02e76d75aa529
Jornada Basin Spatial Data Catalog	Ken Ramsey (kramsey@jornada.nmsu.edu)	https://www.sciencebase.gov/catalog/item/551adfa3e4b0323842783824
California Conservation Science Deserts Reports & Data	The Nature Conservancy (TNC) California Conservation Science (s4c@tnc.org)	https://www.sciencebase.gov/catalog/item/552fcf71e4b0b22a1580327d
Priority Conservation Areas: Grasslands, 2010	Commission for Environmental Cooperation (CEC) (info@cec.org) Rocky Mountain Bird Observatory (RMBO)/ Bird Conservancy of the Rockies Jason Karl (jkarl@tnc.org)	https://www.sciencebase.gov/catalog/item/5510a0f7e4b02e76d75aa52f

USDA Forest Service Southwestern Region GIS Datasets	Candace Bogart (cbogart@fs.fed.us)	https://www.sciencebase.gov/catalog/item/574f65d1e4b0ee97d51abf9d
Sonoran Desert Conservation Plan MapGuide Map	Pima County, Arizona (GISwebmaster@pima.gov)	https://www.sciencebase.gov/catalog/item/551495b6e4b032384276cb07
Environmental Conservation Online System	Department of the Interior (DOI) U.S. Fish & Wildlife Service (USFWS)	https://www.sciencebase.gov/catalog/item/553a6eebe4b0a658d792c959
IABIN -Species and Specimens Thematic Network	Inter-American Biodiversity Information Network (IABIN)	https://www.sciencebase.gov/catalog/item/553aa840e4b0a658d7935489
Downscaled CMIP3 and CMIP5 Climate and Hydrology Projections	Program for Climate Model Diagnosis and Intercomparison (PCMDI) World Climate Research Programme (WCRP)'s Working Group on Coupled Modelling (PCMDI) Department of Interior (DOI) Bureau of Reclamation, Technical Services Center	https://www.sciencebase.gov/catalog/item/551973bfe4b0323842783127
California Landscape Conservation Cooperative (CA LCC) Climate Commons Dataset Catalog	California Landscape Conservation Cooperative (CA LCC) (team@climate.calcommons.org) Point Blue Conservation Science (pointblue@pointblue.org) University of California (UC), Davis, Information Center for the Environment (ICE)	https://www.sciencebase.gov/catalog/item/5547b2c7e4b0a658d794eae6
New Mexico Rangeland Ecological Assessment (REA)	Steven Yanoff, Patrick McCarthy, Joanna Bate, Lara Wood Miller, Anne Bradley, Dave Gori U.S. Department of Interior (DOI) Bureau of Land Management (BLM)	https://www.sciencebase.gov/catalog/item/55107ab0e4b02e76d75aa4c2
National Land Cover Database (NLCD)	Multi-Resolution Land Characteristics (MRLC) consortium (custserv@usgs.gov)	https://www.sciencebase.gov/catalog/item/57d9e8e5e4b090824ffb109e
Nellis Air Force Base Plan 126-4	Nellis Air Force Base, Nevada, 99th Civil Engineering Squadron, Environmental Management Flight	https://www.sciencebase.gov/catalog/item/57e1d399e4b0908250033be0
Southwest Watershed Research Publications	United States Department of Agriculture (USDA) Agricultural Research Service (ARS)	https://www.sciencebase.gov/catalog/item/552d86f6e4b0b22a157f5dac
Western Landscapes Map Viewer	Oregon State University (OSU) Libraries (virtualoregon.support@oregonstate.edu) Oregon University System's Institute for Natural Resources (INR)	https://www.sciencebase.gov/catalog/item/55119713e4b02e76d75b515f

Texas Natural Resources Information System (TNRIS)	Texas Natural Resources Information System (TNRIS)	https://www.sciencebase.gov/catalog/item/56da1e0ae4b015c306f7dd23
Western Governors' Crucial Habitat Assessment Tool	Carlee Brown (cbrown@westgov.org)	https://www.sciencebase.gov/catalog/item/5508a63ee4b02e76d757c598
Desert Renewable Energy Conservation Plan	California Energy Commission Data Basin (databasin@consbio.org) California Department of Fish and Wildlife (CDFW) U.S. Department of the Interior (DOI) Bureau of Land Management (BLM) Department of the Interior (DOI) U.S. Fish and Wildlife Service (USFWS)	https://www.sciencebase.gov/catalog/item/5507511fe4b02e76d757c0da
Chihuahuan Desert Grassland Bird Conservation Plan	Arvind Panjabi (arvind.panjabi@rmbo.org)	https://www.sciencebase.gov/catalog/item/573e4e0be4b0e88d8d08df54
Sistema de Consulta de las Cuencas Hidrográficas de México	Arturo Garrido Pérez (infocuenca@inecc.gob.mx) Enrique Muñoz	https://www.sciencebase.gov/catalog/item/55313885e4b0b22a158062b2
DGIOECE Cartografía en Linea	Dirección General de Investigación de Ordenamiento Ecológico y Conservación de los Ecosistemas (DGIOECE) (mapas@inecc.gob.mx)	https://www.sciencebase.gov/catalog/item/5600472be4b05d6c4e5045a7
Espacio Digital Geográfico (ESDIG)	Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT)	https://www.sciencebase.gov/catalog/item/5537ea0ee4b0b22a158087af
Natural Resource Condition Assessments	Jeff Albright (jeff_albright@nps.gov)	https://www.sciencebase.gov/catalog/item/5515ce6de4b03238427818e5
Web Soil Survey	U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS)	https://www.sciencebase.gov/catalog/item/551b18fde4b03238427839d9
U.S. Fish & Wildlife Service Web Mapping Gateway, Pacific Southwest Region	Pat Lineback (fw8_databasin@fws.gov)	https://www.sciencebase.gov/catalog/item/553a965ce4b0a658d7930541
Central Mojave Vegetation Map	Kathryn Thomas (Kathryn_A_Thomas@usgs.gov)	https://www.sciencebase.gov/catalog/item/5508b10fe4b02e76d757c5a7

Land Cover and Land Cover Change/ Cobertura del suelo y cambios en la cobertura del suelo	Natural Resources Canada/ The Canada Centre for Mapping and Earth Observation (NRCan/CCMEO) Commission for Environmental Cooperation (CEC)/ Comisión para la Cooperación Ambiental (CCA) (info@cec.org) United States Geological Survey (USGS) Instituto Nacional de Estadística y Geografía (INEGI) Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO) Comisión Nacional Forestal (CONAFOR)	https://www.sciencebase.gov/catalog/item/57d9d4b1e4b090824ffb1026
Listed and Imperiled Species by County and Watershed	Jason McNees (jason_mcnees@natureserve.org)	https://www.sciencebase.gov/catalog/item/553a707ce4b0a658d792c95e
AdaptWest - A Climate Adaptation Conservation Planning Database for Western North America	Carlos Carroll (carlos@klamathconservation.org) Josh Lawler Scott Nielsen	https://www.sciencebase.gov/catalog/item/553a8e64e4b0a658d792f530
The Human Footprint in the West	Matthias Leu (mleu@usgs.gov)	https://www.sciencebase.gov/catalog/item/5508bb7ce4b02e76d757c5c1
Integrated Resource Management Applications (IRMA)	Margaret Beer (irma@nps.gov)	https://www.sciencebase.gov/catalog/item/5515dbeae4b03238427818f1
Renewable Energy in the California Desert	Steve Yaffee	https://www.sciencebase.gov/catalog/item/551ae7e1e4b0323842783881
New Mexico Conservation Science	The Nature Conservancy (TNC) in New Mexico	https://www.sciencebase.gov/catalog/item/551ecd85e4b027f0aee3b970
Center for Science and Public Policy	The Nature Conservancy (TNC) of Arizona	https://www.sciencebase.gov/catalog/item/574f3f56e4b0ee97d51abf57
Nevada Natural Heritage Program	Nevada Natural Heritage Program (NNHP)	https://www.sciencebase.gov/catalog/item/551edf32e4b027f0aee3ba2d
The IUCN Red List of Threatened Species (TM)	International Union for the Conservation of Nature (IUCN) Red List Unit (redlistgis@iucn.org)	https://www.sciencebase.gov/catalog/item/553a7ac3e4b0a658d792c982
Wind and Wildlife Assessment Tool	The Nature Conservancy (TNC) American Wind Wildlife Institute (AWWI)	https://www.sciencebase.gov/catalog/item/5509d884e4b02e76d75907a8
NPS Vegetation Inventory	National Park Service (NPS) Inventory & Monitoring (I & M) Program	https://www.sciencebase.gov/catalog/item/5515e0bee4b03238427818f4
BirdLife International Data Zone	BirdLife International (science@birdlife.org)	https://www.sciencebase.gov/catalog/item/553a7618e4b0a658d792c968

Solar Energy Environmental Mapper	Argonne National Laboratory (solarmapper@anl.gov) U.S. Department of the Interior (DOI) Bureau of Land Management (BLM) U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE)	https://www.sciencebase.gov/catalog/item/551eb327e4b027f0aee3b902
Online Data Access, Southwest Watershed Research Center	U.S. Department of Agriculture (USDA) Agricultural Research Service (ARS) Southwest Watershed Research Center (SWRC) (ars-pwa-tucson-swrc-gis@ars.usda.gov)	https://www.sciencebase.gov/catalog/item/552d4997e4b0b22a157f5246
Sistema de Información Geográfica CONANP	Comisión Nacional de Áreas Naturales Protegidas (CONANP) (sig@conanp.gob.mx)	https://www.sciencebase.gov/catalog/item/5536e025e4b0b22a1580846f
Programa de Ordenamiento Ecológico General del Territorio (POEGT)	Instituto de Geografía, Universidad Nacional Autonoma de Mexico (UNAM) Dirección General de Política Ambiental e Integración Regional y Sectorial, Secretaria de Medio Ambiente y Recursos Naturales (SEMARNAT) Dirección de Ordenamiento Ecológico, Instituto Nacional de Ecología	https://www.sciencebase.gov/catalog/item/55304f3ce4b0b22a15806062
Terrestrial Ecological Systems of the United States	NatureServe (productsandservices@natureserve.org)	https://www.sciencebase.gov/catalog/item/553abda2e4b0a658d7937106
Cartografía de Uso de Suelo y Vegetación del Estado de Chihuahua	Ing. Abel López Castillo	https://www.sciencebase.gov/catalog/item/57e02051e4b09082500212ae
Sonoran Joint Venture Climate Change Impacts Tool/ Herramienta de Evaluación de Impactos del Cambio Climático de la Alianza Regional Sonorense	Sam Veloz (pointblue@pointblue.org) Jennie Duberstein (jennie_duberstein@fws.gov)	https://www.sciencebase.gov/catalog/item/556c7edbe4b0d9246a9f7f06
NPScape	Bill Monahan (Bill_Monahan@nps.gov)	https://www.sciencebase.gov/catalog/item/5515ab84e4b0323842781851
LANDFIRE Data Viewer	The Nature Conservancy (TNC) •U.S. Department of Agriculture (USDA) Forest Service (USFS) •U.S. Department of the Interior (DOI)	https://www.sciencebase.gov/catalog/item/5509c26ce4b02e76d758f2c9

LandScope America	LandScope America	https://www.sciencebase.gov/catalog/item/5507625ae4b02e76d757c0f4
Extent and Condition of Grasslands in Arizona, Northern Mexico, and Southwestern New Mexico	The Nature Conservancy (TNC) of Arizona	https://www.sciencebase.gov/catalog/item/5509e62ce4b02e76d75907c9
MC1 Dynamic Global Vegetation Model	Dominique Bachelet Ron Neilson C. Daly Colorado State University (CSU) Natural Resource Ecology Laboratory (NREL)	https://www.sciencebase.gov/catalog/item/553004c8e4b0b22a15803396
Shapefile depicting conservation priority areas on Bureau of Land Management lands in the 11 western states	Brett Dickson (brett@csp-inc.org) Leslie Duncan (Lduncan@pewtrusts.org)	https://www.sciencebase.gov/catalog/item/55009459e4b02419550fa67c
Mojave Basin and Range Rapid Ecoregional Assessment (REA)	Megan Walz (mwalz@blm.gov) NatureServe	https://www.sciencebase.gov/catalog/item/55085dd0e4b02e76d757c193
The Nature Conservancy's Priority Conservation Areas	Joe Fargione (jfargione@tnc.org)	https://www.sciencebase.gov/catalog/item/5509cee3e4b02e76d7590783
Vacíos y Omisiones en Conservación	Patricia Koleff Comisión Nacional de Áreas Naturales Protegidas (CONANP)	https://www.sciencebase.gov/catalog/item/554920abe4b064e4207c9fd0
Springs in the Desert LCC	Jeri Ledbetter (jeri@springstewardship.org) Sally Holl (sholl@usgs.gov)	https://www.sciencebase.gov/catalog/item/551443cfe4b032384276ca5c
Assessment of Grassland Ecosystem Conditions in the Southwestern United States, Volume 1	Deborah M. Finch	https://www.sciencebase.gov/catalog/item/5522c43de4b027f0aee3d04e
Arizona’s Natural Infrastructure	Science Program	https://www.sciencebase.gov/catalog/item/5519d5d2e4b03238427833a3
New Mexico Statewide Resources Assessment	New Mexico Forestry Division Anne Bradley	https://www.sciencebase.gov/catalog/item/555cea26e4b0a92fa7eb81ec
A Linkage Network for the California Deserts	SC Wildlands (info@scwildlands.org) Paul Beier (Paul.Beier@nau.edu)	https://www.sciencebase.gov/catalog/item/551afdc5e4b032384278392e
LANDFIRE Data Distribution Site	U.S. Geological Survey (USGS) The Nature Conservancy (TNC) U.S. Department of Agriculture (USDA) Forest Service (USFS) U.S. Department of the Interior (DOI)	https://www.sciencebase.gov/catalog/item/5509e0cde4b02e76d75907b9
Environmental Change Network	Point Blue Conservation Science (pointblue@pointblue.org) California Landscape Conservation Cooperative (CA LCC)	https://www.sciencebase.gov/catalog/item/55439eece4b0a658d7941647

Arizona Missing Linkages	Dan Majka (dan@corridordesign.org) Arizona Game & Fish Department (AZGFD) (gis@azgfd.gov)	https://www.sciencebase.gov/catalog/item/5519b343e4b03238427832e2
The National Map Viewer and Download Platform	U.S. Geological Survey (USGS)	https://www.sciencebase.gov/catalog/item/55106f12e4b02e76d75aa49f
Climate Change Vulnerability and Adaptation Strategies for Natural Communities	Patrick Comer (pat_comer@natureserve.org)	https://www.sciencebase.gov/catalog/item/551b1ed8e4b03238427839e0
CropScape - Cropland Data Layer	United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) (HQ_RDD_GIB@nass.usda.gov) Center for Spatial Information Science and Systems, George Mason University (GMU)	https://www.sciencebase.gov/catalog/item/5527129ce4b026915857c7ee

Appendix 3. Conservation and management plans and associated urls for the Desert Landscape Conservation Cooperative geography.

Plan	URL
Sonoran Joint Venture Bird Conservation Plan	https://www.sciencebase.gov/catalog/item/55490e35e4b064e4207c9fb0
Sonoran Desert Conservation Plan	https://www.sciencebase.gov/catalog/item/551495b6e4b032384276cb07
Plan de Acción para la Conservación y Uso Sustentable de los Pastizales del Estado de Chihuahua 2011-2016	https://www.sciencebase.gov/catalog/item/55493d55e4b064e4207ca005
Chihuahuan Desert Grassland Bird Conservation Plan	https://www.sciencebase.gov/catalog/item/573e4e0be4b0e88d8d08df54
Plan Maestro de la Alianza Regional para la Conservación de los Pastizales del Desierto Chihuahuense 2011-2016	https://www.sciencebase.gov/catalog/item/554940f7e4b064e4207ca03b
Plan De Acción Para La Conservación Y Recuperación De Especies De Fauna Silvestre Prioritaria En El Estado De Chihuahua	https://www.sciencebase.gov/catalog/item/57e05960e4b09082500213d8
Estrategia para la Conservación de los Pastizales del Desierto Chihuahuense (ECOPAD)	https://www.sciencebase.gov/catalog/item/554930cfe4b064e4207c9ff2
Draft Business Plan for the Sky Island Grasslands	https://www.sciencebase.gov/catalog/item/57dc898de4b090824ffe172d
Programa de Manejo del Area de Proteccion de Flora y Fauna Cuatrocienegas	http://www.conanp.gob.mx/que_hacemos/pdf/programas_manejo/cuatrocienegas.pdf
Programa de Manejo Reserva de la Biosfera Janos	http://www.conanp.gob.mx/que_hacemos/pdf/programas_manejo/2013/JANOS.pdf
Programa de Conservación y Manejo Reserva de la Biosfera Mapimí	http://www.conanp.gob.mx/que_hacemos/pdf/programas_manejo/Mapimi_ok.pdf
Desert Renewable Energy Conservation Plan (DRECP)	https://www.sciencebase.gov/catalog/item/5507511fe4b02e76d757c0da
USDA-ARS Jornada Experimental Range Project Plan	https://www.sciencebase.gov/catalog/item/57e17701e4b09082500339cf
Texas Conservation Action Plan	https://www.sciencebase.gov/catalog/item/556ddbc5e4b0d9246a9f99e1
Arizona's State Wildlife Action Plan	https://www.sciencebase.gov/catalog/item/556c7a3be4b0d9246a9f7efb
Comprehensive Wildlife Conservation Strategy For New Mexico	https://www.sciencebase.gov/catalog/item/556c6f4be4b0d9246a9f7ee3
Central Arizona Grassland Conservation Strategy	https://www.sciencebase.gov/catalog/item/57e18530e4b0908250033a4f
Estrategia para la conservación y el uso sustentable de la biodiversidad del estado de Guanajuato	http://www.biodiversidad.gob.mx/region/EEB/pdf/ECUSBEG_WEB.pdf
Estrategia para la Conservación y Uso Sustentable de la Biodiversidad del Estado de Aguascalientes	http://www.biodiversidad.gob.mx/region/EEB/pdf/ECUSBEA_web.pdf
Estrategia para la conservación y el uso sustentable de la biodiversidad del estado de Chihuahua	http://www.biodiversidad.gob.mx/region/EEB/pdf/ECUSBIOECH_2015.pdf
Land Management Plan for the Apache-Sitgreaves National Forests	https://fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3851851.pdf
Cibola National Forest Mountain Ranger Districts Plan	http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd510428.pdf
Land and Resource Management Plan for the Coconino National Forest	http://a123.g.akamai.net/7/123/11558/abc123/forestservic.download.akamai.com/11558/www/nepa/69549_FSPLT3_1463838.pdf
Coronado National Forest Land and Resource Management Plan	http://www.fs.fed.us/rm/pubs_journals/2013/rmrs_2013_austin_t001.pdf

Gila National Forest Plan	http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5275452.pdf
Lincoln National Forest Land and Resource Management Plan	http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev7_014272.pdf
Land and Resource Management Plan for the Kaibab National Forest	http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3791580.pdf
Land and Resource Management Plan for the Prescott National Forest	http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd509347.pdf
Tonto National Forest Plan	http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd475757.pdf
Mimbres Resource Management Plan	http://www.blm.gov/nm/st/en/fo/Las_Cruces_District_Office/mimbres_rmp.html
Grand Canyon-Parashant National Monument Resource Management Plan	http://www.blm.gov/az/st/en/info/nepa/environmental_library/arizona_resource_management/gcp_ROD.html
Northern and Eastern Mojave Desert Management Plan Amendment	http://www.blm.gov/ca/st/en/fo/cdd/nemo.html
West Mojave Plan Amendment	http://www.blm.gov/ca/st/en/fo/cdd/wemo.html
Yuma Field Office Resource Management Plan	http://www.blm.gov/style/medialib/blm/az/pdfs/nepa/library/resource_management/yuma_rod.Par.18198.File.dat/ROD-ARMPcomplete.pdf
White Sands Resource Area Resource Management Plan	http://www.blm.gov/style/medialib/blm/nm/field_offices/las_cruces/las_cruces_planning/white_sands_rmp.Par.85500.File.dat/White%20Sands%20Resources%20Area.pdf
Safford District Resource Management Plan	http://www.blm.gov/style/medialib/blm/az/pdfs/nepa/library/resource_management/safford.Par.40532.File.dat/SaffordRMP-FEIS.pdf
Roswell Resource Area Resource Management Plan	http://www.blm.gov/style/medialib/blm/nm/field_offices/roswell/rfo_planning/roswell_rmp_1997.Par.53070.File.dat/rmp_rfo_1997_PLAN.pdf
Socorro Field Office Resource Management Plan	http://www.blm.gov/style/medialib/blm/nm/field_offices/socorro/socorro_planning/socorro_rmp_2010.Par.67785.File.dat/RMP_Socorro_2010.pdf
Restoration Design Energy Project Resource Management Plan Amendments	http://www.blm.gov/style/medialib/blm/az/pdfs/energy/rdep.Par.61787.File.dat/RDEP-ROD-ARMP.pdf
Lower Sonoran Resource Management Plan	https://eplanning.blm.gov/epl-front-office/projects/lup/11856/40127/42156/01-LSDA_ROD-ARMP_FINAL_2012-09-19_web-with-Links_sans-map-pages.pdf
Ironwood Forest National Monument Resource Management Plan	http://www.blm.gov/style/medialib/blm/az/pdfs/nepa/library/resource_management/ifnm-rod.Par.1054.File.dat/IFNM-ROD-ARMP.pdf
Carlsbad Resource Management Plan	http://www.blm.gov/style/medialib/blm/nm/field_offices/carlsbad/carlsbad_planning/cfo_rmp_docs.Par.58205.File.dat/rmp.pdf
Carlsbad Resource Management Plan Amendment	http://www.blm.gov/style/medialib/blm/nm/field_offices/carlsbad/carlsbad_planning/cfo_rmp_docs.Par.77969.File.dat/rmp_amendment.pdf
California Desert Conservation Area Plan	http://www.blm.gov/style/medialib/blm/ca/pdf/cdd/cdcaplan.Par.15259.File.dat/CA_Desert_.pdf
TriCounty Resource Management Plan	http://www.blm.gov/style/medialib/blm/nm/field_offices/las_cruces/las_cruces_planning/tricounty_rmp.Par.40632.File.dat/TRICOUNTY_DRAFT_RMPEIS_APRIL.Vol_1JES.pdf
Kingman Resource Area Resource Management Plan	http://www.blm.gov/style/medialib/blm/az/pdfs/nepa/library/resource_management/kingman.Par.20795.File.dat/KingmanRMP-FEIS.pdf

Big Bend National Park Fire Management Plan	https://parkplanning.nps.gov/document.cfm?parkID=29&projectID=12517&documentID=11787
Saguaro National Park Restoration Management Plan	https://parkplanning.nps.gov/projectHome.cfm?projectID=42246
Death Valley National Park Wilderness and Backcountry Stewardship Plan	http://www.wilderness.net/toolboxes/documents/planning/Death_Valley_Wilderness_Backcountry_Stewardship_Plan.pdf
Lake Mead NRA Exotic Plant Management Plan	http://www.fwspubs.org/doi/suppl/10.3996/052015-JFWM-046/suppl_file/10.3996_052015-jfwm-046.s7.pdf
Grand Canyon National Park Fire Management Plan	https://www.nps.gov/grca/learn/management/upload/GRCA_FMP.pdf
Grand Canyon National Park Backcountry Management Plan	https://parkplanning.nps.gov/document.cfm?documentID=69426
Desert National Wildlife Refuge Complex Comprehensive Conservation Plan	https://www.fws.gov/refuge/Desert/what_we_do/planning.html
Cabeza Prieta National Wildlife Refuge Comprehensive Conservation Plan	https://www.sciencebase.gov/catalog/item/57e1a214e4b0908250033af5
Sevilleta National Wildlife Refuge Comprehensive Conservation Plan	https://www.sciencebase.gov/catalog/item/57e1b597e4b0908250033b80
U.S. Army Yuma Proving Ground Integrated Natural Resources Management Plan	https://www.sciencebase.gov/catalog/item/57e1eaa5e4b0908250033c00
Integrated Natural Resources Management Plan For Edwards Air Force Base	https://www.sciencebase.gov/catalog/item/57e1bf5ae4b0908250033b8f
White Sands Missile Range Integrated Natural Resource Management Plan	https://www.sciencebase.gov/catalog/item/57e1dad6e4b0908250033bec
Fort Bliss Integrated Natural Resources Management Plan	https://www.sciencebase.gov/catalog/item/57e1cdbce4b0908250033bd4
Nellis Air Force Base Integrated Natural Resources Management Plan	https://www.sciencebase.gov/catalog/item/57e1d399e4b0908250033be0
Estrategia del área focal de degradación de tierras	https://www.sciencebase.gov/catalog/item/57dc93efe4b090824ffe1739

Appendix 4. Valor, Condición y Alternativas de Mejora de los Pastizales en México

Resumen

Las zonas áridas y semiáridas comprenden prácticamente la mitad del territorio nacional, de ahí su importancia, y son ecosistemas frágiles por la dinámica biológica lenta a la que las condicionan las bajas precipitaciones características de estas regiones. Similarmente, representa un bioma de importancia para el subcontinente Norteamericano; el cual, depende para su conservación y buena funcionalidad, de colaboración (intelectual y económica) internacional, bien estructurada.

Los pastizales áridos y semiáridos del país representan un bien natural escasamente valorado en México, por la sociedad civil, predominantemente urbana, y similarmente, desconocida en su valor, por los tomadores de decisiones; contrariamente, el semidesierto es ampliamente reconocido en su diversidad, importancia y potencial, principalmente por especialistas dispersos en diversas áreas tecnológicas, que gravitan a su alrededor; los cuales no han alcanzado el peso político específico para lograr planes de recuperación, conservación y explotación sustentable de los recursos del pastizal.

Los mejores suelos agrícolas de estas regiones fueron pastizales en la historia reciente y éstos resguardaron grandes poblaciones humanas (nativas), de fauna, microorganismos, plantas de diversas familias (principalmente Poaceae, pastos); las cuales, evolucionaron en una relación funcional excelsa, hasta hace casi 300 años; sin embargo, actualmente muchas de ellas se encuentran en alto riesgo de extinción.

El enfoque productivo de estas regiones se debe ajustar siempre a condiciones que definen su potencial: escasa disponibilidad de humedad y temperaturas veraniegas e invernales contrastantes. La precipitación en zonas áridas ocurre de forma escasa y mal distribuida, con pocos pulsos individuales que superen 25 mm, sequía intraestival con duración normal de tres a cuatro semanas y que se puede prolongar hasta seis semanas; lo anterior, dificulta muchas actividades, como la resiembra de pastizales. Al respecto, existe tecnología para incrementar el éxito del establecimiento de praderas; sin embargo, se deben generar bases de datos en mayor cantidad de estaciones pluviométricas para alcanzar certidumbre tanto para la declaración oportuna de sequía y/o previsión de oportunidades de siembras exitosas.

Se ejerce actualmente en México, una elevada presión de uso de los recursos naturales de estas regiones; principalmente, mediante pastoreo descontrolado (omnipresente en cada rincón accesible al ganado), apertura de tierras a una producción agrícola de alto riesgo, sobre-explotación de mantos acuíferos, descargas de aguas contaminadas, desecación de áreas riparías, exploración y cosecha desordenada de bienes naturales: flora, fauna, leña, petróleo, gas; lo anterior, sin promoción de acciones participativas para su conservación y mejora entre los usufructuarios, lo que resulta en una pobre interpretación de la condición precaria del entorno de éstos hacia el pastizal.

Los usufructuarios piensan que son naturales la frecuencia y efecto devastador de sequías, tolvaneras, baja productividad primaria, erosión, escorrentías desordenadas, entre otros fenómenos; dado que carecen del concepto de la condición ecológica de su región hace 25, 50,

75, 100 o 300 años, más allá de la tradición verbal. La condición de constante deterioro de las regiones de pastizal la hacen altamente susceptible al cambio climático (sequías socioculturales), dada la mayor frecuencia pronosticada de eventos extremos: sequías, lluvias torrenciales aisladas, temperaturas medias veraniegas e invernales, entre otros, y la precaria condición de la funcionalidad ecológica de los pastizales; similarmente, esta condición provoca magras cosechas de cultivos y otros recursos naturales (ganado, miel, flora, fauna) cuando no se dispone de infraestructura productiva, como el riego.

La cultura hacia el enaltecimiento de los componentes bióticos y abióticos del pastizal destaca por su ausencia, lo que representa indicador de la predominancia del interés extractivo y sin una contraparte de balance conservativo del recurso, entre los usufructuarios; lo anterior, debido a desinterés, desconocimiento o al hecho de que no perciben la necesidad de mecanismos de mejora de la funcionalidad ecológica del pastizal.

El pastoreo *per se* es naturalmente aditivo a la condición, estabilidad y funcionalidad del pastizal, además de promover la diversidad vegetal; el problema es el sobrepastoreo, dado que éste, para mantener la estabilidad ecológica, requiere acciones planeadas entre dos aspectos contrastantes y dinámicos uso: descanso del pastoreo (uso: conservación), lo que implica planeación dirigida y eficiente para mantener la carga animal fluctuante y adecuada. Este tipo de relación balanceada es difícil de lograr bajo un esquema extractivo y que no se basa en la conservación y promoción de la buena calidad de los componentes de la funcionalidad del pastizal.

Debido a la condición del pastizal, se cosecha 1/20 de la productividad primaria potencial de éste y junto con esta reducción, se pierden recursos genéticos (fauna, microorganismos, flora) y abióticos (suelo, reciclaje de nutrientes, salinización, etc.) valiosos para el bienestar social. En conjunto con la presión elevada de explotación de recursos del pastizal, las cosechas de bienes renovables que se logran son ineficientes: bajos parámetros de hato, miel, leña, flora y fauna silvestre, infiltración, entre otros. Por tanto, se producen bienes comercializables a costa del deterioro del pastizal, lo que compromete el bien productivo en su conjunto, para futuras generaciones. El manejo del pastizal en México es un sistema abierto, que no recibe retroalimentación para su enaltecimiento; lo anterior, es un ejemplo claro de la tragedia de los comunes postulada por Hardin.

Se debe trabajar en formar usuarios del pastizal capacitados para desarrollar tecnologías de producción con balance entre la extracción y promoción del recurso; lo anterior, mediante estrategias sociológicas de acciones participativas. Ciertamente, existen problemas tecnológicos para alcanzar la funcionalidad; sin embargo, el principal problema es sociológico, se carece de usuarios con buen balance extracción: promoción del recurso natural. En aspectos de producción animal, el caso de los Grupos Ganaderos de Validación y Transferencia de Tecnología (GAVATT), ha mostrado su valor, aún desprotegidos legislativamente; sin embargo, no alcanzan a cubrir la magnitud de población de núcleos productivos (ranchos o propietarios de ganado), por lo que se deben desarrollar otras estrategias sociológicas de empoderamiento tecnológico de los propietarios del pastizal. En caso de no iniciar esta actividad de culturización hacia la producción sustentable, el costo ecológico de la visión puramente extractiva se incrementará y, se hará inalcanzable para la economía nacional, la recuperación de la funcionalidad del pastizal, dada la situación que ésta ha mantenido durante los últimos decenios.

La protección del suelo mediante la promoción de mayor cobertura vegetal basal es de gran importancia para diversos aspectos de funcionalidad ecológica del pastizal y, similarmente, para la vida útil de muchas obras de captación de agua de lluvia y control de escorrentías, dado que se relaciona directamente con la vida útil de éstas; la promoción de la mayor cobertura basal vegetal puede ser el primer objetivo de un programa serio de recuperación de pastizales.

Desarrollar ejidos piloto, donde se muestren las ventajas de un manejo profesional del pastizal, será buena oportunidad para demostrar el potencial de las actividades planeadas para la mejora de la productividad sustentable del pastizal. Estos ejidos pueden ser enfocados hacia actividades diversas: ganaderos, de fauna silvestre, de paisajismo, de ecoturismo, de captura de agua, de captura de carbono o sus combinaciones. El pastizal contiene relaciones alélicas intraespecíficas (recursos genéticos) de muchas especies nativas y endémicas en plantas, fauna silvestre y microorganismos; las cuales, contienen información genética, la gran mayoría inexplorada, para responder tanto a demandas productivas, en empatía con la buena funcionalidad del pastizal, dar respuesta al cambio climático y, similarmente, la oportunidad de alcanzar compromisos internacionales de reducción de emisiones de gases efecto invernadero (ecocultivos para bioetanol), así como mayor captura y secuestro de carbono.

Por su densidad y capacidad de establecimiento: 1 kg de semilla puede contener más de cuatro millones de semillas en algunas especies y en 90 días post-emergencia soportan sequías y temperaturas invernales, los pastos son enormes aliados para mejorar la cobertura vegetal, por lo que debemos aprovechar sus ventajas para lograr, a corto plazo, mayor cobertura basal de suelo.

México ha destacado en la formulación de leyes y reglamentos para el buen flujo de bienes y servicios desde y hacia el pastizal, atendiendo compromisos internacionales y necesidades locales; por otra parte, promoviendo incentivos hacia la producción y conservación del pastizal; sin embargo, adolece de un vínculo y seguimiento con los expertos que consistentemente lo han caracterizado. Similarmente, debe enfocarse a vincular los programas de apoyo hacia el logro de este objetivo: actividades participativas para apropiarse de la conservación y utilización sustentable de los recursos del pastizal, lo que no ocurre hasta la fecha; lo anterior, se puede lograr a través del establecimiento de módulos piloto específicos o combinados, acorde a las oportunidades ecológicas de cada región.

La legislación se debe enfocar a facilitar el empoderamiento de los usufructuarios hacia la conservación del pastizal y su utilización rentable, en respuesta a la dinámica de nuevos modelos económicos globales *i.e.* responder a necesidades de economías más grandes y condiciones actuales: diez veces más habitantes que en 1917, mayor tecnología, mayor capacidad de comunicación y capacitación, necesidades de bonos de carbono, pagos por servicios ambientales, cacería regulada de especies altamente rentables y atractivas al mercado, ecoturismo con servicios adecuados, avistamiento de aves, cultura vaquera, entre otros. Ejemplos de legislación asertiva, que benefician la rentabilidad y condición de pequeñas áreas de pastizal han ocurrido recientemente en México y esta visión debe proliferar no solo en fauna silvestre, como el caso señalado en borrego cimarrón y venado bura; contrariamente, debe generalizarse y ser ágil, para mejorar la funcionalidad de todo el ecosistema árido y semiárido.

El bono poblacional se debe aprovechar para recuperar la funcionalidad del pastizal; lo cual, es una buena noticia. Se da cuenta y analiza en este documento información, principalmente desarrollada en México, que da cuenta de la condición de los pastizales en México, concluyendo sobre su importancia y alternativas de mejora de la condición productiva de estas regiones.

Appendix 5. Participant list for stakeholder interview and assessment effort conducted by Adrian Quero, 2016.

Univesidad Tecnológica de Francisco I. Madero, Hidalgo (students)
Universidad Autónoma de San Luís Potosí. Facultad de Agronomía y Facultad de Veterinaria (students)
Universidad Juárez Autónoma de Durango (students)
Instituto Nacional de Investigaciones Forestales, Agricolas, y Pecuarias (INIFAP researchers)
Colegio de Postgraduados, Universidad Juárez Autónoma de Durango (Investigators)
Community members from Jalisco, Coahuila, Durango, Hidalgo y San Luís Potosí (ranchers)

Appendix 6. Stakeholder survey for use in Mexican stakeholder assessment conducted by Adrian Quero.

State ______________________

Municipality ______________________

Ejido ______________________

Locality ______________________

Property type ______________________

1. Why are you interested in rangelands?
a) researcher b) student c) cattlemen d) other

2. How long have you been interested in rangelands?
a) less than 5 years b) 5 to 10 years c) 10 to 20 years d) more than 20

3). What do you think the condition of rain-fed rangeland vegetation in Mexico is?
a) excellent b) good c) fair d) bad e) poor

4). Do you think that this vegetation condition is:
a) improving b) getting worst c) is normal d) I do not know

5). Do you think that rain-fed rangeland soils are protected from erosive forces such as wind and water run-off?
a) very protected b) protected c) fair d) exposed e) very exposed

6). Do you think that the soil organic matter content on rangeland soils in México is
a) very high b) good c) fair d) poor e) very poor f) I do not know

7). What do you think is the determinant factor for rangeland condition in México?
a) lacking technology b) people don't care c) overgrazing d) lack of agreements

8). Do you think that the conservation of rangeland components (soil, water, wildlife, microbes) is important for México?
a) always b) may be c) no

9). Do you think that the conservation of rangeland components (soil, water, wildlife, microbes) is important for your neighbors, friends or family?
a) always b) may be c) no

10). Do you think that the conservation of rangeland (i.e. soil, water, wildlife, microbes) is a subject of interest for your neighbors, friends or family?
a) always b) may be c) no

11). Do you think that the activities of your neighbors, family or friends influence rangeland condition (i.e. soil, water, wildlife, microbes)?
a) always b) may be c) no

12). Do you think that your neighbors, family or friends know that their activities determine rangeland (i.e. soil, water, wildlife, microbes) condition?
a) always b) may be c) no

13). Do you think that rangeland conservation technology is important to maintain the grazing areas in good condition?
a) always b) frequently c) seldom d) no

14). Have you received technical support for grazing management?
a) frequently b) sometimes c) never

15). When extension agents visit the area, do your friends, neighbors or family participate/interact with them?
a) always b) frequently c) seldom d) no

16). When extension agents visit the area, are your friends, neighbors or family interested in their efforts?
a) always b) frequently c) seldom d) no

17). When extension agents visit the area, do they bring new, good ideas to promote good rangeland condition?
a) always b) frequently c) seldom d) no

18). When extension agents visit the area, does their visit boost or inspire programs or projects to promote rangeland good condition?
a) always b) frequently c) seldom d) no

19). Any time, when the technicians visit the area these new projects to promote rangeland condition consolidate?
a) always b) frequently c) seldom d) no

20). Are you knowledgeable about good forage species from your rangeland?
a) many b) some c) few d) no

21). Are you knowledgeable about good cattle breeds for the area?
a) over five b) from three to five c) common and other d) none

22). Do you think it is important for ejidatarios or common owners to get organized in order to promote better use of common grazing areas?
a) always b) many times c) seldom d) never

23). Is there any government agency that has invited you, your family, or neighbors to organize grazing within common land?
a) always b) many times c) seldom d) never

24). There is a community member who has proposed common land grazing organization as a necessity for common grazing land?
a) yes b) no c) I do not know

25). Your community has detected the importance of organization in order to improve and use the common grazing lands?
a) yes b)no c) this is a taboo subject d) we do not care

26). What do you think is the main obstacle to organize grazing procedures within common areas?
a) local wealthy citizens b) no proposals c) lack of leadership d) scary to propose

27). In such a case a grazing common land proposal emerges, do you think that your community would participate?
a) yes, easily b) yes, with good effort c) I doubt it d) no

28). In such a case a grazing common land proposal emerges, do you think that your community will accept and enforce the agreements?
a) yes, easily b) yes, with good effort c) I doubt it d) no

29). What do you think is necessary to success in organize the common areas grazing processes?

a) lateral benefits b) infrastructure c) proposals d) enhancement and sanctions

30). The grazing systems under use nowadays is a result of:
a) tradition b) nobody talks on the subject c) negotiable grazing areas d) nobody cares

31). Based on your knowledge, do you think your community is prone to organize grazing systems or pressure within common areas?
a) yes, easily b) yes, with good effort c) I doubt it d) never

32). Based on your knowledge, do you believe that forage production within common areas is
a) excellent b) good c) regular d) bad e) I do not know

33). Forage production within common land is
a) normal b) it was better in the past c) it is possible to increase it d) I do not know

34). Based on your knowledge, forage production within common grazing areas is a result of:
a) overgrazing b) drought c) ovegrazing and drought d) I do not know

35). Based on your knowledge, cattle harvesting during the year is
a) excellent b) good c) fair d) poor

36). Do you collect information on your cattle?
a) always b) sometimes c) never

37). Do you know which information about your cattle is important to define productive efficiency?
a) yes b) some c) no

38). Do you supply your cattle with feed during the difficult seasons?
a) every year b) some years c) never

39). Are you willing to collect information on your cattle on a regular basis?
a) yes b) may be c) no

40). Is it of interest to receive focused training for cattle production?
a) yes b) may be c) no

41). Do you have a program or season to reduce cattle pressure on the rangeland (weaning sales, old cattle sales)?
a) every year b) some years c) never

42). Do your cattle graze all year round?
a) yes b) grazing and barns c) no

43). Do you harvest grass seed within the grazing areas?
a) yes b) sometimes c) no

44). Do you sow forage plants within the grazing areas?
a) yes b) sometimes c) no

45). Would you be willing to apply techniques to increase grass density and vigor within the common grazing areas?
a). yes b) may be c) no

Appendix 7. Participant list for Southwest Decision Resources partner mapping effort in Aguascalientes, MX 2014.

Commission for Environmental Cooperation
CONANP
CONANP, Programa de las Naciones Unidas para el Desarrollo
Conservación de Fauna del Noroeste A.C
Desert Landscape Conservation Cooperative (DLCC)
Ecosistemica A.C.
IMC Vida Silvestre
Instituto de Ecología del Estado de Guanajuato
Instituto Nacional de Ecología y Cambio Climático
Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias
Mexican Government (Federal, state, local)
National Park Service
Northern Arizona University
Pronatura Noroeste A.C.
Recursos Sustentables, Biodiversidad y Cultura A.C
Rio Grande Joint Venture
Rocky Mountain Bird Observatory (now Bird Conservancy of the Rockies
Secretaria de Medio Ambiente de Coahuila
Secretaria de Medio Ambiente y Desarrollo Territorial
Sky Island Alliance
Texas Water Development Board
U.S. Government (Federal, state, local)
Unidades de Riego Centro Sur Estado de Chihuahua
Universidad Autónoma de Aguascalientes
Universidad Autónoma de Nuevo León
Universidad Estatal de Sonora
University of Arizona
US Bureau of Reclamation
US Department of Agriculture (USDA) Natural Resource Conservation Service
US Geological Survey (USGS)
World Wildlife Fund
World Wildlife Fund, Chihuahua Desert Program

Appendix 8. Full model structure of conversion risk analysis of Mexican grasslands within the Desert Landscape Conservation Cooperative geography.