Desert Landscape Conservation Center

Appendix 1c.
Madrean Watersheds Conservation Design Workshop Report

2017

Transboundary Madrean Watersheds Landscape Conservation Design Report

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DESERT LANDSCAPE CONSERVATION COOPERATIVE

Madrean Watersheds Conservation Design Workshop Report

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Workshop Overview

Workshop Context

In October 2016, the Madrean Watersheds pilot area was selected by the Desert Landscape Conservation Cooperative (Desert LCC) as a pilot area in which to develop a Landscape Conservation Design. Following selection of this pilot area, a coordinating team comprised of local partners involved in nominating the pilot area, or interested in actively engaging in developing a Landscape Conservation Design started meeting regularly. In May of 2016 the pilot area coordinating team and the Landscape Conservation Design contracting team hosted a bi-lingual (English and Spanish) Madrean Watersheds kick-off webinar to brief potential partners on the process of developing the conservation design, and invite them to participate in upcoming activities to develop key components of the Landscape Conservation Design. The Madrean Watersheds Conservation Design Workshop was one of these key activities.

The Madrean Watersheds Pilot Area includes watersheds spanning Arizona, New Mexico, Sonora, and Chihuahua. The area includes the Madrean Archipelago, characterized by isolated forested mountain ranges surrounded by a "sea" of intervening flatlands, and expands east to include adjacent grasslands. As a testament to its rich diversity of species and habitats, the area has been recognized by Conservation International as one of only 35 Global Biodiversity Hotspots. With more than 4,000 vascular plant species, the Madrean Archipelago harbors the highest diversity of mammals, birds, bees, and ants anywhere in the conterminous U.S. It provides habitat for lower elevation species to migrate in response to increasing temperatures and is home to species and habitats found nowhere else in the world. Ranching is key to the area's economy, cultural identity, and social structure. However, based on climate change projections, this area will likely experience some of the greatest changes in temperature and water availability in North America.

Workshop Structure

In September 2016, the Desert LCC convened a workshop in Tucson, Arizona to advance development of a Landscape Conservation Design in the Madrean Watersheds Pilot Area. Participants included 93 individuals from 48 different organizations from the U.S. and Mexico. Participants had extensive knowledge of the ecology, threats, and management of springs, streams, grasslands, species and ecosystems, and comprised many of the practitioners, managers, and researchers that will ultimately use the Landscape Conservation Design. The workshop was convened and staffed by the Desert LCC Coordinator and Science Coordinator, the Landscape Conservation Design contracting team, Southwest Climate Science Center Staff and members of the Madrean Watersheds pilot area coordinating team.

This workshop was the first in-person convening for Landscape Conservation Design specific to this pilot area. This workshop utilized outputs developed over the past two years including: key findings and products from the 2015 Desert LCC hosted Conservation Design Workshops held in Tucson and Aguascalientes (full report available on the Desert LCC website); information from the Madrean and San Pedro Watershed Pilot Area Proposals that were submitted to the Desert LCC in 2015; information

gathered at a Desert LCC steering committee, working group and partner meeting held in February 2016; and information gathered from participants pre-workshop.

The workshop was provided a structured, collaborative forum for articulating the planning context and developing foundational components of a Landscape Conservation Design including, a pilot area vision, as well as goals/fundamental objectives that lead toward that vision. Participants also identified important natural resources in the Madrean landscape that should be focal points for conservation actions (examples included elements of biodiversity, ecosystem processes, local cultural values, and human well-being). Given the vision, goals, objectives, and important resources, participants developed some short-term, "no regrets" adaptation strategies to implement in the immediate future.

This workshop report includes a summary of the activities and methods we undertook at the workshop, an explanation of how various workshop outcomes advance development of a Landscape Conservation Design, a summary of key information/science needs going forward, summaries of various issues, desired outcomes and topics of interest that are unique to the Madrean Watersheds pilot and an explanation of how results from the previous workshop and other work that has occurred in the pilot area, such as the Madrean Rapid Ecoregional Assessment, are being incorporated into the planning and design for this pilot.

Workshop Outcomes

- Formed **shared values of Desert LCC partners** for the Madrean Watersheds landscape, and management challenges and opportunities in this region.
- Developed a **common understanding** of Landscape Conservation Design for the Madrean Watersheds, including the following components: the purpose and process for the Pilot Area; the status of data development in the region; the Stakeholder Assessment; and the conservation goals for grasslands, streams, and riparian areas.
- Established **shared goals** for large-landscape resources in the Madrean, such as connectivity, biodiversity, and socio-ecological services.
- Further prioritized **important resources** in the Madrean landscape for subsequent in-depth analysis, scenario development, spatial design, and, ultimately, conservation actions.
- Refined existing regional **strategies** (short-term and long-term), and identification of new locally relevant strategies to achieve shared goals.

Workshop Activities and Methodology

The following section describes the activities undertaken at the workshop and associated methods. See also Appendix A for the workshop agenda.

Desert LCC and Partner Presentations

The purpose of this activity was to orient workshop participants to the Landscape Conservation Design approach of the Desert LCC as well as fundamental concepts of large landscape conservation. It was also to foster a shared understanding of the Madrean Pilot Area including some of the highest impact

stressors affecting resources in the area. Participants were oriented through the following series of presentations:

- Desert LCC and Landscape Conservation Design Approach - *Genevieve Johnson, Desert LCC*
- The Importance and Potential of Large Landscape Conservation - *Larry Fisher, University of Arizona School of Natural Resources & the Environment*
- Overview of Madrean Watersheds Pilot Area: history, challenges and opportunities - *Juan Carlos Bravo, Wildlands Network*
- Role of this Workshop in Developing a Madrean Conservation Design - *Louise Misztal, Sky Islands Alliance and Tahnee Robertson, Southwest Decision Resources*
- Identifying High Impact Stressors and Threats in the Madrean pilot area in the Desert LCC - *Carol Beardmore, Sonoran Joint Venture and Esther Rubin, Arizona Game and Fish Department*

Developing a Shared Conservation Vision: Small-Group Discussions

After gaining an understanding of the purpose of the workshop and conservation design, attendees participated in small-group discussions to develop large landscape goals supported by more detailed fundamental objectives for the Madrean pilot area. During the 2015 Desert LCC conservation design workshops and 2016 partner meetings, partners identified the need to develop goals for Biodiversity, Connectivity, and Socio-Ecological Services. At this workshop, participants broke out into several smaller groups to develop goal statements for these topics and to formulate fundamental objectives that describe in more detail the focal components of Biodiversity, Connectivity and Socio-Ecological Services that the group cares about and the direction in which they want them to go (Groves and Game 2015).

Identifying Madrean Priority Resources: Small-Group Discussions - Participants were given a list of priority natural and cultural resources within the Madrean Pilot Area that was developed from input received at the 2015 DLCC-wide conservation design workshops, the pilot nomination report for this pilot area, and the information gathered from participants pre-workshop. They utilized the list to identify which resources within the Madrean Pilot Area are most important to focus collaborative planning and management efforts on in order to reach the goals and fundamental objectives they identified in the morning. Participants worked in breakout groups organized by Biodiversity, Connectivity, and Socio-Ecological to recommend priority resources and developed a list of subcomponents specific to the Pilot Area for the already identified Desert LCC focal resources of grasslands, streams, and springs. In addition, a new focal resource area was created: Elevational/Sky Island-related Resources.

Identifying Stressors that Can Be Addressed Through Management: Small-Group Discussions -

Participants utilized a list of highest impact stressors for springs, streams, and grasslands in the Madrean Watersheds. The list was developed from work conducted by the Desert LCC Landscape-Scale Monitoring Team (formerly called CMQ2). The purpose of this team is to identify species and ecological processes sensitive to large scale stressors (e.g., drought, invasive species, altered fire regime, wind erosion) that can be effectively monitored to understand the overall effects of these stressors on ecosystems, habitats, and species, thus helping managers detect, understand, and respond to these changes. This Team has done extensive work to identify pressures and stressors (utilizing Salafsky et al, 2008) that are impacting ecosystems and species within the Desert LCC and that may be exacerbated by climate change. In preparation for this pilot area workshop, the Landscape-Scale Monitoring Team

surveyed practitioners in the Madrean Watersheds to identify the highest impact stressors acting on grasslands, streams and springs locally. Workshop participants broke out into small groups by resource, reviewed the list of highest impact stressors and assessed which ones they felt could be addressed through management action within the control of the partners in the room.

Desert LCC tools, programs, and research: Presentation and Q&A - A compilation of tools relevant to the Madrean Watersheds were presented. Presentations included:

- Desert LCC website and Conservation Planning Atlas - *Amanda Webb, Desert LCC; Maureen Correll, Bird Conservancy of the Rockies*
- Partner Assessment Results - *Colleen Whitaker, Southwest Decision Resources*
- Madrean Rapid Ecoregional Assessment Available Data Sets and VISTA Tool - *Patrick Crist, NatureServe*

Exploring Current Adaptation Strategies in the Pilot Area: Panel Discussion - Resource experts from various partner agencies and organizations discussed their current work and associated challenges and successes and highlighted how they are already implementing adaptation strategies within the Madrean Watersheds. Panelists included: Amy Markstein, Bureau of Land Management; Don Swan, Saguaro National Park; Brian Powell, Pima County; Carianne Campbell, Sky Island Alliance; and Antonio Esquier, Protección de la Fauna Mexicana.

Developing Short-term Adaptation Strategies: Small-Group Discussions - Building upon the information and discussions of the panel, priority resources and stressors attendees began planning for immediate actions to support adaptation to the anticipated stressors in the Madrean Watersheds. The participants first listed important short-term and long-term strategies related to Grasslands, Springs, Streams, and Elevational/Island-related resources. Of those lists, participants identified the short-term strategies to begin implementing this year.

Scenario Planning Introduction: Presentation by Carolyn Enquist, Southwest Climate Science Center - The purpose and key elements of scenario planning were presented to the participants, along with the key uncertainties that could be addressed in the Madrean Watersheds.

Next Steps and Closing - The workshop concluded with a panel of workshop participants who had volunteered to discuss insights and outcomes of the workshop. All participants were asked to complete workshop evaluations.

Summary of Outcomes and Key Findings

A Shared Conservation Vision for the Madrean Watersheds Landscape

A shared conservation vision is an essential building block for developing a landscape conservation design. The following Madrean mission and goal statements reflect key themes and shared values that emerged from the collective input of partners. These elements provide a vision and direction from which to develop supporting analysis and action plans.

In addition to biodiversity, connectivity, and socio-ecological services, participants identified the following additional topic areas which they felt should be addressed by developing goals and in some cases, fundamental objectives: Water, Ecosystem Integrity, and Stakeholder/Community Engagement. Participants also felt that articulating how they would like to work with each other should be captured in process goals related to collaboration and information sharing.

Mission

The Madrean Watersheds initiative is a large landscape, international effort to maintain and enhance the interconnected system of mountains, grasslands, deserts and waters that supports species diversity, promotes healthy watersheds, and maintains the overall ecosystem integrity that enriches the lives of human communities.

A Conservation Vision – Goals and Fundamental Objectives

Biodiversity - Madrean watersheds are a haven for the unique diversity of native and endemic species.

- Maintain water and riparian systems
- Maintain and enhance native species and habitat
- Maintain populations of priority species

Landscape Connectivity - Enhanced linkages connect the diverse life zones of Sky Island ecosystems, from valley bottoms to mountain tops, from southern Sonora to the Gila River in Arizona, enabling persistence of migratory wildlife and allowing for the possible future shift of species and ecosystems in a changing climate.

- Maintain/increase linkages for wildlife
- Maintain connected network of water sources for wildlife
- Restore and increase habitat connectivity

Socio-Ecological Services - Healthy watersheds, functioning ecosystems and cultural resources deliver highly valued benefits to human communities.

- Optimize watershed benefits for humans, ecosystems, and wildlife
- Maintain soil function and reduce erosion
- Increase human connection to place
- Support working landscapes for ecological, agricultural and community benefits
- Prioritize ecosystem integrity

Process Goals

The follow draft process goals were developed by participants to articulate how they would like to work with each to develop and implement a Landscape Conservation Design. Development of these goals is very much in line with the approach of the Desert LCC and the National LCC Network which has already developed goals related to collaboration and the sharing of science and information. These Madrean draft goals will be refined and updated to be brought in line with the LCC Network goals.

Collaboration - U.S. and Mexican institutions and stakeholders are actively engaged and effectively collaborating across boundaries on restoration, conservation, stewardship, education and public outreach. Partners' work is aligned to achieve maximum benefits, and there is support and capacity to continue work into the future.

Science and information sharing - Regional monitoring and scientific research is tailored to ensure relevancy to managers and decision makers, and is coordinated to promote effective partnerships and enhanced capacity.

Important Resources in the Madrean Watersheds

In order to develop a Landscape Conservation Design that is meaningful and relevant to a specific geography, it is necessary to identify the resources that contribute to meeting biodiversity, connectivity, socio-ecological goals. Grasslands, streams, and springs were identified as focal resources for Landscape Conservation Design development by the Desert LCC at the outset of the planning process. Additionally, each pilot area geography has unique resources, or particular aspects of grassland, streams and springs that are of high importance to partners and contribute to the special character of the area. During this workshop, participants identified a diversity of components and aspects of these resources that are relevant and important within the Madrean Watersheds. These lists were developed in part by extensive discussions at previous workshops and meetings on values of importance within the Madrean Watersheds. Participants also refined a working list of additional resources partners had previously identified as important in the Madrean Watersheds. Participants identified the follow aspects of grasslands, streams and springs as well as the additional resources as being important to biodiversity, connectivity and socio-ecological services in the Madrean Watersheds.

Grasslands, Streams and Springs

Grasslands

- Riparian grasslands: Sacaton/floodplain grasslands
- Mix grama grasslands (Bouteloua sp., Elymus sp., Eragrostis sp., Hilaria sp., and Muhlenbergia sp.)
- Regionally endemic grassland birds, both breeding and especially over-wintering
- Pronghorn
- Bison
- Ecosystem services
    - Soil stability and genesis
    - Carbon sequestration
    - Infiltration of water (slowing run-off and recharge services)
    - Oxygen production
    - Managed working landscapes (notably for ranching)

Spring Ecosystems (riparian and aquatic)

- Presence of species endemic to springs
- Water quality at spring emergence (defined by supporting endemic species)
- Water quantity

- Traditional cultural knowledge and value of springs to Native peoples

Streams (Riparian and Aquatic)

- Riparian Woodlands (gallery forests and mesquite bosques)
    - Neotropical bird species nesting and overall avian diversity
    - Wildlife Corridors/Landscape Linkages
- Xeric-riparian (especially to breeding birds and as corridors for regional wildlife)
- Riparian-related avian migration stop-over and breeding corridors
- Transboundary aquifers
- Beavers (keystone species)
- Southwestern Willow Flycatcher/ Yellow-billed Cuckoo
- Grey Hawk
- Fish habitat and other aquatic species habitat and connectivity support (supporting T & E sp., and other very rare native species)
- Herpafauna habitat and connectivity (supporting T &E sp.)
- Invertebrate habitat and connectivity
- Mammal habitat and connectivity
- Ecosystem services
    - Groundwater recharge
    - Erosion control
    - Mediation of flood flows
    - Thermal refugia (providing micro-climates)
    - Carbon sequestration (notably old-growth mesquite bosques)
    - Biodiversity habitat support
    - Recreational services

Other Resources

Madrean pine-oak woodland (a biodiversity hotspot)

- High avian species diversity, including threatened/restricted species (e.g., Mexican Spotted Owl, small owls, and Arizona Woodpecker)
- Stop over location for birds in migration (major habitat use at certain times/conditions during spring), also notable for “molt migration” stop-over habitat in fall migration
- Mammal, heptafauna high diversity

High elevation montane ecosystems

- High elevation specialist/restricted species (e.g. Mt. Graham Red Squirrel, black bear, and avian species)

Critical wildlife movement corridors

- Suite of species to represent connectivity (species with large ranges and dispersal needs)
- Elevational gradients to support species movement (seasonally and evolutionary adaptation potential)
- Pollinator corridors (birds, moths, bats, other insects)
- Hemispheric migratory and pollinating corridor

- "Carni-scape" (many large migrating carnivores, sub-set of above bullet)
- Jaguars and ocelots (apex predators, flagship species
- Desert Tortoise/Gila Monster (regionally of concern)
- Springs that provide water for wildlife moving through a corridor/linkage
- "Live-in" linkages for incremental movement over generations

Upland Sonoran Desert

- Old growth ironwood forest
- Saguaro/Palo Verde Desert Scrub community

Transboundary species (insects, mammals, birds)

- Nectar species and pollinators
- Golden Eagle
- Mountain Lion
- Black Bear
- Monarchs
- Bald Eagle

Cultural knowledge and heritage values (e.g. cultural landscapes, culturally significant species)

- Saguaro fruit-harvest

Non-montane Seasonal Biodiversity Hotspots

- Playas
- Cienegas

Ecological Refugia and Restricted Landscape Facets – Important to regional biodiversity resilience and persistence, respectively

- Topographic/Aspect-based climate refugia (ability to mediate climate change extremes)
- Talus slopes (specialist invertebrate and vertebrate habitat)
- Limestone outcropping (specialist plants and animals)
- Caves (bat habitat)
- Cliffs/Escarpments (raptor nest habitat)

Species

- Mexican Wolf
- Desert Bighorn
- Endemic and Neotropical birds
    - Fall migrants in particular
- T&E species
    - Fish (Gila Topminnow, Desert Pupfish, Gila Chub, and others)
    - Gastropods (Spring Snail)
    - Insects (Butterflies, moths, and spiders)

- Amphibians (Chiricahua Leopard Frog)

Sky Island Ecosystem Services (cross-cutting)

- Groundwater recharge
- Ecosystem processes (e.g. fire, water availability, nutrient cycling)
- Natural disturbance regime
- Recreation and ecotourism
- Aesthetic values
- Managed working landscapes
- Headwaters – tops of watersheds providing water sources across the elevational range downstream
- Water availability and sustainable use
  - Water for livestock
- Alternative livelihoods based around ecosystem restoration/conservation, and/or sustainable harvest of forest resources (e.g. mushrooms)

Stressors related to Grasslands, Springs, and Streams

Participants identified the following stressors in the Madrean Watersheds as both high priority to address *and* able to be effected through management. These stressors below are organized by main stressor/sub-stressors and are listed alphabetically by main stressor.

Grasslands

- Climate Change
  - Changes in forage or cover (e.g. availability, structure, or composition)
  - Increased erosion (e.g. vegetation loss leading to wind erosion)
  - Desertification
- Dams and water Management/Use
  - Increased groundwater pumping
- Ecosystem Effects
  - Increased habitat fragmentation (e.g. from development, land conversion, etc.)
- Fire and Fire Suppression
  - Decreasing fire frequency, size, and/or changes in severity outside of historical of variability (e.g. from fire suppression
  - Invasive or exotic species (e.g., fire-adapted, new aggressive invasives that will likely alter fire regimes)
- Invasive Species
  - Changes in community composition
  - Spread of invasive non-native and native species (e.g., bark beetle, creosote, mesquite tamarisk, etc.)
- Livestock, Farming, and Ranching
  - Altered streambank structure and erosion from domestic animal pressure
  - Unsustainable grazing
  - Stream channelization

    - Increased spread of invasive plant species (e.g., planting exotic forage and passive spread
- Renewable Energy
    - Habitat fragmentation (transmission lines, roads)

Streams and Riparian Stressors Synthesis

- Dams and water management/use
    - Stream channelization
    - Changes in groundwater recharge
    - Increased groundwater pumping
    - Altered hydrology (e.g. flow regimes, including changes in peak flows)
    - Decreasing water availability (including timing), affecting aquatic and riparian habitat)
- Ecosystem Effects
    - Changes in disturbance regime
    - Loss of ecosystem services (certain components can be affected)
    - Increased habitat fragmentation (e.g. development, land conversion, etc.)
- Fire and fire suppression
    - Increasing fire frequency, size, and/or severity outside of the historical range of variability (e.g. from increased human caused fire ignition rates, build-up of fuels)
- Livestock, farming and ranching
    - Unsustainable grazing
    - Increased groundwater pumping to attempt to maintain farming
- Mining and quarrying
    - Harmful/toxic byproducts (including those in ponds and downstream) *especially in Mexico
    - Habitat destruction and modification

Springs Stressors Synthesis

- Climate change
    - Conditions exceeding species adaptive capacity
    - Changes in evapotranspiration
- Dams and water management/use
    - Increased groundwater pumping
    - Reduced aquatic habitat connectivity (e.g. with salmonids, leopard frogs)
    - Changes in groundwater recharge
- Ecosystem effects
    - Decrease in water availability to the ecosystem (Depends on type of spring, easiest if alluvial)
    - Changes in community composition
- Fire and fire suppression
    - Increasing fire frequency, size, and/or severity outside of historical range of variability (e.g.) from increased human-caused fire ignition rates, build-up of fuels
- Invasive species
    - Changes in community composition
    - Increased competition with native species due to climate change
- Livestock, farming and ranching

- Increased groundwater pumping to maintain farming
- Increased spread of invasive plant species (e.g. planting exotic forage and passive spread

Information Needs and Critical Uncertainties Related to Management

A key function of Landscape Conservation Design is to synthesize and/or develop information such that management decisions can be better informed and build toward the shared conservation vision. The identification of information gaps and uncertainties that are currently hindering management came up throughout the workshop a natural part of discussions. In addition, we specifically asked workshop participants to answer two questions in order to assess information needs that we may be able to address through developing the Landscape Conservation Design: "What are the highest priority management questions for a particular focal resource?" and "What critical uncertainties need to be addressed (especially in the context of stressors to the focal resource)?"

Emerging Themes by Resources

We received 241 individual comments from approximately 75 workshop participants. The following section summarizes recurring themes of management interest and current uncertainties based on managers' responses.

Grasslands Themes

- Agricultural expansion
- Climate change impacts
- Connectivity
- Ecological Health
- Fire
- Funding
- Human impacts on resources
- Hydrology
- Invasive species
- Ranching
- Restoration
- Socio-Ecological Values

Springs Themes

- Grazing
- Climate change impacts
- Connectivity
- Drought
- Ecological health
- Environmental Flows
- Fire
- Geology
- Groundwater pumping
- Human impacts on resources
- Hydrology
- Information sharing

- Invasive species
- Socio-ecological values
- Spring discharge
- Water policy
- Water use
- Watershed Health

Streams Themes

- Climate change impacts
- Connectivity
- Drought
- Ecological Health
- Effluent
- Environmental Flows
- Fire
- Funding
- Groundwater Pumping
- Human impacts on resources
- Hydrology
- Information sharing
- Invasive species
- Phenology
- Restoration
- Socio-ecological values
- Water policy
- Water use

Summary of desired new information and synthesis to inform management

We reviewed the participant responses to the two questions about information needs and outstanding uncertainties as well as reviewing information needs that were articulated throughout the workshop sessions, and developed the following summary of questions and information needs that may be answerable at least in part through development of a Landscape Conservation Design. This summary provides important grounding in the current information and analysis needs of managers working within the Madrean Watersheds and should provide guidance to development of spatial analysis and information synthesis during the next steps of Landscape Conservation Design Development. The information needs and questions are summarized by topic area below.

Biodiversity

Information on the current state of resources:

- Spatial location and extent of aspect-based refugia. Notes – need to identify scale and integrate this assessment with biodiversity.
- Spatial location/extent of previously disturbed landscapes with biodiversity value (to help prioritize restoration). Notes – need to define “previously disturbed” and extent of disturbance we would want to assess.
- Spatial location of grasslands likely to be most affected biologically by invasive species and those most appropriate as reserves.

- Spatial location of grasslands that should not be grazed due to their importance in contributing to infiltration of water.
- Spatial location of dirt tanks for cattle that are actually springs.
- Spatial location of springs with associated information on biotic community, water amount/quality and other aspects as well as classification of spring (i.e. type).
- Spatial location and extent of springs that have already been lost.
- Location of low elevation springs in proximity to groundwater pumping.
- Evaluation of springs for their potential response. Notes –need to identify what influences we want to evaluate response to.
- Historic and current conditions of all springs.
- Synthesis of flora and fauna occurrence at springs where information is accessible.
- Spatial location of where recharge/slowing runoff in tributaries will increase groundwater levels at the downstream (valley) main stem shallow aquifers.
- Spatial location of the most important areas for recharge and their current conservation status.
- Develop new information on threatened and endangered species' ranges in the Mexico portion of the pilot.

Information regarding the potential future state of resources:

- Trending conditions of all springs.
- Model of habitat changes we can expect at streams (aquatic and riparian) due to climate change.

Connectivity

Current

- Spatial location and extent of where new protected areas are needed.
- Spatial location and extent of intact threads of habitat through "pinch points."
- Map of status of areas for connectivity: fully impaired – fully protected.
- Map of areas of connectivity that can be lived in for generations. Notes – need to identify scale.

Socio-Ecological Services

Future

- Spatial location and extent of grasslands most likely to be affected economically by climate change. Notes – assess if these locations may overlap with most likely to be affected biologically.
- Identification of development options that do not make the current situation worse for streams.

Management Approaches and Techniques

- How to develop grassland objectives that are realistic given climate/human scenarios?
- What grassland sustainable management practices will increase resilience?
- Develop a grassland monitoring approaches for local conditions.
- What grassland goals will be appropriate for woody/brush balance with grass?
- Identify approaches for grasslands that are addressing specific high impact pressures/stressors?
- How do we prevent a loss of biodiversity at springs?
- Grassland restoration strategies – identify which are right under circumstances and how to prioritize where to apply
- Which grassland management techniques to halt/slow encroachment of shrubs that are affordable?
- How can we better manage groundwater recharge?

- How can we effectively remove invasive species at springs?
- What approaches will help us coordinate across an international boundary to maintain water connectivity for fish?

Adaptation Action Plans

We've heard repeatedly from partners within the Madrean Watersheds that many of them have already undertaken some type of climate change adaptation assessment or planning and that It was crucial to this group of partners to better coordinate and advance on-the-ground work in the short-term while continuing to develop longer-term plan through development of the final Landscape Conservation Design. Therefore, one focus of this workshop was to identify immediately implementable conservation action plans for grasslands, streams, and springs. Workshop participants also identified two additional topics that require immediate actions: Sky Island specific resource including elevational gradients and building and strengthening collaboration. Sky Island resources are resources that depend on the unique ecosystems and habitats created by the elevational gradients formed by the "sky island/desert sea" structure. Collaboration pertains to the actions that the Madrean partners should take to strengthen relationships throughout the pilot area geography.

Below is a list of the immediate-term actions recommended for each of the five topics:

1. Grasslands: Invasive Species Management
2. Streams: Enhancing Tributary Recharge and Slowing Water in Uplands
3. Springs: Mexico Spring Inventories
4. Unique Sky Island Resources - Endemism and Refugia; Design and Complete a Corridors Study
5. Building and Strengthening Collaboration: Partnering with Tribes; Conducting Outreach for the Madrean Pilot Process

Grasslands: Invasive Species Management

Action Plan Steps

1. Implement an education campaign about invasive species
    - Purpose: Sharing knowledge about the function of grasslands, and discouraging the perception of the burro as iconic symbol for Sonora
    - Recommended activities for the next year: Develop educational presentations, such as a PowerPoint showing the impact of burros as an invasive species
2. Research existing programs on bio-control
3. Identify and collaborate with funding sources
4. Create an index of the work being done on managing invasive species. Suggested features of the index:
    - Organize by geography and by target species
    - Record both effective and ineffective methods

Partners to Involve

- Arizona Antelope Foundation
- Audubon Society

- Altar Valley Conservation Alliance
- US Bureau of Land Management
- US Natural Resource Conservation Service
- Sweetwater Center
- Tohono O'odham Nation
- Academic institutes
- Arizona Department of Transportation
- County Departments of Transportation
- Arizona Cooperative Extension
- Landowners
- Tri-national organization

Streams: Enhancing Tributary Recharge and Slowing Water in Uplands

The goals of this action plan are to slow water movement in uplands around tributaries and within tributaries to decrease peak flow and channelization, and to increase base flow and carbon sequestion.

Action Plan Steps

1. Conduct an inventory of existing and potential activities
    - Identify ongoing efforts in the Madrean region (including long-term monitoring of project impacts).
2. Inventory strategic locations for implementing stream recharge and slowing water movement in uplands
    - Identify private lands with potential for resource benefit where work is not currently being done
    - Identify funding and expertise
    - Current location opportunities include:
        i. Cienega Ranch in Dos Cabezas
        ii. San Pedro Riparian National Conservation Area – Resource Management Planning process may propose uplands work
        iii. El Coronado Ranch
        iv. Babocomari River
        v. Elkhorn Ranch
        vi. Patagonia (north of the town of Patagonia)
        vii. Muleshoe and Aravaipa properties of The Nature Conservancy
        viii. Silver Creek and Cienega Creek

3. Develop a decision support framework and/or best practices for choosing locations for tributary recharge work
    - Scale and place important – where in a watershed and then where in a drainage
4. Identify willing partners for these projects
        i. This list would be ready to select from when there is an opportunity to do an on-the-ground project
        ii. Make sure to include landowners, as well as partners from Mexico and indigenous/tribal communities

5. Convene a working group to prioritize the most implementable strategies related to enhancing tributary recharge and slowing water in uplands
6. Implement the prioritized strategies
7. Document effects and effectiveness and include human benefits metrics
8. Explore potential funding and policy nexus with Burned Area Emergency Response work

Partners to Involve

- Borderlands Restoration
- Cuenca los Ojos
- Sky Island Alliance
- The Nature Conservancy
- Tucson Audubon Society
- US Bureau of Land Management
- US Bureau of Reclamation
- US Fish and Wildlife Service - Refuges; Partners for Fish and Wildlife program
- US Geological Survey
- Watershed Management Group

Additional recommended activities

- Transfer water rights from other purposes to environmental flows
    - Secure reclaimed water for the environment if safe
- Proactively restore native trees in anticipation of Tamarisk beetle arrival
- Reconnect floodplain along the Gila River
- Create islands of native plants and create a seed source as well as refugia for flycathcers
- Work with ditch associations to optimize water available to the environment
    - Manage timing of flow
    - Change point of diversion to be closer to human use
- Increase flexibility of agricultural water in areas where agricultural water use impacts shallow groundwater and streams, use to change timing of when water returns to river
    - Demonstrate creative farming practices that increase flexibility in agricultural water use e.g. low water use crops like stool; crops like native grasses that can survive time without irrigation and potentially help transition to retiring irrigation; standard crops that use water when it strains creeks the least e.g. winter barley).
- Implement strategies in geographically strategic locations such as next to stretches of protected land to get more environmental “bang” from the water
- Implement net-zero development with water harvesting and recharge
- Flood skimming – pump flood water upstream within a tributary to increase base flow later
- Execute severances and transfers to change diversion points (work with irrigation districts)
    - Water markets can do this if the water is metered
    - Mechanisms exist to do this in Mexico via Water Trusts
- Work to ensure water being recharged has environmental benefits

Springs: Springs Inventories in Mexico

Action Plan Steps

1. Develop a strategic process for inventory
    - See past Kaibab National Forest effort as an example
    - Inventário Nacional de Humidádes GIS layer is inclusive of springs (CONAGUA)
2. Identify existing spring inventories/monitoring efforts. Include the list below:
    - State government – Sonora and Chihuahua
    - CEDES Sonora
    - IRIS Chihuahua
    - Universities of Sonora and Chihuahua
    - University of New Mexico Albuquerque – Department of Geology
    - Commission Sonora-Arizona (Springs not previously focused on)
    - San Pedro Watershed – 10 years of hydrology monitoring
    - Participants in the Madrean workshop
    - Naturalia - not well-known, has ad-hoc efforts
1. Identify opportunities for collaboration around species at springs
    - AZGFD and Sonoran State Agency
    - USGS, AGFD, CEDES – Chiricahua Leopard Frog
    - Work with voluntary protected areas in Mexico (such as Rancho los Fresnos and Cuenca los Ojos).
    - Partner with National Parks in the US – Possible partnership with Saguaro NP and Mexican protected areas

Partners to Involve

- US Fish and Wildlife Service
- Springs Stewardship Initiative
- Bureau of Land Management
- Sky Island Alliance
- Northern Arizona University
- Comisión Nacional de Areas Naturales Protegidas
- Naturalia
- Comisión Nacional del Agua
- Tribes (Mex – Yaqui)
- Pima County and other landholding entities
- Areas voluntaries para la Conservación Mexico
- US Geological Survey
- Private landowners
- Cuenca los Ojos
- Rancho los Fresnos (Naturalia)
- Bilingual university students
- Game and Fish Departments
- State of Arizona
- SGM
- National Park Service

Additional activities recommended for spring conservation

- Improve research on sources of water (chemistry, isotopes) in springs
- Work with ranchers to free/improve springs used by livestock
- Develop prioritized stewardship-planning process – how do we prioritize which springs?

- Continue spring inventories – mapping/assessments, especially in Mexico
- Engage in citizen science activities for spring monitoring, including continuing the development of citizen science monitoring tools

Unique Sky Island Resources: Conserving Endemism and Refugia and a Corridor Study

Conserving Endemism and Refugia Action Plan Steps

1. Complete an inventory of the endemic species in the region, and the locations of their refugia.
    - Identify current refugia, as well as areas species would potentially move to
2. Identify a list of endemic species to focus on for refugia
    - Use the inventory to identify species and places of highest value
    - Prioritize species using existing efforts, such as:
        - Assessment of existing refugia projects
        - Arizona State Wildlife Plan
        - Existing species recovery plans
        - Past workshops in the Madrean region
        - IUCN Red Lists
        - Sky Island Alliance springs surveys (mostly in the Galiuro Mtns and in Sonora)
    - Consider making this assessment a study for a grad student
3. For each species, identify the state of knowledge:
    - Map known distribution
    - Identify existing areas of conservation, as well as potential new areas
    - Describe population trends – indices of status
    - Model how distributions may change over time (potentially develop scenarios)
    - Identify where new reserves may be needed
4. Develop conservation recommendations based on species needs
    - Recommendations could be made collaboratively through a symposium*
5. Pick a species to do a pilot project on, and implement a bi-national process for conservation
    - Possible species: thick-billed parrot
    - Launch a public education program
    - Obtain funding to begin conservation efforts
6. Workshops or meetings should be held to support the inventory, prioritization of species, recommendations on conservation, pilot project, or other phases of the process.

Partners to Involve

- Arizona Center for Nature Conservation
- Arizona Game and Fish Department (mostly for herps and invertebrates, and some large mammal species)
- Comisión Nacional de Areas Naturales Protegidas
- Cuenca Los Ojos
- Naturalia
- New Mexico Department of Game and Fish
- Saguaro National Park
- Sky Island Alliance
- Springs Stewardship Institute

- The Nature Conservancy
- US Fish and Wildlife Service
- Botanists and entomologists
- Chiricahua Leopard Frog group
- Comisión Nacional Forestal
- Universities
- US Forest Service
- US Department of Defense

Corridors Study Action Plan Steps

1. Create a collaborative structure for regional sharing of information about corridors
2. Create a framework or strategy to complete connectivity mapping and a camera trapping database
3. Complete an assessment of the existing efforts to promote connectivity (mapping, plans, conservation projects, etc.)
    - Existing projects (include camera trapping projects)
    - Methods and designs used
    - Effectiveness of methods/designs (e.g., are animals using wildlife culverts?)
    - Contact people who are mapping <u>every</u> area, including:
        - Inter-island: mapping needs to be completed
        - Within islands: mapping needs to be completed
        - Pilot area-wide
        - Mexican Highway 2
        - Mexican Wolf historic distributions
        - Sonora and Chihuahua
        - US-Mexico fence line inventory being done by Arizona Center for Native Conservation
        - Pollinator adaptation project by Sky Island Alliance
4. Compile the information gathered in the assessment
5. Identify next steps by getting partners together (through a workshop, meetings, digital communications, etc.). Next steps could involve:
    - Deciding on a single method to document corridors (Land Cover, etc.)
    - Continuing and expanding mapping efforts to identify additional needed areas of inter-island connectivity
    - Connectivity modeling for a suite of surrogate species in the pilot area
    - Using Wildlands Network Guide for influencing Forest Plans and BLM management plans
    - Identifying streams that are infested with exotic species, and protecting their headwater springs from invasion
    - Creating a connectivity map – draw on existing/past processes (Wildlands Network, jaguar effort in Costa Rica, Wild Utah, etc.)

Partners to Involve

- Animas Trust
- Arizona Center for Nature Conservation
- Arizona Department of Transportation (in multiple areas)
- Arizona Game and Fish Department
- Arizona State University

- Audubon Society
- Borderlands Habitat Network
- Conservation Science Partners
- Cuenca los Ojos
- Foundations and donors – there are existing lists
- Sky Island Alliance
- Some counties and local governments
- Southwest Monarch Study
- The Nature Conservancy (for large-scale mapping)
- US Bureau of Land Management
- US Fish and Wildlife Service
- US Geological Survey
- US National Park Service
- US National Phenology Network
- Wildlands Network
- Bird Joint Ventures – Sonoran, Rio Grande
- Comisión Nacional del Agua
- Comisión Nacional de Áreas Naturales Protegidas
- Comisión Nacional Forestal
- County and local government planners
- Hummingbird Monitoring Network
- Hunters
- Private landowners and communal landowners
- Profauna
- Pronatura Noreste
- Transportation authorities
- US Border Patrol
- US Congress
- US Department of Defense
- US Forest Service

Additional activities recommended for unique Sky Island resources

For the following topics, three main steps are recommended:

1. Identify knowledge gaps.
2. Identify key people who may act to fill the gaps.
3. Convene key people, or incorporate them into existing groups working on the issue.

Camera documentation and coordination

- Efforts are already being made – just need to inventory and coordinate existing projects
- Make coordination and documentation cloud-based
- Use the Southwest Camera Network Facebook site to get people together, arrange a possible meeting, and build capacity

Wildlife Crossings

- Already occurring. One notable opportunity is Mexico Highway 2
- Wildlands Network can implement
- Would like input on locations and designs

Additional topics for potential future work

- Influencing management (fire, Wilderness, meta-populations, cross-border differences)
- Fire management
- Sustainable forest management (fuel wood cutting, restoration, Burned Area Ecological Restoration, etc.)
- Soil, erosion
- State of Science on elevational gradients
- Water systems (recharge, groundwater, etc.) – connectivity, gaps, understanding of aquifers in the region

Building and Strengthening Collaboration: Partner with Tribes

Action Plan Steps

1. Approach Tribes with a clear idea that has benefits to them.
    - Potential benefits include:
        - Greater cooperation
        - Enhancing wildlife
        - Investing in science
        - Collaborating on grants
        - Managing large areas together
        - Optimism for the future
        - Communicate using keywords “land stewards,” “traditional ecological knowledge”
    - Places to engage
        - Tribal Council
        - Inter-tribal council/leader forum agenda
        - Native American Fish and wildlife Society
2. Create and distribute tangible communication materials
    - Newsletter
    - Brochure describing the Desert LCC/Madrean Pilot Area
        - What’s going on, who is involved, what the benefits are
    - Stories of Desert LCC successes
    - Engage Land Manager group

Building and Strengthening Collaboration: Conduct Outreach for the Madrean Landscape Conservation Design

Action Plan Steps

1. Go to policymakers - learn what’s happening on the ground, and inform about Desert LCC/Madrean process
2. Establish indicators of success for the Madrean process
3. Engage Mexico to a greater extent in the Partner Assessment
4. Convene cross-visits between partners
5. Utilize citizen science (such as Safford volunteerism)
6. Engage inmates and veterans
7. Engage youth

- Integrating youth into existing restoration projects
- Creating a Madrean Youth Conservation Corps
    i. Model/use Tohono O'odham air quality programs
- Coordinate with Mexican colleges - opportunities to have experience elsewhere
- Including multi-cultural youth
- Including youth in land/water/outdoors
- Partner with Tucson Audubon and individuals from the Madrean Workshop

8. Link place-based groups, and prioritizing projects that are relevant to place-based efforts
    - Annual forum
    - Partner with the Borderlands Restoration Leadership Institute

Conclusions and Recommendations

Developing a Landscape Conservation Design in the large and diverse Madrean Watersheds pilot area that truly reflects shared interests and goals of a myriad of partners, and advances conservation of natural resources, is a significant undertaking with precious few examples to look to for guidance. It is an essential step to bring the Landscape Conservation Cooperative's vision to work effectively across jurisdictions, sectors, and varying landscapes to solve the conservation problems of our time together that cannot be solved by any one organization. We've taken an approach to Landscape Conservation Design development that is thoroughly grounded in the values, priorities, goals and information needs of the diverse entities managing and stewarding natural resources in both the U.S. and Mexico within the Madrean Watersheds. This is reflected in the extensive input that has been gather from some 150 individuals and more than 60 different organizations over the course of this project, including through this workshop. Bringing this information together in a way that clarifies meaningful shared goals and that helps managers work together more effectively over the long-term is no small task. As reflected in this workshop report, understanding natural resources at a landscape scale in a cohesive way includes a diversity of aspects including goals, objectives, particular resources such as species or special ecosystems,

This workshop developed key components of a Landscape Conservation Design for the Madrean Watersheds Pilot Area. Practitioners within the pilot area came together to craft a shared vision of conservation action, to assess cross-jurisdictional priorities and key areas for collaboration going forward, to articulate pressing information needs for management, and to develop tangible strategies to begin to adapt to climate change now while continuing to develop a comprehensive Landscape Conservation Design.

The shared conservation vision and framework detailed in this report will provide common ground and an important reference point from which to develop additional information and an analysis structure. Key next steps must address bringing the pieces described here (vison, goals/objectives, values, focal resources and ecosystems, priority stressors, and management options) together into a cohesive understanding of the state of resources in the Madrean Watersheds, likely changes over time, and how the partner group can best respond collaboratively.

Next Steps for Conservation Design Development

We are now working with wealth of information on the Madrean Watersheds that must be synthesized, where possible spatially analyzed, and in many cases further developed in order to craft spatial analyses that The Landscape Conservation Design for the Madrean Watersheds pilot area will include an interactive map depicting key places and action plans needed to conserve natural cultural and social values, and to sustain them in the face of future climate change. It will also include collaboratively developed action plans and new groups of partners working together to implement the design cooperatively.

Key next steps to advance development of the Landscape Conservation Design for the Madrean Watersheds include:

- Work with the Madrean Watersheds coordinating team and Desert LCC management question and science teams to develop indicators and targets to support analysis for the goals and fundamental objectives.
    - Synthesize indicators already in use in current plans and management approaches.
    - Develop and approach to assess ecosystem condition based on chosen indicators (likely 3 (2-5) per ecosystem).
    - Develop any remote sensing data products or spatial analyses needed to represent these indicators over the scale of each pilot area.
    - Review available data sets that may best represent the indicator, either directly or indirectly, and the how best to quantify levels of condition for providing status assessments and target setting (potentially) of future condition/status.
- Develop spatial information related to resources and stressors of high interest.
- Utilize information from the workshop, including managers' information needs, to develop a scenario planning approach and scenarios to inform the Landscape Conservation Design
- Further engage Mexican partners within the pilot area to ensure products are relevant to their information needs and work.
- Utilize information from the workshop, including managers' information needs, to inform spatial analysis approach and to inform consideration of other information/synthesis/analysis products that may be most useful to managers.
- Engage the Madrean Watersheds coordinating team in reviewing interim products and assessing progress toward a useful Landscape Conservation Design.

Appendices

Appendix A: Workshop Agenda

Desert Landscape Conservation Cooperative

Madrean Watersheds Landscape Conservation Design

Wednesday and Thursday, September 21-22, 2016 --- 9AM–5PM

Tucson, Arizona – University of Arizona (Environment and Natural Resources 2, Room S107)

Agenda

Workshop Goals

1. Develop a **common understanding** of the importance of the Madrean Watersheds landscape and management challenges and opportunities in this region.
2. Provide an **overview of Landscape Conservation Planning and Design**, including purpose and process, status of data development, stakeholder assessment, and shared conservation goals for grasslands, streams and riparian areas.
3. Draft **shared goals** for Madrean large landscape resources, such as connectivity, biodiversity, and socio-ecological services
4. Further prioritize **important resources** in the Madrean landscape for subsequent in-depth analysis, scenario development and spatial design
5. Refine existing and identify new locally relevant **strategies** (shorter-term and longer-term) to achieve shared goals.

Day 1 – Wednesday, September 21

8:30am	**Registration and Networking**
9:00	**PLENARY: Welcome and Introductions -** *Genevieve Johnson, Desert LCC* **Workshop Overview -** *Tahnee Robertson, Southwest Decision Resources*
9:15	**PLENARY: Landscape Conservation Planning and Design and Madrean Pilot Area Overview**

- **Desert LCC and Landscape Conservation Design Approach -** *Genevieve Johnson, Desert LCC*
- **Overview of Large Landscape Conservation** - *Larry Fisher, Univ. of AZ School of Natural Resources & the Environment*
- **Overview of Madrean Watersheds Pilot Area** - *Juan Carlos Bravo, Wildlands Network*
- **Madrean LCPD Process and this Workshop** - *Louise Misztal, Sky Islands Alliance and Tahnee Robertson, SDR*
- **Identifying High Impact Stressors and Threats in the madrean pilot area in the Desert LCC** - *Carol Beardmore, Sonoran Joint Venture and Esther Rubin, Arizona Game and Fish Department*

10:30	**PLENARY: Madrean Shared Vision Intro -** *Genevieve Johnson, Desert LCC*
10:45	**Break**
11:00	**BREAKOUT GROUPS: Madrean Shared Vision**
12:15pm	**Lunch** (on your own at nearby restaurants)
1:15	**PLENARY: Madrean Shared Vision Sharing Back**
2:00	**BREAKOUT GROUPS: Madrean Resources Round 1 - Madrean Specific Resources**
3:00	**Break**
3:15	**BREAKOUT GROUPS: Madrean Resources Round 2 - Grasslands, Springs, Streams**
4:15	**Break**
4:30	**PLENARY: Madrean Resources and Objectives Outcomes Sharing Back**
5:00pm	**Adjourn and Evening Social (Brew of A)**

Day 2 – Thursday, September 22

9:00am	**PLENARY: Welcome and Day 2 Agenda Review -** *Tahnee Robertson, Southwest Decision Resources*
9:05	**PLENARY: Relevant Tools and Programs**

- **Desert LCC website and Conservation Planning Atlas** - *Amanda Webb, Desert LCC; Maureen Correll, Bird Conservancy of the Rockies*
- **Partner Assessment Results** - *Colleen Whitaker, Southwest Decision Resources*
- **Madrean Rapid Ecoregional Assessment Available Data Sets and VISTA Tool** - *Patrick Crist, NatureServe*

10:15	**Break**
10:30	**PLENARY PANEL: Current Adaptation Strategies in the Madrean –** *MODERATOR Louise Misztal, Sky Island Alliance* *Amy Markstein, Bureau of Land Management; Don Swan, Saguaro National Park; Brian Powell, Pima County; Carianne Campbell, Sky Island Alliance; Antonio Esquier, Protección de la Fauna Mexicana*
12:00pm	**Lunch** (On your own at nearby restaurants)
1:00	**BREAKOUT GROUPS: Strategies Part 1 - Cross-cutting High Priority Strategies**
2:00	**Break**
2:15	**BREAKOUT GROUPS: Strategies Part 2 – Short-term Strategy Recommendations**
3:15	**Break**
3:30	**PLENARY: Short-term Strategies Sharing Back**
3:45	**PLENARY: Scenario Planning Introduction -** *Carolyn Enquist, Southwest Climate Science Center*
4:30	**PLENARY: Next Steps and Closing Comments -** *Louise Misztal, Sky Island Alliance and Tahnee Robertson, SDR*
5:00pm	**Adjourn**

Appendix B: Workshop Participant List

Desert Landscape Conservation Cooperative

Madrean Watersheds Landscape Conservation Design

Wednesday and Thursday, September 21-22, 2016 --- 9AM–5PM

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Appendix C: Initial Recommendations on Integration of BLM REAs

The following synthesis was prepared to outline our understanding of the applicability of BLM Rapid Ecoregional Assessments to developing Landscape Conservation Designs in the Desert LCC. The BLM has completed three different Rapid Ecoregional Assessments that overlap pilot areas selected by the Desert LCC, at least to some extent.

Madrean Rapid Ecorogional Assessment

The Madrean Rapid Ecoregional Assessment (MAR REA**)** is an ecological assessment of selected Conservation Elements of the Madrean region of the U.S. and Mexico, but ultimately focused on the U.S. portion because of data availability issues. The area of study for the MAR REA very closely overlaps the U.S. portion of the Madrean Watersheds pilot area. This limitation of the MAR REA to the U.S. portion of the region is an important reality to remember with respect to integration with Landscape Conservation Design. Key to understanding the MAR REA is knowing that "management questions" from input of (primarily) BLM and Forest Service managers drove selection of Conservation Elements (CEs) by researchers. Conservation Elements are the core focal natural resources that were assessed within this ecoregion, they included: – habitats, ecosystems, and species, or other features. These CEs included identified ecological systems that were intended to be a representative cross-section of the region's diversity or are generally restricted to this ecoregion, as well as a suite of complementary and regionally significant species that are representative of other environments that were not adequately reflected by the ecological system types or that span ecological system types. The ecosystem CEs for were selected from NatureServe's classification of terrestrial ecological systems (Comer et al. 2003). A terrestrial ecological system is defined as a group of plant community types that tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients. This NatureServe product is unique and useful, but it has limitations with riparian systems, especially where lowland riparian forest types, including mesquite bosque, are lumped together, and thus do not represent riparian gallery forests (i.e. cottonwood/willow) well.

The total number of CEs ultimately assessed (modeled) were 11 ecological systems and 8 species. The MAR REA completed standard assessments for each CE, which included: calculating **ecological status of each CE**, **overall ecological integrity of the ecoregion**, and **climate change trends** (recent, future, CE intersected with future climate, and bio-climate envelope models). Special Assessments to address management issues were also completed for: 1) **Development (including solar)**; 2) **Mesquite Scrub Expansion**; and **Soil Erosion Potential**.

The REA provides an assessment of ecological condition based on combined indicators that represent Change Agents (often stressors), described in figures as "full scenarios". These indicators are those "measures" derivable from remote sensing or ecoregion wide monitoring programs, an important point to remember. In the Madrean region these indicators fall primarily to **three main terrestrial indictors: Development, Invasive species, and Fire regime departure. Aquatic indicators consist of: Endangered species, Native fish, Index of aquatic macroinvertebrates, Non-native invasive species, Presence of bullfrogs & crayfish, Combined total surface and groundwater use by groundwater basin or County, Proper Function Condition Assessment, Aquatic Habitat Quality Assessment** (note these last two indicators are BLM and FS agency riparian/aquatic monitoring protocols that are very weakly distributed

across the landscape and I would advise great caution extrapolating them beyond their origin of measurement).

Mohave Basin and Range Rapid Ecoregional Assessment

The Mohave Basin and Range Rapid Ecoregional Assessment (MBR REA) is an assessment of selected Conservation Elements of the Mojave region of the U.S., essentially covering the southern third of Nevada, much of southeastern California, northwestern Arizona, and a small corner of southwest Utah. The MBR REA overlaps with the Mojave pilot area that is currently undergoing Landscape Conservation Design development within the Desert LCC. Key to understanding the MBR REA is knowing that "management questions" from input of (primarily) BLM drove what Conservation Elements (CEs) were selected by researchers.

Conservation Elements are the core focal natural resources that were assessed within this ecoregion, they included: habitats, ecosystems, and species, or other features. These CEs included identified ecological systems that were intended to be a representative cross-section of the region's diversity or are generally restricted to this ecoregion, as well as a suite of complementary and regionally significant species that are representative of other environments that were not adequately reflected by the ecological system types or that span ecological system types. The ecosystem conservation elements for the MBR REA were selected from NatureServe's classification of terrestrial ecological systems (Comer et al. 2003). A terrestrial ecological system is defined as a group of plant community types that tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients. This NatureServe product is unique and useful, but it does have limitations on riparian systems. In their attempt for added value they segmented their riparian cover class using SSURGO and STATSGO, where available, for depicting hydric soils with natural land cover. Further, National Wetland Inventory (NWI) was used as additional back-up for wetland locations, and NHD Plus (1:100K and 1:24K scale data) was used for streams, lakes, intermittent washes, and playas.

The total number of CEs ultimately assessed (modeled) were 19 ecological systems, 7 soil types, 9 Terrestrial Habitat-bases Species Assemblages, 28 Landscape Species, and 306 local species. The MBR REA assessment included what they termed standard assessments, which included: calculating **ecological status of each CE**, **overall ecological integrity of the ecoregion**, and **climate change trends** (recent, future, CE intersected with future climate, and bio-climate envelope models). Southwest ReGAP maps provided the starting point for most landscape species, with existing habitat location/ suitability models available for all but the California portion of their distribution. For ecologically-based species assemblages, Maximum Entropy (Maxent) was used with available georeferenced observations to produce a probability surface for suitable habitat that might support a given CE. Local species data were derived primarily from field observations and/or Element Occurrence records from Natural Heritage programs.

The MBR REA is providing an assessment of ecological condition based on these combined indicators representing Change Agents (often stressors). Change Agents in the Mohave include: Wildland Fire, Development, Invasive Species, and Climate Change. Indicators are those "measures" derivable from remote sensing or ecoregion wide monitoring programs, an important point to remember. In the Mohave region these indicators fall primarily to **three main terrestrial indictors: Landscape Condition,**

Invasive Annual Grass, and Fire Regime Departure. **Aquatic indicators consist of: Hydrologic Condition and Water Quality.** Unprotected Places (Places 1) of high biodiversity were analyzed against a Protected Lands layer (GAP Status 1 and 2). Much of the analyses in this REA were presented at the 5th level watershed, which is a scale choice that may or may not be appropriate with assessments of larger landscape analysis.

Sonoran Desert Rapid Ecoregional Assessment

The Sonoran Desert Rapid Ecoregional Assessment (SOD REA) is an ecological assessment of selected Conservation Elements of the Sonoran Desert region of the U.S. and Mexico, but ultimately focused on the U.S. portion because of data availability issues. This is an important reality to remember with the DLCC LCD goals ahead. Key to understanding the SOD REA is knowing the regional management questions from input of (primarily) BLM drove what Conservation Elements (CEs) were selected by researchers. Conservation Elements are the core focal natural resources that were assessed within this ecoregion, they included: habitats, ecosystems, and species, or other features. These CEs included identified ecological systems that were intended to be a representative cross-section of the region's diversity or are generally restricted to this ecoregion, as well as a suite of complementary and regionally significant species that are representative of other environments that were not adequately reflected by the ecological system types or that span ecological system types. The ecosystem conservation elements for the SOD REA were selected from NatureServe's classification of terrestrial ecological systems (Comer et al. 2003), LANDFIRE existing vegetation type (EVT), and LANDFIRE Biophysical Settings (BpS) data sets. A terrestrial ecological system is defined as a group of plant community types that tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients. NatureServe and LANDFIRE EVT were used to determine current vegetation communities, but LANDFIRE BpS historic vegetation reference was used to compare with LANDFIRE EVT.

The total number of CEs ultimately assessed (modeled) were 3 ecological systems and 11 species. The SOD REA assessment included what they termed coarse-filter elements for Ecological System CEs, which included: calculating **ecological intactness of each CE**, **existing vegetation community status**, and **effect of disturbance** (recent, future, development). Species CEs were included using fine-filter elements which included: calculating **Current distribution of each CE, Areas of connectivity**, **Biodiversity site location,** and **HMA (Herd Management Areas) locations.**

The REA is providing an assessment of ecological condition based on these combined indicators representing Change Agents (often stressors). These indicators are those "measures" derivable from remote sensing or ecoregion wide monitoring programs, an important point to remember. In the Sonoran Desert region these indicators fall primarily to **four main terrestrial indictors: Development, Invasive species, Climate Change, and Fire Regime Departure**. **Aquatic indicators consist of: Endangered Species, Native Fish, Non-native Invasive Species, Altered Flow Regimes,** and **Change in Riparian Community Composition**.