Gulf Coast Prairie Landscape Conservation Cooperative
Science Strategy
FINAL - August 1, 2014

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1. Background & Purpose

The Gulf Coast Prairie Landscape Conservation Cooperative (GCP LCC) Mission is to: *sustain, protect and conserve natural and cultural resources in the Gulf Coast Prairie landscape/geography in the face of such threats and stressors as climate change, population growth that brings increased demand for water and other resources, and urbanization*. To meet this purpose, the GCP LCC Partnership provides scientific and technical support, coordination, and communication to the conservation community while fostering cooperative capacity and facilitating the refinement of that purpose through adaptive management.

This document fulfills a need identified by the GCP LCC Steering Committee to have a Science Strategy that is based on the Strategic Habitat Conservation (SHC) framework and integrated with the Human Dimensions efforts of the GCP LCC. The implementation of this Strategy is the responsibility of the GCP LCC Partnership with the Science Team providing technical support. This effort builds upon the 2011 Strike Team Priorities, the 2012 Science Forum, the Focal Species work, and the ongoing science projects the LCC has invested in.

This Strategy identifies key science needs and suggestions for where collective efforts are best employed. It demonstrates where the GCP LCC can bring value to the partners and harness the synergy that comes from having a Partnership where the collective impact is greater than the sum of the individual partners. The GCP LCC Partnership has a clear role in integrating objectives and priorities for multiple species and directing conservation efforts towards areas where conservation activities can influence a variety of species.

GCP LCC Vision: The GCP LCC is a Collaborative Partnership of agencies, tribes, and organizations working together, realizing common goals, and having a cooperative determination to enhance cultural and natural resource conservation and sustainability across the landscape. By sharing knowledge and building a greater "collective" of resources, we can improve conservation outcomes.

2. Intent of the Science Strategy

This Science Strategy was developed by the Science Team through a collaborative process. Input and expertise was also sought from conservation and species experts throughout the LCC geography and beyond. It is meant to be a living document that will provide strategic guidance for the next five years.

This document sets the stage for a more concerted Partnership effort on implementing SHC using the focal species identified by the GCP LCC. In short, this strategy:

- Informs science investment decisions going forward
- Informs science-based strategies for targeting and conserving habitats for Focal Species through Landscape Conservation Design as part of SHC

- Identifies desired ecological conditions of the broadly defined habitats within the GCP LCC for the Focal Species identified in this Strategy, focusing on Tier 1 species first
- Identifies means to help partners: (1) organize known and needed information and data; (2) acquire climate, habitat, and species data at relevant scales; (3) measure, model, and monitor effects of stressors on ecological systems, habitats, communities, and species; and (4) target and facilitate implementation of effective management strategies and conservation measures to reinforce ecosystem resiliency

The Partnership intends to implement SHC as the framework for achieving functional[1] landscapes across the GCP geography, which includes identifying, developing and providing tools to help guide conservation decisions for the partners.

3. The Evolution and Roles of the Science Team

The Science Team is charged by the Steering Committee to maintain and continually provide the best available science and information to guide the Partnership. The Science Team is composed of members who lend their perspectives, experiences, knowledge, and qualifications to the GCP LCC Partnership. The effectiveness of the Team is dependent on the active contribution and commitment of the partners and the individuals that compose the Partnership.

Early in the inception of the GCP LCC, a *Science Strike Team* was organized to develop and identify high priority science needs. This led to the Science Forum held in Fort Worth in February 2012 (See Appendix A).This forum assembled an invited group of scientists, researchers, and managers from across the GCP LCC to: (a) implement the first step in a priority science needs process; and, (b) identify and prioritize scientific information and decision support tool needs to address conservation challenges and opportunities that the LCC Partnership could provide to support conservation actions by the individual partner organizations. The resulting portfolio of science needs served as a critical guiding framework to facilitate and support conservation planning, delivery, and applied research and monitoring efforts of the GCP LCC.

The membership of the first official Science Team was decided at the June 2012 Steering Committee meeting. One of the first tasks given to the Science Team was to develop the Focal Species list, a key step in implementation of SHC, which was approved by the Steering Committee in January 2014.[2] The other key roles of the Science Team to date have been the development of this Strategy, participation in the development, oversight, and review of the science projects funded through the GCP LCC, and provision of technical assistance to the

[1]The USFWS defines functional landscapes as lands and waters with the properties and elements required to support desirable populations of fish and wildlife, while also providing human society with desired goods and services, including food, fiber, water, energy, and living space.

[2] See section 6 of this strategy for the Focal Species List. A more complete overview can be found in the Summary Report: *Gulf Coast Prairie LCC: Focal Species & Associated Habitats: Summary*. January 21, 2014.

Partnership. In addition to the formal Team members there are numerous species and habitat experts who regularly contribute to the efforts of the GCP LCC (Appendix E).

The Science Team will continue to serve as a core team to provide technical assistance regarding the implementation of this Science Strategy and provide recommendations to the Steering Committee. The core Science Team is augmented by species and habitat experts as well as individuals with experience in implementation of SHC. The Science Team will be actively engaged in developing projects that address the science needs identified in this Strategy. For projects directly funded by GCP LCC funds, the Science Team members will: (a) develop criteria by which project proposals are scored; (b) develop the targeted Requests for Proposals (RFPs) in consultation with the Steering Committee; (c) review project proposals; and, (d) provide ongoing oversight of the resultant projects. Each project will have a Technical Review Team in place, which includes Science Team members and additional expertise as needed.[3] The Science Team will seek opportunities to pursue other collaborative science efforts in furtherance of this strategy, irrespective of funding source, including options to engage Climate Science Centers.

The successful implementation of this Strategy requires the ability to leverage the capability of the Science Team and broaden the influence of the Partnership. The Science Team is a small body of individuals who have a key responsibility in advancing this Strategy but we also need to bring additional capacity to achieve the Vision of the Partnership – this begins with the Science Team and the Steering Committee but will need to be expanded beyond those entities. The concept of roles and linkages is explored more in Section 10.

4. Projects to Date

The GCP LCC has directly supported ten science projects as well as the development of several tools to aid in conservation delivery. Several additional projects that address GCP LCC partner priorities have been funded through the South Central and Southeast Climate Science Centers. The science needs that these projects address were identified and refined through the *Strike Team* and efforts at the 2012 Forum along with ongoing work through projects like the Gulf Coast Vulnerability Assessment (GCVA). Ongoing efforts include the dissemination of the information and products produced within these projects along with clarification of any additional science needs identified during the course of their completion.

The first six projects funded through the GCP LCC were fully implemented by 2012:

1) *Spatially-explicit Decision Support Tool for Guiding Habitat Conservation for Western Gulf Coast Mottled Ducks*. Principal Investigator, Bart Ballard (Texas A & M University).

[3] Additional information on Technical Review Teams can be found in Appendix F.

2) *Employing the Conservation Design Approach on Sea-Level Rise Impacts on Coastal Avian Habitats along the Central Texas Coast*. Principal Investigator, Elizabeth Smith (International Crane Foundation).
3) *Managing In-stream Flows and Developing Hydrologic Information for the Gulf Coast Prairie Landscape Conservation Cooperative*. Principal Investigator, Scott Robinson (Southeast Aquatic Resources Partnership).
4) *"Common Ground" Landcover Classification: Oklahoma Ecological Systems Mapping*. Principal Investigator, Allan Janus (Oklahoma Department of Wildlife Conservation).
5) *A Conservation Framework for Priority Species of Grassland-Shrublands of the Southern Great Plains*. Principal Investigator: Michael Morrison (Texas A&M University).
6) *Riparian Corridor Re-Vegetation & Restoration Design in the Tamaulipan Brushlands and Gulf Coast Prairie Bird Conservation Regions*. Principal Investigator, Timothy Brush (University of Texas-Pan American).

Four additional projects were initiated in 2013:

1) *Evaluation of Regional Sea Level Affecting Marshes Model (SLAMM)*. Principal Investigator, Jonathan Clough (Warren Pinnacle Consulting).
2) *Barrier Island Vulnerability Data Integration and Assessment Research Focus: Gulf of Mexico barrier islands*. Principal Investigator, James Gibeaut (Harte Research Institute).
3) *Grassland Decision Support Tool*. Principal Investigator, David Diamond (Missouri Resource Assessment Partnership).
4) *Use of River-Reservoir Interface Habitats by Larval and Juvenile Fishes: Influence of Lateral Connectivity and Multi-scale Environmental Conditions*. Principal Investigator, Allison A. Pease (Texas Tech University).

More comprehensive descriptions of the projects to date are included in Appendix D. Information and data derived from these efforts will be stored on the Gulf Coast Prairie LCC Website and Conservation Planning Atlas.[4]

5. Strategic Habitat Conservation[5]

The GCP LCC is committed to operating under the adaptive management concept of the Strategic Habitat Conservation (SHC) philosophy to provide the best available science as the foundation in delivering a coordinated approach to meeting conservation needs. SHC is at the core of what the LCCs were designed to do, although there remains some confusion about what

[4] See: gcplcc.databasin.org.
[5] This section is primarily based on the USFWS Strategic Habitat Conservation Handbook: *A Guide to Implementing the Technical Elements of Strategic Habitat Conservation (Version 1.0).* Report from the National Technical Assistance Team. February 2008. More information on the SHC framework can be found at: http://www.fws.gov/landscape-conservation/shc.html

that really means. The most important aspect is the linkage between species population objectives[6]and habitat – the core of SHC. SHC is a method by which to do environmental accounting – making the linkages between objectives, options to achieve those objectives through habitat conservation and management, actions, monitoring, and additional research.

SHC builds on the adage of 'what gets measured gets managed'. It has also been identified as a form of 'environmental accounting' that enables people working in this field to know when they are making progress. Figure 1 below illustrates the SHC 'wheel' – it is important to recognize that, depending on the species and habitats of concern, science needs will not always be identified linearly. For example, conservation delivery need not wait until all sub-elements of biological planning and conservation design are complete, and assumption-based research can be employed at any time to address documented uncertainties. On the other hand, assumption-based research must be preceded by development of explicit assumptions, and outcome-based monitoring must be based on outcomes that are planned for or predicted.

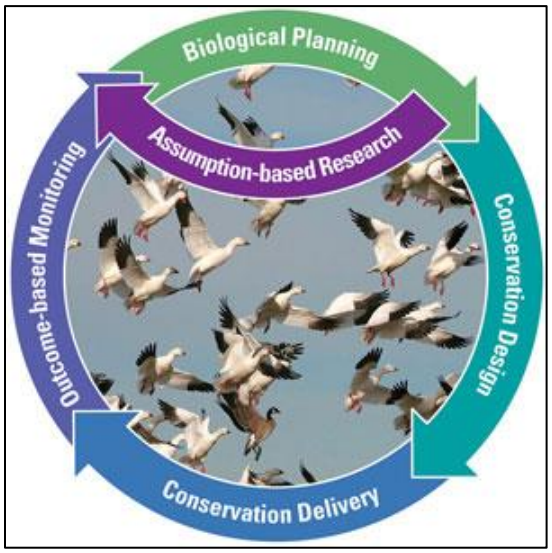


Figure 1: The SHC Wheel

Although the SHC framework does not work perfectly for all conservation activities, it is generally a good framework, in part because it is not linear but an adaptive and dynamic process. This section outlines the core elements of SHC and the role of the LCC Partnership in utilizing SHC to advance conservation across our geography. The Steering Committee decided that once sufficient progress is being made on the SHC framework for Focal Species to ascertain the degree to which important landscape characteristics will be addressed, they will then

[6]Population refers not only to abundance and in some cases objectives will be centered on factors such as mortality, recruitment, genetic purity, etc.

consider whether any additional desired ecological conditions or additional conservation endpoints are necessary.

As illustrated in Figure 1 there are five key components of the SHC framework. The Science needs are identified for the Tier 1 Focal Species and organized by SHC component to help demonstrate where the partnership is focusing its efforts to advance species and associated habitat needs within the SHC Framework.

a. *Biological Planning*: involves setting measurable biological objectives for selected conservation targets. The selection of initial "conservation targets" has been accomplished within the GCP LCC Partnership with the January 2014 approval of the Focal Species List. The next step is identifying biological objectives, assessing limiting factors, and synthesizing available information into models that relate population needs with habitat objectives.

b. *Conservation Design*: involves combining geospatial data with biological information and models from the biological planning phase to create tools such as maps that evaluate the potential of selected habitat areas to support a species population. These tools can then be used to determine the current habitat capability and its potential. Integrating species- or guild-specific models into a landscape design yields spatial guidance about the kind, quantity, and configuration of habitat needed. This information then informs conservation delivery decisions.

c. *Conservation Delivery*: involves using the products of the design effort to target conservation practices to those areas that best enhance habitat across the landscape for the suite of focal species. This involves influencing human behaviour through incentives and information as well as direct conservation activities such as wetland restoration and conservation easements. Several of the partners within the GCP LCC engage directly in conservation delivery and in most instances the role of the broader Partnership is to support all aspects of SHC, including making existing delivery efforts more efficient and coordinated across the partners. Several of the GCP LCC science projects will produce information to help partners make more informed program delivery options.

d. *Outcome-based Monitoring*: helps us track landscape and population change relative to established objectives or predicted conditions, as well as measuring programmatic delivery contributions toward landscape-level objectives. For example, the GCP LCC Partnership has already invested in the development of the Grassland Management Inventory Tool (GMIT) to help support partners monitoring progress towards their habitat conservation objectives for quail and grassland bird species. This step enables partners to determine whether the process was effective in meeting the outcome, and what adjustments may need to be made.

e. *Assumption driven research*: there are many assumptions made during habitat conservation planning regarding species population responses, limiting factors, species-habitat relationships, ability to deliver programs, and public support for conservation efforts. This step enables partners to evaluate these explicit assumptions and refine objectives in subsequent planning iterations, and determine whether the conservation planning and delivery process was effective in meeting the outcome.

The role of the GCP LCC Partnership is in developing the science to inform and support conservation efforts for the identified focal species, coordinating efforts of the partners where needed, and coordinating partner funding of science needs.

6. Science Strategy Implementation – *Advancing Conservation Efforts*

This Section includes a summary of the science needs for each of the Top Tier Focal Species and begins to identify where the Partnership needs to focus efforts toward advancing SHC and achieving outcomes to aid conservation of these species. More detailed information on each of the Top Tier Focal Species is included in Appendix B.

The first step in SHC has been completed with the identification of the following 28 focal species that will be used as a foundation for defining functional landscapes and focusing (refining) priority science needs. These species have been separated into Tiers as a means to focus efforts on a subset of species recognizing that species assemblages may be used depending on the science needs being addressed at any given time.

In order to make a change to this list, the Science Team will need to come to consensus and present the recommended change to the Steering Committee for approval. The Science Team will need to evaluate the addition of a species using the same criteria used to develop this initial list. Removal of a species is expected to be very rare, but would be considered if, for example, assumption-driven research elucidated that the species' limiting factor was already addressed by another focal species or could not be addressed through conservation actions. Consideration of removal of a species would occur only after the Science Team provided justification to the Steering Committee. The Science Team would need to provide the Steering Committee with the logic for the decision and identify how the change would better characterize the landscape condition desired by the Partnership. Ideally the addition of a species would be accompanied by the removal of another, but that will not necessarily be the case.

This list has been separated into three ‘Tiers’ that reflect the Science Team’s assessment of where LCC science support efforts should first be directed given criteria including, but not limited to, respresentativeness across habitats, ongoing efforts, and immediacy of need. Tier 1 includes 6 species; Tier 2 includes 12 species and Tier 3 includes the remaining 10 species. In some cases, GCP LCC efforts, including science projects, may focus on the use of species assemblages that would see species across Tiers being addressed. For example, a ‘grasslands’ species assemblage could include Northern Bobwhite and Eastern Meadowlark while a ‘coastal’ species assemblage could include American Oyster, Blue Crab, and Penaeid Shrimp.

Tier	Species Common Name
1	Alligator Gar
	American Oyster
	Guadalupe Bass
	Mottled Duck
	Northern Bobwhite
	Quadrula spp. (freshwater mussels)[7]
2	Black Skimmer
	Blue Crab
	Broadcast-spawning Prairie Minnows[8]
	Brown Pelican
	Eastern Meadowlark
	Eurycea spp. (salamanders)[9]
	Golden-cheeked Warbler
	Little Blue Heron
	Penaeid Shrimp[10]
	Red-billed Pigeon
	Sea Turtles[11]
	White Bass
3	Black-capped Vireo
	Brazilian (Mexican) Free-tailed Bat
	Crawfish Frog
	Diamondback Terrapin
	Dionda spp. (minnows)[12]
	Gulf Menhaden
	Northern Pintail
	Rafinesque's Big-Eared Bat
	River Prawns
	White-tipped Dove

Table 1: GCP LCC Focal Species – *approved January 8, 2014 by the GCP LCC Steering Committee*

[7] Quadrula spp. includes: Golden Orb, Smooth Pimpleback, Texas Pimpleback, Winged Mapleleaf, and Wartyback

[8] Guild represented by Small eyed shiner, Red River shiner, Sharpnose shiner, Arkansas River shiner, Chub shiner, Silverband shiner, Tamaulipas shiner, Rio Grande shiner, Sabine shiner, all Macrhybopsis spp. including the M. species clade and Silver Chub), Plains minnow, Rio Grande silvery minnow , and Mississippi silvery minnow

[9] Eurycea spp. includes the following salamanders: the Salado Springs, Cascade Caverns, San Marcos, Georgetown , Texas, Blanco River springs, Texas blind, Blanco blind, Barton Springs, Jollyville Plateau, Comal blind, and Austin blind

[10] Penaeid shrimp includes Brown, White, and Pink shrimp

[11] Sea turtles includes the Green Sea Turtle and the Kemp's Ridley Sea Turtle

[12] Dionda spp. includes the following minnows: Devil's River, Manantial Roundnose, Nueces Roundnose, Spotted, Guadalupe Roundnose, and Roundnose

A. Science Needs going forward – *Advancing SHC: Tier 1 Focal Species*

The following section summarizes the science needs for the first six species of focus: Alligator Gar, American Oyster, Guadalupe Bass, Mottled Duck, Northern Bobwhite, and Quadrula spp. Appendix B includes the complete explanation of these needs structured by the SHC framework components. Each species requires attention at different spots on the SHC 'wheel'. Through evaluation of these needs we can better determine where the synergies are in terms of habitat needs, identification of priority areas for conservation, and similar threats.

Population objectives for these species were provided through partners who focus on certain species, including Joint Ventures for avian species and Fish Habitat Partnerships for freshwater fish. The GCP LCC strives to coordinate efforts among the partners, rather than duplicating or developing new population objectives where they already exist.

Alligator Gar

Alligator Gar populations are believed to be declining throughout much of their historical range. The severity of these declines is unknown. Habitat alteration and overfishing are believed to be partially responsible.[13] Although Alligator Gar are found in several habitat types across the LCC, the primary limiting factor is suitable spawning habitat and conditions for recruitment, which have been compromised through disruption and fragmentation of river-floodplain corridors, flow alteration, and loss of connectivity with backwater spawning areas. Alligator Gar spawn in tributaries and inundated floodplain habitats depositing eggs on inundated terrestrial vegetation. Timing (during spawning months, April to June) and duration of inundation (short duration could strand adults and/or desiccate eggs) are also important. Within river systems, reduced high flow pulses and overbank flow magnitudes limit hydrologic connectivity to floodplain habitats reducing Alligator Gar spawning habitat and conditions for recruitment.

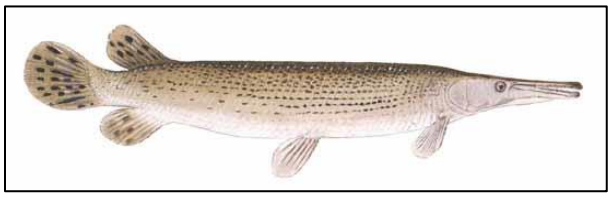
Sustaining Alligator Gar populations implies addressing longevity with a target longevity (age at which 1% of the recruits remain) of at least 40 years with a minimum of one strong year class per decade. For a population to have longevity of 40 years, total annual mortality must average less than 11%. Because of apparent genetic variability among river basins, a target of sustaining a minimum of one Alligator Gar population per basin in which they are native is recommended.

Regarding *Conservation Design*, results from a recently completed study in Mississippi indicate the warmest portions of the floodplain that are inundated roughly 50% of the time and are open canopy may be the most important for spawning Alligator Gar.[14] The analysis indicated that

[13] Ferrara, A. M. 2001. Life-history strategy of Lepisosteidae: implications for the conservation and management of Alligator Gar. Doctoral dissertation. Auburn University, Alabama.
[14] Allen et al. 2014.

when water is present at the right time, mowed fallow fields, moist soil units, and barren dirt with vegetation at field edges seemed to provide the structure and temperature to support gar spawning. A key science need is to expand this work on flood inundation west into the GCP LCC. Estimations of stage-specific spawning habitat suitability models are possible with the methodology used in the Mississippi study; however, data would need to be extrapolated for stages not available within imagery databases.

Priority habitat areas should include known spawning and nursery areas such as backwaters and floodplain areas, including oxbow lakes, with restoration of habitat focused on reconnecting main river channels with high quality floodplain and backwater spawning areas. While we know the fish spawn in inundated terrestrial vegetation, little is known about conditions needed for successful recruitment. The ongoing GCP LCC project looking at the River-Reservoir Interface may assist in answering questions about that habitat specifically. The Texas In-stream Flow Program (TIFP) is currently conducting in-stream flow studies in the Guadalupe and Trinity Rivers; efforts to monitor flows will inform population objectives. These efforts will be used to determine additional monitoring needs for the species.



Alligator Gar – source: TPWD

American Oyster

American Oysters are unique in that they effectively create an important habitat type through shell deposits, provided hard substrate exists for oyster spat to settle on initially. American Oyster population dynamics are critically dependent upon water quality (salinity, depth, temperature), which is predicted to change with climate and local management activities. Oysters also need sufficient water exchange to provide food, and suitable hard substrate for spat settlement/attachment. Maximum oyster abundance occurs within brackish waters and is influenced by a physiological intolerance to low salinity (which varies with temperature and duration of low salinity condition), and high predation and diseases which are prevalent in high salinity areas in some areas in the Gulf. Although somewhat different for populations in Texas and Louisiana, the threats to American Oyster populations can generally be summarized as: salinity and temperature changes due to circulation changes, acidification of estuarine waters, hurricanes (including sedimentation), dredging of shell reefs, disease, oil spills, harvest pressure, and predation.

In applying the SHC framework to oysters, care needs to be taken to differentiate between commercial (harvestable) population objectives, those that sustain individuals of the population,

and those that sustain oyster reef accretion. While these three objectives overlap from a conservation perspective, each has associated unique factors or issues. The 2012 Gulf States Marine Fisheries Commission Oyster Fishery Management Plan includes the following management objective: "The goal of this plan is to provide management strategies that ensure the maintenance and health of oyster stocks and oyster habitat, and ensure the sustainability of the fishery. An additional management goal is the maintenance of ecosystem services provided by healthy oyster reefs within the management unit. Ecosystem management must include oysters as habitat, a biological resource, a fishery resource, and an essential part of the environmental process." [15] American oyster production and the associated commercial harvesting makes this species an important element of many coastal communities, which may result in additional effort put into human dimensions aspects.

Work is ongoing to develop spatially explicit models for oysters including The Nature Conservancy's preliminary oyster restoration suitability index[16,17] and Dr. Jennifer Pollack's detailed restoration suitability index for the Mission-Aransas Estuary.[18] The Gulf Coast Vulnerability Assessment also includes development of a Conceptual Ecosystem Model for Oyster Reefs to assess vulnerability across the Gulf. Freshwater inflows are a key component of habitat suitability, with the issues surrounding flow varying from too much in parts of southeast Louisiana to not enough for extended periods along the Texas mid coast.

Understanding oyster reefs is critical to the needs of the species and the habitat those reefs provide for other species. Texas Parks and Wildlife Department (TPWD) has completed mapping efforts for oyster reefs in Sabine Lake, Copano Bay, and most of Galveston Bay using high resolution side scan sonar. But across Louisiana, basic bottom mapping is missing. Ongoing reef restoration projects are occurring in Galveston, Copano, Aransas,[19] and Matagorda bays in Texas; and Vermilion Bay and Grand Isle in Louisiana.[20]

Extensive oyster reef rehabilitation is occurring in Louisiana in response to impacts from the 2010 Deepwater Horizon oil spill. The Louisiana Department of Wildlife and Fisheries (LDWF) website includes a list of reefs being worked on through their 'Inshore Reef Program'.

[15] VanderKooy, S. (editor). 2012. The Oyster Fishery of the Gulf of Mexico United States: A Regional Management Plan – 2012 Revision. Publication No. 202, Gulf States Marine Fisheries Commission, Ocean Springs, Mississippi.
[16] See: http://maps.coastalresilience.org/gulfmex/.
[17] A more comprehensive Oyster Habitat and Restoration Suitability Model has been developed through the TNC Texas Marine Program. It is currently in draft form.
[18] Beseres Pollack J, Cleveland A, Palmer TA, Reisinger AS, Montagna PA (2012).A restoration suitability index model for the eastern oyster (Crassostrea virginica) in the Mission-Aransas Estuary, TX, USA. PLoS ONE 7(7): e40839. doi: 10.1371/journal.pone.0040839.
[19] Dr. Jennifer Pollack, TAMU-CC.
[20] TNC.

Science needs related to quantification and prioritization of habitat needs for American Oyster include:

- continuation of meta-population efforts to evaluate the dynamics of populations and the influence of no-take reefs that could serve as nurseries. Meta-populations typically have a source population that, if damaged, can affect the overall (meta) population
- monitoring the effectiveness of ongoing restoration efforts to determine oyster tolerance to changes in water quality and adaptive capacity under predicted climate change scenarios
- monitoring flow rates (freshwater inflows), water quality and circulation patterns, including improved analysis of food resources in the bays and how those affect oyster feeding, all of which have a direct impact on the oyster suitability index for restoration. This will require adequate reef mapping work, particularly in Louisiana.

American Oyster – source: gulffishinfo.org

Guadalupe Bass

The Guadalupe Bass is a native black bass species endemic to Texas that has been identified as a species of greatest conservation need by TPWD. It is found primarily in the Edwards Plateau Ecoregion. Population objectives include: 7 to 10 self-sustaining, genetically pure populations; [21] and a 30% increase in distribution of pure Guadalupe Bass populations to conserve existing genetically pure populations.

Guadalupe Bass are susceptible to the threat of flow alteration given the impacts from new and existing water supply projects on streams in their distribution range and the Edwards Aquifer.[22]The area encompassing the range of Guadalupe Bass is projected to experience some of the highest population growth in Texas over the next 25-50 years placing increased demands on the aquifers and watersheds of the Edwards Plateau[23] and altering land use patterns throughout the region. How these changes and other urbanization effects such as eutrophication and hydrological alteration affect stream fishes, and Guadalupe Bass in particular, is not known and represents a significant information gap in the understanding of the

[21] This is the population goal set in the NFWF Native Black Bass Restoration Business Plan.
[22]Texas Water Development Board 2012
[23] Texas Water Development Board 2012

threats to Guadalupe Bass. Persistent low flow conditions from water withdrawals and drought can alter the availability, productivity, connectivity, and accessibility of riffle-run complexes, forcing individuals into pool habitats and increasing the potential for predation by or competition with Largemouth Bass. Dr. Timothy Grabowski at Texas Tech University is leading an effort looking at the effects of urbanization on Guadalupe Bass populations in the Colorado River watershed on and off the Edwards Plateau. Recently, the State of Texas instituted environmental flow standards, applicable to new water development projects, which need to be evaluated for effectiveness in maintaining Guadalupe Bass populations.

Most Guadalupe Bass populations have experienced some level of hybridization with introduced Smallmouth Bass.[24] Interspecific hybridization became a threat when Smallmouth Bass was introduced, beginning in the 1950's. The consequences of this hybridization on the sensitivity of affected populations to disturbance are unknown.[25]

In terms of Conservation Design, Guadalupe Bass habitat needs could be woven into an overall design for the Edwards Plateau, linking headwaters habitats to streams, rivers, and riparian areas – and downstream to the Gulf Coast to capture the needs of other Focal Species. This effort would include mapping current distribution and prioritizing areas for conservation to address the needs of multiple species identified through the GCP LCC partnership. This should incorporate ongoing Watershed Management Plans underway in the South Llano, James, Pedernales and Blanco watersheds. Guadalupe Bass are negatively affected by siltation and physical changes in the environment due to dams. Removing dams in Texas could be a conservation delivery option, albeit a complex one given competing interests. The first dam removal project in Texas (Ottine Dam on the San Marcos River) was just initiated in 2013.

Building on the existing GCP LCC Southeast Aquatic Resources Partnership (SARP) instream flow project, three of the most important science needs for Guadalupe Bass are to better determine the relationship between flow and growth, availability of habitat, and reproductive success and recruitment in order to test the project's Guadalupe Bass flow-ecology hypotheses (hypotheses F.4.a, F.4.b., F.4.c.).[26]

Furthermore, assuming that urbanization will have a negative impact on Guadalupe Bass, additional research is necessary to:

- fill existing gaps in understanding and to refine restoration activities
- determine the influence of local and regional factors on multiple scales, including Guadalupe Bass populations and other aquatic communities within their range
- monitor the efficacy and efficiency of restoration activities

[24]Whitmore et al. 1982; Whitmore 1983; Bean 2012
[25]Bean 2012
[26] *Gulf Coast Prairie Landscape Conservation Cooperative Regional Hypotheses of Flow Alteration*. A report by the GCP LCC Flow-Ecology Hypotheses Committee. Edited by M. Davis and S.K. Brewer. May 2014.

Guadalupe Bass – source: TPWD

Mottled Duck

Mottled Ducks (MODU) are year-round residents of coastal marshes and prairies in the Western Gulf Coast (WGC), a focal species for the U.S. Fish and Wildlife Service, and a priority species in the Texas and Louisiana Comprehensive Wildlife Action Plans. The WGC accounts for approximately 80-90% of the world population of this species. Available population survey data suggest the WGC Mottled Duck population has experienced a long-term steep decline in Texas, is stable or slightly increasing in Louisiana, and is stable to declining across the entire WGC range. Conversion and degradation of important wetland and upland habitats are believed largely responsible for historical declines in MODU abundance.

Population targets to guide conservation (i.e., objectives) are available from the *Gulf Coast Joint Venture (GCJV) Mottled Duck Conservation Plan*.[27]The GCJV's existing MODU population targets are based on the long-term average of Mid-Winter Survey (MWS) estimates in the coastal zones of Louisiana, Texas, Mississippi, and Alabama from 1971 – 2004. There are three geographically based components of the GCJV Mottled Duck population target, each of equal importance: WGC Total (105,816), Texas (35,322), and Louisiana (70,132). A priority planning need is to revisit this objective in light of the availability of a breeding population survey designed specifically for the species, and translate the existing winter objective into a breeding objective that can be monitored via the improved range wide breeding population survey, which has been developed and operationalized since 2010.

In terms of habitat objectives, bioenergetics models can be used to link dietary energy demands during winter (food availability presumed to be most important habitat consideration during that period of annual cycle) to habitat objectives, but objectives for breeding habitat are currently not available due to difficulty linking breeding habitat conditions to population abundance and/or vital rates. Quantifying the linkages between population vital rates and habitat requirements is a key science need.

Because of limited conservation resources and continued habitat threats, maximizing the biological impact of current and future conservation delivery efforts is a high priority. The

[27] Wilson, B.C. 2007. North American Waterfowl Management Plan, Gulf Coast Joint Venture: Mottled Duck Conservation Plan. North American Waterfowl Management Plan, Albuquerque, NM.27 pp. + appendixes.

MODU is the subject of an ongoing GCP LCC Science Project being led by Dr. Bart Ballard[28] to develop a spatially-explicit Decision Support Tool (DST). This DST will reflect contemporary knowledge of the influence of habitat and landscape characteristics on breeding ecology, and will guide the spatial (i.e., where) and thematic (i.e., what kind) delivery of conservation activities to achieve the greatest population impact.

Barriers to conservation delivery include the availability of water for wetland management, economic sustainability of the rice industry (including competition for irrigation water), and implementation of conservation programs by private landowners. An improved understanding of the barriers to program implementation may be addressed through application of social science tools.

Priority science needs related to MODU habitat conservation in the WGC are addressed in the *GCJV Mottled Duck Conservation Plan* and *GCJV Waterfowl Science Needs* report.[29,30] While not necessarily exhaustive, the following represent some of the highest priority needs:

- estimating priority vital rates for MODU (e.g., breeding propensity, brood survival, nesting success, breeding season survival) and identifying environmental and habitat factors responsible for vital rate variation
- evaluating the effectiveness of wetland and grassland conservation strategies at impacting MODU vital rates
- establishing quantitative breeding habitat objectives based on understanding of relationships between vital rates and habitat/landscape conditions

Mottled Duck – source: DU

Northern Bobwhite

Population objectives for Northern Bobwhite (NOBO) are based on existing Gulf Coast Joint Venture (JV), Rio Grande JV and Oaks & Prairies JV partnership objectives. National planning efforts also exist within the National Bobwhite Conservation Initiative (NBCI), which provides

[28] Caesar Kleberg Wildlife Research Institute - Texas A&M – Kingsville
[29] Wilson, B.C. 2007.
[30] Brasher, M. G., J. D. James, and B. C. Wilson. 2012. Gulf Coast Joint Venture priority waterfowl science needs. Gulf Coast Joint Venture, Lafayette, LA, USA.54 pp.

population objectives in terms of 'coveys added' for applicable Bird Conservation Regions (BCRs). Because of the strong partnership linkages between the JVs and the efforts of the GCP LCC, the focus of this section is on the existing JV population objectives.[31]

The Oaks & Prairies JV population objective for NOBO (includes BCRs 20 and 21) is 343,425 additional individuals. This translates to a habitat objective of 1,144,752 hectares (2,828,743 acres) of new useable space.[32] The Rio Grande JV is in the process of determining focus grassland areas for the Tamaulipan Brushlands BCR (BCR 36) as well as habitat and population objectives for grassland bird species and NOBO. The GCJV's population objective for BCR 37 is to support 626,143 birds (~52,178 coveys). This would require improvements to approximately 2.9 million agricultural, rangeland and forested acres. For NOBO recovery efforts, agriculture is both a threat and an opportunity with well managed agricultural areas providing habitat.

Conservation Design uses the essential linkage between population objectives from the biological planning and the potential habitat distribution derived from GIS data to develop models to direct conservation activities. There has been a good deal of effort on NOBO including the identification of habitat objectives and focal areas in some ecoregions. The JV priority areas will be used for NOBO and refined through the adaptive management process through the JV partnerships. The JV efforts will continue to be supported by the LCC through conservation design efforts that incorporate the habitat needs of other non-avian focal species, evaluation and tracking of conservation delivery efforts, and the development of grassland DSTs.

There are several ongoing efforts focused on NOBO conservation, including the *Grassland Restoration Incentive Program* (OPJV and GCJV partnerships with TPWD), Oklahoma Department of Wildlife Conservation (ODWC), Local Quail Coalition Chapters, Wildlife Habitat Federation and efforts to improve grazing management in South Texas. Throughout the GCP LCC area, grazing can be potentially compatible with restoring and sustaining NOBO habitat if done correctly. Many areas of South Texas have swung from being over grazed to under-grazed during the past 20 years, with exotic and/or invasive grasses also needing attention in many areas.

One of the key barriers to conservation delivery is the ability to get fire on the landscape. A better understanding of these barriers is a key human dimensions science need that is beginning to be addressed through the GCP LCC Case Study on the *Human Dimensions of Fire*.

The GCP LCC will work with partners on continued development of the Grassland Decision Support Tool that can be used to improve biological planning, conservation design and delivery, and the monitoring of grassland species response to habitat changes. This includes continued improvement of the Grassland Management Inventory Tool (GMIT).

[31] For more information on the NBCI objectives, see http://bringbackbobwhites.org/.
[32] 171,713 territories at 6.7 hectares/territory (16 acres)

Additional assumptions regarding NOBO populations that require research include:

- assessment of how vital rates vary from large, contiguous NOBO habitat to fragmented areas of NOBO habitat
- quantifying how much of varying habitats (which types) are needed to sustain viable NOBO populations
- assessing the status of existing monitoring efforts required to determine success of habitat conservation

Northern Bobwhite – source: Audubon

Quadrula spp.[33]

There is a general lack of knowledge on the current status of most Quadrula spp. (freshwater mussels). For some river systems the last known surveys are more than twenty years old and in most cases it is impossible to determine population objectives due to a lack of knowledge regarding what a 'normal' population looks like in terms of recruitment, distribution, and life history.[34] A better understanding of the baseline population and the elements of a sustainable population are the primary science needs for this guild, including the results of ongoing genetic/molecular work that will be used to determine taxonomic identities and the need to combine or add species within the group.

Quadrula were chosen as a focal species in part because of their sensitivity to changes in water quality and quantity, making them akin to the proverbial 'canary in the coal mine'. The threats to this guild are primarily caused by human population growth and the development that accompanies it, including changes to flow regimes. Increased efforts to inform population objectives and associated habitat needs for Quadrula is hypothesized to provide indications of how other species in the system will be affected by these threats.

Recent research in Texas has started to address the need for spatially explicit models for Quadrula; however, it is in the very early stages. This research tends to point toward alteration of the hydrologic cycle of rivers as the primary limiting factor in their distribution and the mussel's need for large expanses of relatively unaltered rivers.

[33]Quadrula spp. includes: Golden Orb, Smooth Pimpleback, Texas Pimpleback, Winged Mapleleaf, and Wartyback.
[34]Charles Randklev, TAMU. Personal Communication.

There are significant gaps in routine monitoring of mussels with different approaches and protocols being used. TPWD is currently working to develop a mussel sampling protocol related to project specific impacts. Mussel monitoring is not routinely part of stream or river rapid bio-assessments in the way that fish and macro-invertebrates are used to assess aquatic life use designation as it relates to Texas Surface Water Quality Standards. The absence of regular and repeated monitoring of known populations defeats efforts to determine local, short-term population trends and to detect the local response to management and environmental factors. Objective characteristics to define long term viability of mussel populations are also lacking.

One of the key science needs is to determine the fish-host relationships of Quadrula wherein fish are utilized as an intermediary host for the glochidia stage of their development. It is assumed that various Quadrula spp. use different fish as hosts. More research is needed to identify and verify fish-host relationships in order to better articulate population objectives and the habitat needs required to meet those objectives. Limited information on distribution and abundance is an obstacle to making recommendations to advance conservation and must be addressed first.

Science needs for Quadrula spp. can be summarized as:

- defining a baseline population in terms of recruitment, distribution, abundance and life history and those elements needed to define a sustainable population
- developing a systematic mussel sampling protocol
- identifying and verifying fish-host relationships to help identify population and associated habitat objectives

Texas Pimpleback – source: TPWD

B. Broadly Defined Habitats – *Meeting the needs of Focal Species*

The GCP LCC is made up of four ecoregions, which correspond to BCRs: the Edwards Plateau, Gulf Coastal Prairie, Oaks & Prairies, and the Tamaulipan Brushlands. It is a diverse area that covers approximately 100 million acres in the U.S. plus parts of three Mexican States. The Science Team has identified a list of 17 habitats that the partners can use in directing efforts to link species to habitat needs through SHC, communicating to others about our conservation work, and directing science resources.

The six Tier 1 Focal Species occur in 12 of the 17 broadly defined habitats identified within the GCP geography (in italics):

1) *Tidal Wetlands*
2) *Floodplain Forests, Swamps & Riparian Systems*
3) *Rivers & Lakes*
4) *Headwaters & Streams*
5) *Freshwater (non-forested) Wetlands*
6) *Tallgrass Prairie*
7) *Open Bay Systems*
8) Barrier Islands & Beaches
9) Aquifers, Springs and Spring-runs
10) Mixed Deciduous & Juniper Woodlands
11) *Oak Hardwood & Pine Forests*
12) *Shrubland & Shortgrass (Mixedgrass) Prairie*
13) *Semi-desert Shrub & Grassland*
14) Nearshore Gulf Systems
15) Caves
16) *Reservoirs*
17) *Agricultural Lands*

The Science Team has drafted a more comprehensive document that describes these habitats and more information is found in Appendix C.

The linkages between population objectives and habitat needs serve as the basis for conservation design, addressed in section D below.

C. Meeting High Priority Science Needs for Tier 1 Focal Species

The Science Team assessed the list of needs and identified the most important needs to address for the species first, recognizing that more emphasis is needed on integrating those needs through the implementation of this strategy. In summary, the most immediate science needs for each of the Tier 1 Focal Species are:

1) Alligator Gar – expansion of the work on flood inundation west into the GCP LCC with an emphasis on development of stage specific inundation models. This work will inform the development of habitat objectives required to do *Conservation Design*.
2) American Oyster – increased efforts to determine how flow rates, water quality and circulation patterns, including improved analysis of food resources in the bays, affect populations. This will require adequate reef mapping work, particularly in Louisiana, and will inform *Biological Planning*.
3) Guadalupe Bass – building on SARP instream flow project to test the validity of flow-ecology hypotheses. This would help inform *Biological Planning* efforts and could be done in conjunction with a broader *Conservation Design* effort for the Edwards Plateau.
4) Mottled Duck – estimating priority vital rates for MODU and identifying the environmental and habitat factors responsible for vital rate variation is a key science need to advance *Conservation Design* efforts in conjunction with the GCJV partners.
5) Northern Bobwhite – a better understanding of how vital rates vary from large, contiguous NOBO habitat to fragmented areas, and how much of which types of habitat

are needed to sustain viable populations is needed to advance *Conservation Design* in conjunction with Joint Venture partners.

6) Quadrula – defining a baseline Quadrula population in terms of recruitment, distribution, abundance and life history and those elements needed to define a sustainable population are needed – and may require additional genetic work – in order to implement SHC beginning with *Biological Planning*. Additional *Monitoring* will be needed to define the baseline.

D. Integrating Focal Species Needs through *Conservation Design*

Advancing the elements included in this Strategy requires additional capacity to address the modeling requirements to implement conservation design at a landscape scale. The species and associated habitat needs identified in this Strategy provide the impetus to develop spatially explicit data that identifies the most important areas to conserve so as to meet the needs of the Tier 1 Focal Species as well as assemblages of all the Focal Species identified in Table 1.

Given the ranges of the Tier 1 Focal Species, several key areas of the GCP LCC landscape are revealed as key areas to focus Conservation Design efforts. These include:

- The Edwards Plateau through the Colorado River Basin to the Gulf Coast. This would require revitalization and expansion of the Edwards Plateau Working Group and would address four of the six Tier 1 Focal Species: Guadalupe Bass, Mottled Duck, Northern Bobwhite and American Oyster as well as additional Focal Species such as the Eurycea spp. and Blue Crab. It would also facilitate linkages to the proposed Texas Mid-Coast pilot area within the Grassland DST project.
- Grasslands across the LCC as an expansion of the Grassland DST project. This Project currently has two pilots proposed within, one to look at the development of Static Map Products at a large landscape level with emphasis in North Texas into Oklahoma and the use of a Dynamic approach in the Texas Mid-Coast Region.
- Advancement of the Gulf Coast effort through Landscape Conservation Design that would integrate projects on the Gulf to date and the effort being completed under the Gulf Coast Vulnerability Assessment as part of the ecologically connected network for conservation within the Southeastern Conservation Adaptation Strategy (SECAS). The Focal Species identified in this Strategy may have habitat needs that are contradictory, and need to be balanced through an integrated approach to Conservation Design.
- Aquatic Systems including Headwaters & Streams and Rivers & Lakes require more attention given the number of aquatic species identified in Table 1. The proposed Conservation Design effort proposed in the Texas Mid-Coast from the Edwards Plateau to the Gulf Coast can be used to develop an approach that could be used elsewhere in the LCC.

E. Other Indicators of Functional Landscapes

Functional landscapes can be identified by their ability to provide habitat for focal species while providing other goods and services that benefit wildlife and people. These include cultural services such as recreational fishing; provisioning services such as clean air and water; and, regulating services such as water, nutrient, and pollution circulation. The GCP LCC may expand efforts to more fully integrate these additional ecological endpoints as time progresses, if such endpoints are not adequately addressed through models linking focal species to habitat needs. In the advancement of SHC for focal species through science projects and coordination on efforts, improvements will be made in these other goods and services (quality and or quantity) and those will be quantified to the extent possible. Indicators such as water quality and quantity (including flow regimes) are directly linked to the success of several of the Focal Species, implying that they are good indicators of functional landscapes.

F. Human Dimensions[35]

In addition to addressing habitat conservation needs, the GCP LCC Vision also addresses the need to enhance cultural resource conservation. This can be achieved in part by understanding what those cultural resources are, who values them, and how they overlap with natural resource conservation efforts. This in part gets to the inclusion of Human Dimensions (HD) science, but the cultural aspect is not the whole story. Humans influence (directly and indirectly) the landscape in many ways – and the recognition of those roles, their reach and their implications is essential to achieving the Vision for the LCC. Human Dimensions science needs and priorities are integrated with the other science needs above as a means to identify and address what is needed to advance SHC for the focal species.

The GCP LCC Focal Species list includes many species that are harvested, both commercially and recreationally. This helps to ensure a balance between species and human needs and implies a broad scope beyond Threatened and Endangered Species within the GCP geography. In some cases population objectives exist for the sustainability of the species in conjunction with harvest objectives; these have been noted where applicable.

The GCP LCC Case Study on the *Human Dimensions of Prescribed Fire* is the first solid foray into harnessing the HD sciences to address a specific conservation issue within the Partnership. This Case Study demonstrates the breadth of expertise available to help address complex issues like

[35] Human Dimensions (HD) science is defined as follows: "A suite of issues related to how people value natural resources, how they want those resources to be managed, and how they affect or are affected by those resources and related decisions. It is an umbrella of people/natural-resource issues that can be addressed by the social sciences - including the disciplines of anthropology, sociology, psychology, demography, geography, political science, and economics - and their integration with biophysical science." *Modified from USFWS Chief of the National Wildlife Refuge System's Human Dimensions Branch (Natalie Sexton).*

barriers to delivery of conservation programs. It is imperative that HD science needs are treated the same as biophysical science needs in terms of the level of rigour applied. This will require additional expertise to be brought into the Partnership and for those HD needs to be understood at the Partnership level. In some cases there is a clear role for leadership by the LCC in advancing human dimensions efforts, but it ultimately comes down to the partners to use HD science as they would biophysical science.

7. Landscape Change & Drivers

The LCCs were set up in part to incorporate future landscape conditions into current planning efforts – in light of drivers as substantial as climate change and urbanization. In an effort to work across LCCs, the GCP LCC – along with the others in the Southeast – is adopting the use of the IUCN – CMP Threats Taxonomy.[36] There are a dozen broad categories of Threat:

1) Residential & Commercial Development
2) Agriculture & Aquaculture
3) Energy Production & Mining
4) Transportation & Service Corridors
5) Biological Resource Use
6) Human Intrusions & Disturbance
7) Natural System Modifications
8) Invasive & Other Problematic Species, Genes & Diseases
9) Pollution
10) Geologic Events
11) Climate Change & Severe Weather
12) Other Direct Threats

The Focal Species are all affected by a number of these Threats, including broad implications of urbanization within the *Residential & Commercial Development* category, droughts within *Climate Change & Severe Weather*, and the broad category of *Pollution*. But there are also nuances and differences among the species and the primary threats that impede the sustainability of the species. For example, Guadalupe Bass are affected by introduced genetic material through hybridization with Smallmouth Bass within the *Invasive & Other Problematic Species, Genes & Diseases* category. NOBO habitat has been severely altered through fire suppression, which is captured in the *Natural System Modifications* category.

More information on specific threats for each of the Tier 1 Focal Species is included in the *Biological Planning* sections for each of them within Appendix B.

[36] The International Union for Conservation of Nature (IUCN) and the Conservation Measures Partnership (CMP) developed a set of standard classifications of direct threats that conservationists encounter worldwide. See: https://griffingroups.com/pages/view/31892/iucn-cmp-threats-taxonomy.

8. Objectives of the LCC

One objective of this Strategy is to ensure that the information generated through the GCP LCC science projects are readily and easily available to the partners in a format that fits their needs. The GCP LCC uses the Conservation Planning Atlas (CPA) to deliver spatial data created by these projects, as well as other existing data important to the geography, to the partnership. The CPA is an online platform that allows users to access and integrate existing spatial data layers and maps for use in analysis and conservation planning.[37] Much of the spatial data generated through 2012 GCP LCC projects is currently housed within the CPA. For example, the Science Team and the working group on the *Managing In-stream Flows* project used the CPA to store and share data for review by partners.

A. Measures of Success

Conservation focuses us on managing the landscape and using population objectives to help us determine whether those management activities are working. We manage what we measure and the linkage between species and habitat objectives must be clear in order for us to determine success. Species and habitat objectives are tied together through those linkages and need to be made clear in the Conservation Design element of SHC.

For each species, the ultimate measure of success is the achievement of stated population objectives. Getting to that point includes a number of steps including identification of limiting factors, synthesis of those into stated population objectives, habitat models that are predicted to achieve population objectives, the identification of potential trade-offs between species needs within Conservation Design, monitoring the impacts of change and the application of research to improve associated hypotheses. Not all of these steps will be the purview of the GCP LCC partnership but much will be the responsibility of individual partners. The GCP LCC role is to coordinate the effort and use science to inform adjustments to be made within the SHC wheel.

Ultimately we want to demonstrate that the GCP LCC Partnership has helped advance conservation efforts directed at the Focal Species. The Partnership as a whole has agreed to focus on selected Focal Species, proceed with science projects to address the needs of those species, employ Conservation Design to demonstrate the overlap and implications of addressing the needs of multiple species, and continue to coordinate conservation efforts of the partners. There is a distinction between the measures of success of the Partnership – which include development of tools to assist in conservation delivery – and the partners that actually deliver on the ground conservation programs.

[37] See: http://gcplcc.databasin.org/

Measures of success associated with the implementation of this Strategy include:

- Completion of projects that address key science needs
- Provision of information and data that assist partners in achieving their conservation objectives, and ultimately the objectives of the Partnership
- Lead indicators of success including identification of and investment in science needs agreed to by the Partnership
- Partner willingness to invest their resources in the advancement of conservation efforts to increase the sustainability of Focal Species
- Conservation Design efforts that address a number of focal species and identify areas of high priority for conservation efforts within the GCP LCC

9. Linkages

Each of the partners engaged in the GCP LCC brings a unique set of skills and attributes that can be harnessed to achieve the objectives of the Partnership, including those identified within this Strategy. The strength of the LCC is within the Partnership itself and how we connect with other partners on the landscape. In some cases those linkages, roles and responsibilities need to be further clarified with each partner having a role in achieving the collective outcomes; the successful implementation of this Strategy lies with the partners.

The Science Team intends to continue to provide sound scientific support for the achievement of the broader objectives of the GCP LCC and this Strategy will serve as the basis for doing so. The linkages to individual partners are numerous and it is the collective actions of these partners that can be harnessed to advance conservation of the species identified here and to meet the habitat objectives needed to sustain them. This Strategy helps to provide the direction needed to reduce duplication, streamline data collection and provision of information, and to ensure the partners are focused on meeting the GCP LCC Vision.

For example, the three Joint Venture (JV) partnerships within the GCP LCC serve as the 'bird wing' of the LCC, but more effort needs to be dedicated to better defining how the GCP LCC can support the role and activities of the JVs while working to incorporate the needs of other non-avian species. Because the JV partnerships began working collaboratively with many of the same partners as the LCCs, cooperation between the JVs and LCCs is uniquely positioned to provide early successful examples of how landscape level partnerships can work under an SHC framework. Several fruitful and mutually beneficial collaborative efforts have been initiated to date, including development of the MODU DST and the Grassland Management Inventory Tool, both of which will help advance efforts on priority JV and LCC species. A similar effort must continue with Fish Habitat Partnerships to ensure the LCC is adding value to ongoing efforts and providing coordination where it is needed, as opposed to duplicating efforts.

Ongoing broad efforts like the Gulf Coast Vulnerability Assessment (GCVA), which will be used to better define the vulnerability of coastal ecosystems, can help inform the GCP LCC efforts on

Conservation Design across the Gulf Coast. The climate change associated threats will in part be addressed through our partners in the Climate Science Centers (CSCs) in their ongoing research looking at the impacts of large scale stressors. This Strategy will help guide the LCC input to high priority science needs at the Southeast and South Central CSCs. The LCC and CSC staff will continue to work together to best identify who should lead broad-scale climate efforts.

10. Timeline & Review

This Strategy is meant to be a "living" document to respond to emerging needs and given the time period between the identification of science needs to completion of projects; this Strategy will be a 5 year picture of what the LCC needs to focus on. Time will be dedicated at one of the two annual Steering Committee meetings to give an update on the implementation of this Strategy but there will not be a complete review each year. In the longer term, progress will be measured primarily by the achievement of population and associated habitat objectives for each of the Focal Species.

11. Next Steps

The Science Team will strive to advance SHC for the Focal Species identified by the Partnership. This includes advancing Conservation Design efforts as laid out in this Strategy as well as to develop project descriptions for the priority science needs identified within it. This will be done given current budget scenarios, including the potential to leverage additional funding from partners across the LCC. The Science Team will also seek opportunities outside USFWS LCC funding to coalesce resources in pursuit of identified science needs, and will seek assistance from the Steering Committee as appropriate. The Science Team forms the core group responsible for implementing this strategy and will bring on additional expertise as needed, including the development of working groups, similar to the Edwards Plateau Working Group. The Steering Committee is ultimately responsible to ensure the resources are secured and the direction is given to the Science Team to implement the actions identified within this strategy.

An additional next step, based on direction from the Steering Committee, is to integrate the conservation needs of our Mexican partners.