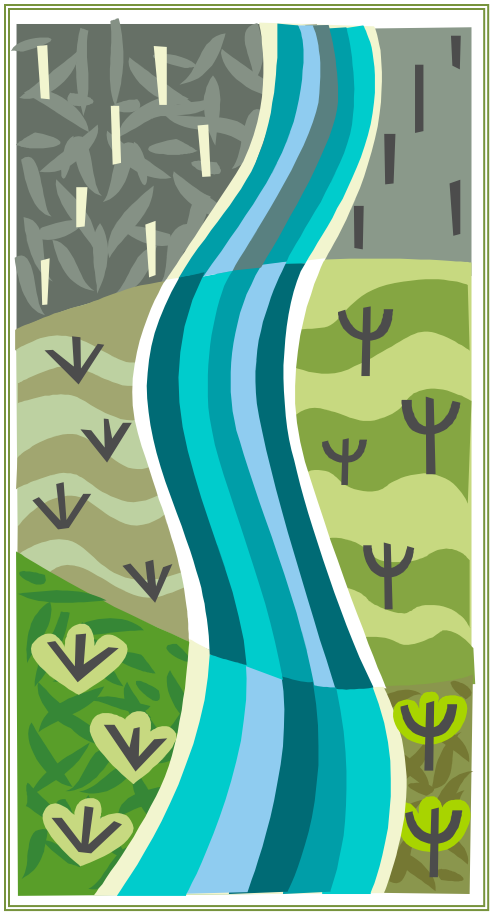

# TEXAS CONSERVATION ACTION PLAN

## DRAFT

## State/Multi-Region

## HANDBOOK

## June 2011

Note: text in red in this document will be revised between June 10 Public Comment Draft and the final USFWS-approved document.

In accordance with Texas State Depository Law, this publication will be available at the Texas State Publications Clearinghouse and/or Texas Depository Libraries.



PWD insert number when approved

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## SUMMARY

Texas is one of the largest, most biologically diverse states[1] with prairies, expansive plains and grasslands, woodlands and forests, mountains and canyons, springs and bogs, fast flashy ephemeral streams and deliberate large perennial rivers – all of which *eventually* feed the Gulf of Mexico in some way. Because we have such variety in our habitats and some are isolated systems different from their more extensive surroundings – aquifer-fed springs, mountain tops in a sea of grasslands, bogs within forests, pools and crevices on granite domes, limestone karst and caves within woodlands– our state is home to some species which occur nowhere else on earth. Texas habitats are very important links in the pathways for thousands of migratory songbirds making their annual journeys north and south. We share many of our natural resources and issues directly with four other states and Mexico along our borders, and indirectly with other states, Central America, and Canada.

Culturally diverse, historically proud, and scenic, our state is also one of the most attractive places for *people* to live and work.[2] Because over 80% of Texas is privately held and managed, private landowners have always contributed to this state's stewardship.[3] In 1950, Texas hit a crossroads and began a long, steady shift to our current population distribution: approximately 17% rural and 83% urban.[4] Change – and understanding that change – takes time, sometimes generations. Many land and water resources managers, planners, researchers, policy makers, and advocates have spent time trying to understand this change and proposing conservation solutions.

Through the Texas Conservation Action Plan (TCAP), ecologists and other stakeholders all across the state have identified 1311 Species of Greatest Conservation Need (SGCN), 232 Rare Plant Communities, the best examples of habitats and those at risk, issues affecting our resources, and potential solutions to continue to protect lands and water for future generations of people, fish and wildlife. The challenges are many, but the landscape of conservation partners and opportunities is extensive. This plan is designed to help interested folks connect and put into practice the most needed conservation actions.

This **Statewide/Multi-region (SMR) Handbook** provides insight into certain Texas rare resources, special habitats, and conservation issues that cross regional boundaries, including a few we share with other states, Mexico, Central America, and Canada. It also contains a compiled statewide SGCN list and a list of large-scale (broader than one ecoregion or ecological drainage unit) Conservation Actions.

Throughout the document, there are resources – web links, programs, incentives, and contacts – to help you participate in and learn more about natural resources needing our conservation attention in Texas. More references, keys to acronyms, a glossary, other resources, and the remaining handbooks (an Overview and 11 ecoregions) are available on the Texas Conservation Action Plan 2011 Web Page.[5]

[1] NatureServe. 2002. *States of the Union: Ranking America's Biodiversity*. http://www.natureserve.org/Reports/stateofunions.pdf

[2] Milken Institute. 2010. *2010 Best Performing Cities – Largest and Smallest Metropolitan Areas*. http://bestcities.milkeninstitute.org/

[3] Texas A&M Institute of Renewable Natural Resources and American Farmland Trust. 2009. *Texas Land Trends*. www.texaslandtrends.org

[4] Texas State Data Center. 2010. *Office of the State Demographer: presentation* (see also raw data for community distributions at the Texas State Data Center) http://txsdc.utsa.edu/download/pdf/presentations/2011_03_31_Texas_Dept_of_Insurance.pdf

[5] TPWD. 2011. *Texas Conservation Action Plan 2011-2016.* In progress. http://www.tpwd.state.tx.us/landwater/land/tcap/

*"Action that grows out of urgency, frustration, or even determination is missing a critical ingredient. For action to be effective, for action to be meaningful, it must also grow out of respect and a deep sense of connection to the things and people that surround us."* – *Orion Magazine* Editors, March/April 2011

## HOW TO GET INVOLVED

Each handbook has a list of partners and programs who can be contacted for more information. Additionally, most handbooks have identified targeted outreach and partners in conservation actions which may be helpful for specific issues.

There are many wonderful, energetic public and private conservation providers in Texas who have active volunteer networks, strategic needs, and programs. For more information, also check the handbook for your ecoregion (or the one in which you are most interested in participating) and the Natural Resource Conservation Programs and Services for Texas Landowners.[6]

If you have questions about the TCAP content and cannot find what you need on the TPWD TCAP 2011 website or in one the handbooks, please contact the TCAP Coordinator at TPWD Headquarters in Austin, Texas:

Phone (512) 389-4800

Email Texas Conservation Action Plan Coordinator

NOTE this email link for questions and implementation participation will be live AFTER the Public Comment period to ensure that we get all public comment on these draft documents through the posted survey on the WEBSITE.

[6] TPWD. 2007. *Natural Resource Conservation Programs and Services for Landowners*. http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_w7000_1198.pdf

## TEXAS, OUR TEXAS

"Texas, Our Texas," the official state song of Texas, was adopted by the Legislature in 1929 after being selected in a state-wide competition. It was composed by William J. Marsh of Fort Worth; lyrics were written by Marsh and Gladys Yoakum Wright.

### NATURAL STATE

Across its more than 260,000 square miles, no tall tale, Texas IS one of the largest, most biologically diverse states with prairies, expansive plains and grasslands, woodlands and forests, mountains and canyons, springs and bogs, fast flashy ephemeral streams and deliberate large perennial rivers – *all* of which *eventually* contribute to the Gulf of Mexico in some way. Twelve ecoregions and 17 ecological drainage units cover about 170 million acres (Figure 1, Figure 2, Table 1) in Texas.[7] We share many of these resources across the adjacent political boundaries of four states – New Mexico, Oklahoma, Arkansas, and Louisiana – and Mexico.

We are home to some species which occur nowhere else but Texas – plants dependent on certain soils or geology, invertebrates and fishes dependent on springs and spring-fed systems, cave and karst species, some geographically isolated small mammals and amphibians, among others. Our lands and waters provide very important pathway links among Central America, Canada, and points-in-between for thousands of seasonal migratory birds. From several species catalogues for Texas[8], we are known to have over 5,000 species of plants, 300 of which are known to be endemic; 636 species of birds; over 180 mammal species; and more than 30,000 insects … that's just a snapshot. Texas has tens of thousands of species that are not hunted or fished. All wildlife and fish resources are important contributors, from decomposers to top predators, in every habitat and ecosystem in our state.

### CULTURAL APPEAL

Culturally diverse, historically proud, and so scenic, Texas has five of the top 200 largest and five of the top 179 smallest *best-performing* metropolitan areas in the United States, based how well they are creating and sustaining jobs and economic growth.[9] *People* love to live and work here.

Texas supports three of the ten most populous cities in the US: Houston, San Antonio, and Dallas.[10] By 2030, Texas population is estimated to grow more than 70% (over 2010 levels) or nearly 15 million people; of the total, 7 counties will grow by more than 40%![11]

In 2005, Texas population was estimated to be approximately 86% urban[12]

Based on TPWD's Ecological Systems of Texas[13] project's completed phases which cover approximately the eastern half of the state, about 5% of Texas's land area is developed in high and low density urban; projections for the entire state are about the same.

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[7] For more information about the ecoregion boundaries and names, and changes from the 2005 Plan, see the Overview Handbook.

[8] Turner, B.L., H. Nichols, G. Denny, and O. Doron. 2003. *Atlas of the Vascular Plants of Texas, volumes I and II.* Sida, Bot. Misc. 24, 1 and 2

Poole Jackie M, William R Carr, Dana M Price and Jason R Singhurst. 2007. *Rare Plants of Texas*. Texas A&M University Press. 640 pgs.

Texas Bird Records Committee. 2011 (March). *Accepted Texas Bird Species*. http://www.texasbirds.org/tbrc/statelst.htm

William B. Davis and David J. Schmidly. 1994. *Mammals of Texas*. Texas Parks and Wildlife Department (1994) and Texas Tech University (online edition 1997). http://www.nsrl.ttu.edu/tmot1/

TPWD. 1999. *Learn About Texas Insects*. http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_p4000_0043.pdf

[9] Milken Institute. 2010. *2010 Best Performing Cities – Largest and Smallest Metropolitan Areas*. http://bestcities.milkeninstitute.org/

[10] U.S. Census Bureau. 2011. *Population Distribution and Change: 2000 to 2010*. http://www.census.gov/prod/cen2010/briefs/c2010br-01.pdf

[11] Texas State Data Center. 2010. http://txsdc.utsa.edu/

Texas Forest Service. 2010. *Forest Resources Strategy*. http://txforestservice.tamu.edu/uploadedFiles/Sustainable/assessment/Texas%20Forest%20Resource%20Strategy.pdf

[12] Texas Comptroller of Public Accounts. 2008. *Texas in Focus: A Statewide View of Opportunities*. Publication 96-1286. Austin TX. http://www.window.state.tx.us/specialrpt/tif/

[13] TPWD, TNRIS, MoRAP, TNC Texas, NatureServe, NRCS, Texas Forest Service, US Forest Service, and USFWS. in progress. *Texas Ecological Mapping Systems*. http://www.tpwd.state.tx.us/landwater/land/maps/gis/tescp/index.phtml

**Figure 1. Ecoregions of Texas**

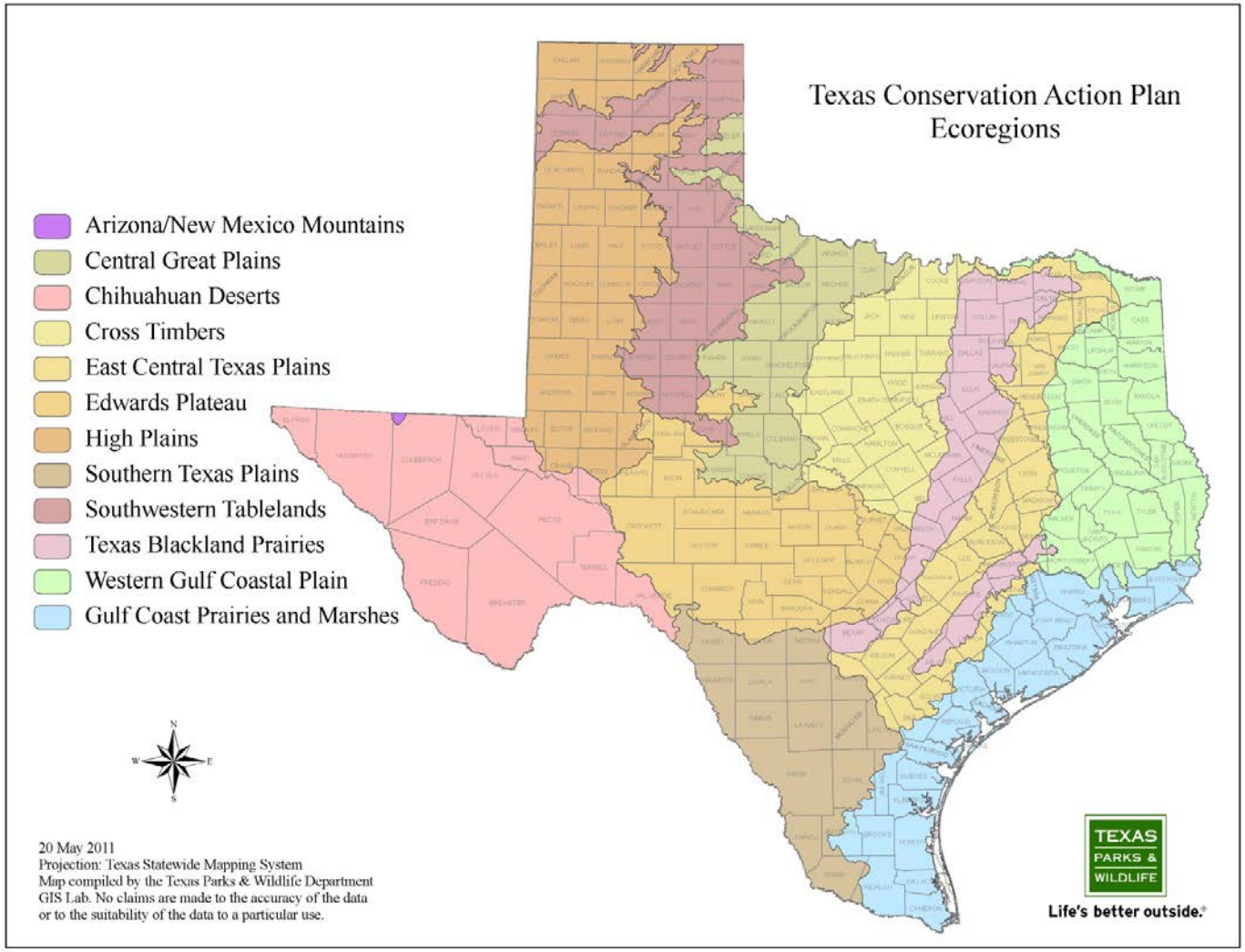
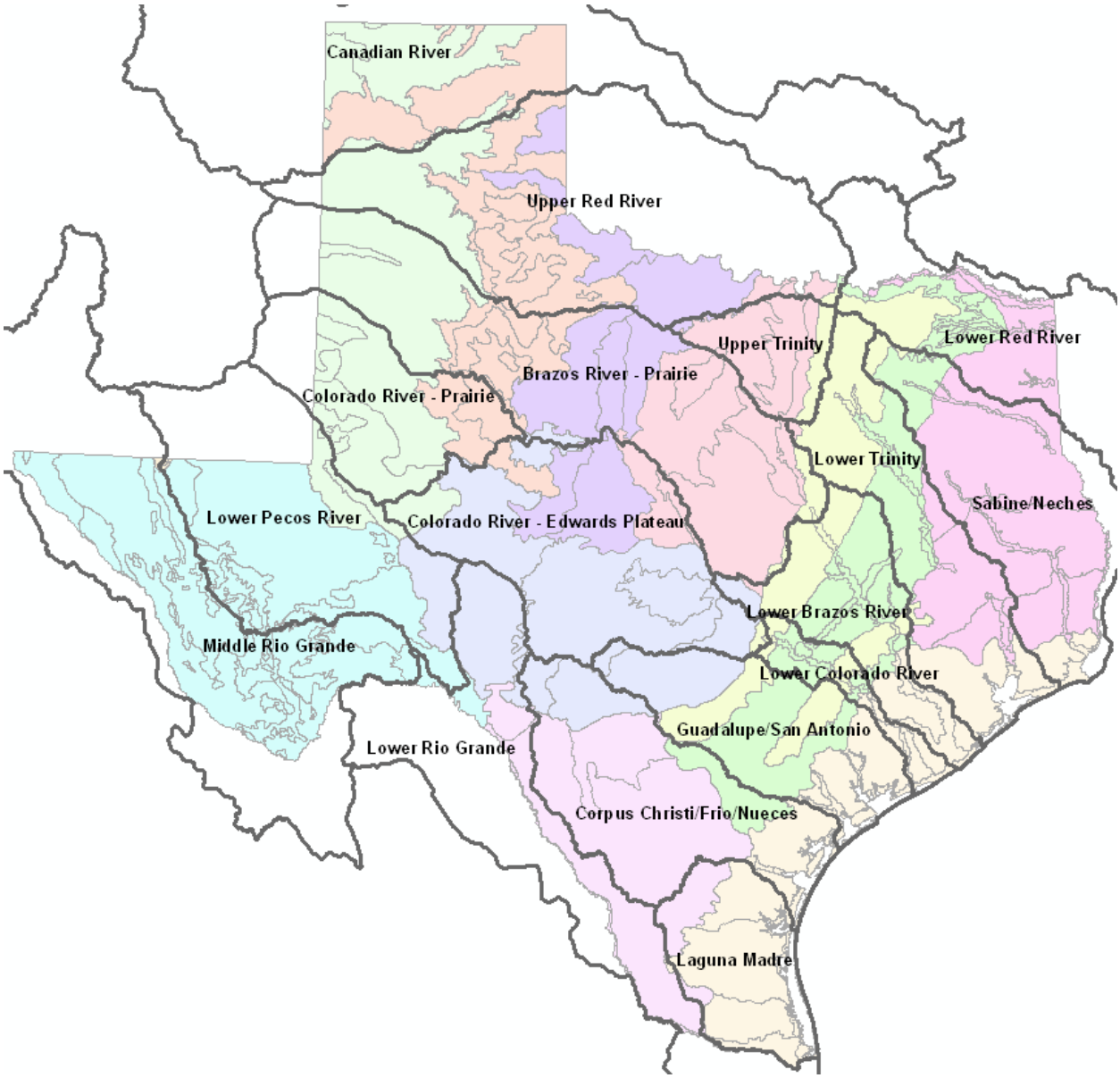


**Figure 2. Ecological Drainage Units of Texas**




Map compiled by Texas Parks and Wildlife Department TCAP Coordinator, 2011.

No claims are made to its accuracy or suitability for a particular use.

See also http://www.nbii.gov/far/nfhap/data/NFHAP_Initial_Assessment_Report_Esselman_etal_2010.pdf

**Table 1. Ecoregion Acres in Texas**

*Note: Table is formatted 8-1/2" by 11", portrait orientation*

| Ecoregion | Acres (rounded to nearest acre)* |
|---|---|
| Arizona/New Mexico Mountains (AZNM) | 52,253 |
| Central Great Plains (CGPL) | 11,566,646 |
| Chihuahuan Deserts (CHIH) | 22,624,928 |
| Cross Timbers (CRTB) | 12,829,239 |
| East Central Texas Plains (Post Oak Savanna) (ECPL) | 13,535,078 |
| Edwards Plateau (EDPT) | 18,523,969 |
| High Plains (HIPL) | 20,964,631 |
| West Gulf Coastal Plain (Pineywoods) (WGCP) | 15,732,780 |
| Southern Texas Plains (STPL) | 13,197,607 |
| Southwestern Tablelands (SWTB) | 14,904,215 |
| Texas Blackland Prairies (TBPR) | 10,719,913 |
| Gulf Coast Prairies and Marshes (GCPM) | 14,661,484 |
| **All Ecoregions Total Acres** | **169,312,743** |

* Acreage calculations are approximate, based on geographic information systems data and accuracy of the ecoregions' boundaries. Acre figures in various print and web sources range from approximately 165 million to 172 million.

## WHY CONSERVATION?

Many of the species and habitats of Texas are iconic and important to our identity – the context in which we, as Texans native-born or "got here as fast as we could", think of ourselves and tell our stories to others. We're from or live in the hill country, plains, coast, pineywoods, brush country.

What would our vision of Texas be without the vast open grasslands and playas of the Panhandle plains, pronghorn herds and "sky – island" mountains out west, eastern lush forests filled with filtered sunlight and the sound of woodpecker and warbler, hot colorful yet understated prairies alive with thousands of butterflies, rolling songbird-filled woodlands punctuated by open meadows, sycamore- and cypress-scented river corridors and steep limestone bluffs overlooking spring-fed waters teeming with silvery schools of small fishes, thickets of impenetrable thornscrub concealing cryptic plants and animals, and wild meandering rivers ever-flowing to feed the teeming marshes, shores and waters of the Gulf of Mexico?

These habitats support several elements of the state's resource-based economy – timber, coastal fisheries, livestock production, recreational hunting and fishing, and nature tourism in bird-watching, kayaking, and hiking, to name a few. These resources contribute to our views and perceptions of our state and our selves, whether it's from the back porch or on the highway at 70 miles per hour.

Conservation efforts are usually directed at species and habitats at risk, initiated and implemented by people who work on natural resource issues because they care; so goes the TCAP. While this is the primary focus, **every person in Texas benefits from conservation work to protect, restore and promote lands and waters we rely on for living and making a living**. Working lands – ranches and farms – are important partners in our habitat conservation efforts and benefit from sustainable land and water management practices. Groundwater (aquifer), instream flow, and water quality protection which benefit aquatic species also support healthy, sustainable drinking water sources, recreational and commercial freshwater and coastal fisheries. Open space conservation boosts public access to recreation and enhances aesthetic property values, especially near urban areas.[14]

So, while the TCAP is a conservation plan for resources most at risk, its purpose is also to bring people together to realize a broad spectrum of conservation benefits, prevent species listings, and preserve our natural heritage for future generations – so that they have their own stories to tell.

### RELATIONSHIP TO OTHER PLANNING BOUNDARIES, PLANS, AND PROGRAMS

Some other conservation efforts in Texas use ecoregion boundaries and names that are different from those in Figures 1 and 2; some are the same or similar. Conservation planning unit choices[15] are made relevant to the goals, partners and activities which the efforts hope to engage. The Ecological Drainage Units are aquatic resource based; however, these units are useful to relate aquatic and terrestrial resources (e.g. riparian and streams, terrestrial impacts to aquatic resources such as stormwater runoff). Several adjacent states and natural resources agencies/organizations operating in Texas use the ecoregions framework we've chosen for this Plan or something very close to it. This framework is also the underpinning for the statewide vegetation and ecological systems mapping project[16] – a high priority in the 2005 Action Plan. It fits with the national framework developed by NatureServe.[17] The

[14] Lincoln Institute of Land Policy. 1996. *The Economic Value of Open Space*. http://www.lincolninst.edu/pubs/506_The-Economic-Value-of-Open-Space

Trust for Public Land. 2009. *Conservation: An Investment that Pays*. http://cloud.tpl.org/pubs/benefits_econbenefits_rpt_7_2009.pdf

[15] For more information about how ecoregions relate to other planning boundaries in the state, see the Overview document or the Conservation Crosswalk Table link on the TCAP 2011 webpage.

[16] TPWD et. al. in progress.

[17] NatureServe Ecological Mapping Systems http://www.natureserve.org/prodServices/ecomapping.jsp

TCAP directly contributes to and is sourced from conservation efforts across the state. Where our efforts work together, the other conservation plans are referenced through links in the text and the *Resources and References* section.[18]

## UNDERSTANDING CHANGE TO SOLVE PROBLEMS

Change – and understanding that change in a certain context – takes time, sometimes generations; however, sometimes the *need* to understand change is more immediate. Many land and water resources managers, planners, researchers, policy makers, and advocates work daily to understand our natural resources, how or why they change (positively and negatively) and how our conservation efforts affect that change over different time frames in order to define conservation needs, develop the best approaches to solve problems, form partnerships, and apply best management practices.

It is impossible (and impractical) to fully understand or know every need and/or contribution of a species or population in a habitat or system. We must move forward with our conservation practice, not paralyzed by a lack of understanding, but rather using the best information we have now, documenting our work well, and sharing lessons learned so that we may learn from each other's experiences. To accomplish this, the actions presented in this handbook recommend using a "theory of change" to measure effectiveness and share that information with others.[19]

The way people work and play in, live on, and move through Texas affects how conservation providers do all of these things. So, it's important to not only understand natural resources' needs and how they change with our actions, but also people's needs, attitudes and behaviors. Issues like energy needs, water development, population growth, and communication all affect how well we can conserve the species and habitats we care about.

External forces on resources of the state have also impacted the issues we consider in conservation decision-making. Natural disasters, like Hurricane Ike along the Gulf Coast and the Rockhouse Fire near Fort Davis, make us think about recovery, how we live with natural cycles, and resources management in scales beyond our lifetimes. Cultural shifts and forest clearing in Central America encourage us to work internationally to solve problems that affect wintering habitats on which several of Texas's breeding birds rely. The 2010 Deepwater Horizon (Macondo Blowout, BP Spill) ±5 million barrel oil spill[20] energized a multi-national community of coastal ecologists and concerned citizens into emergency response, long-term research and recovery planning. The national and international discussions about climate change and conflict in oil-producing regions have affected energy production and delivery landscape in Texas – wind, solar, "frac-ing" – in ways we hadn't envisioned five or ten years ago.

The TCAP Statewide/Multi-region Handbook takes advantage of many different perspectives to **understand broad changes and identify actions that will reduce issues that adversely affect specific natural resources: species, rare communities and the habitats on which they rely**. The Plan contributes to our ability to share our natural heritage with future generations of Texans and their understanding of what we did to make *progress* toward that goal.

## SETTING PRIORITIES

To work on these larger conservation issues and the ones closer to home, all of which we feel need attention, it's important to prioritize to the degree that we can. The TCAP 2011 taps into a broad

[18] All references used in this Plan are consolidated into one document, Resources and References, linked on the TCAP 2011 website.

[19] AFWA TWW. 2011. *Measuring the Effectiveness of State Wildlife Grants*. http://www.fishwildlife.org/files/Effectiveness-Measures-Report_2011.pdf

[20] NOAA. 2011. Deepwater Horizon. http://response.restoration.noaa.gov/dwh.php?entry_id=809

NOAA. 2011. Gulf Spill Restoration. http://www.gulfspillrestoration.noaa.gov/

network of conservation service providers, natural resources managers, alliances and working groups, policy makers, stakeholders and the public to define **what's at risk, what issues are most important, where we need to work, and how to best engage the right partners to solve the problems**.[21]

This Statewide/Multi-region Handbook of the TCAP 2011 covers **broad resources of conservation need and issues – those which cross regional, state, and international lines**. More local resource issues and actions are covered in the Ecoregion Handbooks.

In the sections that follow – SGCN, Priority Habitats, and Issues –species and rare communities related to important multi-regional habitats and broad issues will be discussed.

**Actions** are proposed in the last section to bring together conservation partners, species, communities, habitats and issues for potential solutions. It's important to remember as you are reading this document that many of these resources offer us opportunities for restoration of degraded systems as well as protection of the best examples.

[21] For more information about how resources, issues, and actions were identified, see the Overview handbook, TCAP 2011 website.

## SPECIES OF GREATEST CONSERVATION NEED (SGCN)

While most conservation work is done at the habitat level to address issues and threats, Action Plans' stated primary purpose is to improve and sustain *species'* populations and prevent the need to list species as federally or state threatened or endangered. The Species of Greatest Conservation Need (SGCN) list, one of the Eight Required Elements in all states' Action Plans, is the foundation for the habitat- and issues- based actions in the Plan.[22]

In Texas, species included in the 2011 TCAP Final SGCN and Rare Communities lists are supported by current science, peer-reviewed references and/or other dependable, accessible source documentation, and expert opinion. The revised SGCN lists are substantial and representative of conservation targets needing attention in this Plan.

The list is sorted into the following categories:

| | | |
|---|---|---|
| Mammals | Birds | Reptiles and Amphibians |
| Marine Mammals | Invertebrates | Marine Reptiles |
| Freshwater Fishes | Bay and Estuary Fishes | Marine Fishes |
| Plants | | Plant Communities |

### Status and Ranks

Each species has a NatureServe calculated state and global conservation rank, which accounts for abundance, stability and threats. Additionally, several species have federal and/or state listing (endangered, threatened, candidate) status. See the Status and Ranks Key on the TCAP 2011 website.

### SGCN and Rare Communities in this Handbook

In the SGCN and Rare Communities lists, there are several SGCN with statewide or broad multi-region distributions (more than one ecoregion box noted on the spreadsheet) which could benefit from habitat conservation or issues resolution at a large scale (e.g. black bear, long-tailed weasel, northern bobwhite, scissor-tailed flycatcher, common snapping turtle, western diamondback rattlesnake, spiny softshell turtle). And, while many of the aquatic species only occur in one or two ecoregions, nearly all of them are dependent on sound EDU or watershed-scale land and water management practices that cross many regions. Coastal and marine species in the Gulf are all dependent on our best practices upstream. Texas supports a number of SGCN in habitats that cross into adjacent states and Mexico and/or which depend on or contribute to systems in other states and Canada. The actions presented in this handbook focus on habitat conservation and issues solutions which benefit SGCN with broad, multi-ecoregion habitat needs.

[22] For more information about how the SGCN list was developed, including the changes from the 2005 list, see the Overview Handbook. For specific ecoregion SGCN lists and conservation actions, see each ecoregion's handbook, TCAP 2011 website.

## PRIORITY HABITATS

While the SGCN list formed the basis for every Action Plan, *species* conservation cannot be successful without defining the *lands and waters species need to survive and thrive*. If it was only important to know about individuals or even populations, we could put representatives in zoos or herbaria or other curated collections and that would be enough; but, it's not …. **It's important to conserve populations in the context in which they thrive, to the best of *their* abilities, where they can contribute to and benefit from the systems in which they live**.

### HOW PRIORITY HABITATS WERE SELECTED FOR THIS HANDBOOK

Although ecoregion and political boundaries are useful to humans to organize our activities and interests, SGCN populations, rare communities and the habitats on which they depend do not always abide by such boundaries. To address this need beyond the more locally focused Ecoregions' handbooks, the Statewide/Multi-region handbook identifies habitats which

- require cooperative management or protection across ecoregions, state boundaries, and/or perhaps international boundaries; and/or
- are rare, declining or threatened in some way *and* beneficial to the SGCN with statewide, multi-state, multi-region or international distributions.

#### Adjacent States

Texas shares its border with four states – New Mexico, Oklahoma, Arkansas, and Louisiana. Using the states' Action Plans and the National Fish Habitat Data viewer for watershed stream habitat risk assessment[23], Table 3 identifies habitat priorities from those states which overlap those in Texas ecoregions.

Note: In the online viewer, the risk assessment can be viewed by Ecological Drainage Units (EDU) identified in Figure 2, or smaller scale Hydrologic Units – watersheds within the EDU. These are referred to as "HUCs" (stands for Hydrologic Unit Code). The HUC 8 is a step down from EDU; HUC 12 is a step finer than HUC 8. The HUC 8 and HUC 12 scales are likely the most useful for certain partnerships and actions and will be discussed further in the Actions section.

*Habitat or. Vegetation (Community)?*

Habitats are not necessarily the same as vegetation communities.

"Habitat" provides a species or community with the specific physical location and conditions needed to survive and thrive. This may be a vegetation community; however, it may also be a particular waterbody, water flow amount or quality in that waterbody, geologic substrates (e.g. limestone, granite, sands), species host, or other environmental factors.

Habitat requirements are based on a species' life history – breeding, feeding, sheltering – including dispersal and migratory needs.

[23] NBII and USGS. 2011. National Fish Habitat Risk Assessment Viewer (online). http://www.nbii.gov/far/nfhap/

**Table 2. Shared Habitat Priorities with Adjacent States**

*Table is formatted 8-1/2" x 11", landscape orientation*

| Adjacent States | Ecoregions Shared with Texas | Habitat Priorities Shared with Texas<br>*(Action Plans and the National Fish Habitat Action Plan viewer online)* |
|---|---|---|
| New Mexico<br>(NM) | Arizona – New Mexico Mountains<br>Chihuahuan Desert<br>High Plains | semi-desert grasslands and scrub/shrublands<br>shortgrass prairie<br>ephemeral and perennial tributaries and mainstem of the Pecos, Rio Grande/Rio Bravo, and Brazos Rivers, and associated riparian zones and floodplains<br>springs and seeps<br>wetlands<br>playas<br>TX – NM HUC 8 watersheds are all mapped at low to very low risk (although those near El Paso are mapped at high to very high risk at finer HUC 12 scale) |
| Oklahoma<br>(OK) | High Plains<br>Southwestern Tablelands<br>Central Great Plain<br>Cross Timbers<br>East Central Texas Plain<br>Western Gulf Coastal Plain | shortgrass prairie<br>playas, springs and other wetlands<br>sand sagebrush/bluestem shrublands<br>mixed grass prairie<br>ephemeral and perennial tributaries and mainstem of the Canadian and Red Rivers, and associated riparian zones and floodplains<br>shinnery oak shrubland<br>tall grass prairie<br>oak woodlands and savanna<br>mesquite savanna<br>bottomland forests<br>shortleaf pine – oak forests/woodlands/savanna<br>TX – OK HUC 8 at moderate risk: Palo Duro, Lower Beaver, Washita headwaters, Lower North Fork Red, Lower Salt Fork Red, Blue-China, Farmers-Mud<br>TX – OK HUC 8 at very high risk: Lake Texoma, Bois d'Arc Island, Pecan Waterhole at very high risk |

| Adjacent States | Ecoregions Shared with Texas | Habitat Priorities Shared with Texas<br>*(Action Plans and the National Fish Habitat Action Plan viewer online)* |
|---|---|---|
| Arkansas<br>(AR) | Western Gulf Coastal Plain | oak-hickory-pine forest<br>bottomland forests<br>blackland prairie<br>ephemeral and perennial tributaries and mainstem of the Red River, and associated riparian zones and floodplains<br>TX – AR HUC 8 at moderate risk: Cross Bayou<br>TX – AR HUC 8 at high risk: McKinney-Posten Bayous<br>TX – AR HUC 8 at very high risk: Lower Sulphur |
| Louisiana<br>(LA) | Western Gulf Coastal Plain<br>Gulf Coast Prairies and Marshes | oak-hickory-pine forest<br>bottomland forests<br>swamps, seeps, bogs, other wetlands<br>dry sandhill woodlands<br>hardwood slope forests<br>mixed hardwood – pine forests<br>longleaf pine savanna<br>prairies, glades and barrens<br>coastal marshes and grassland<br>cypress and cypress-tupelo swamp<br>coastal live oak-hackberry forest (chenier)<br>ephemeral and perennial tributaries and mainstem of the Sabine River, and associated riparian zones and floodplains<br>TX – LA HUC 8 at moderate risk: Cross Bayou, Bayou Pierre,<br>TX – LA HUC 8 at high risk: Middle Sabine and Sabine Lake<br>*Note: Marine and offshore Gulf of Mexico priorities were not included in the Louisiana plan online.* |

Sources:

New Mexico Department of Game and Fish. 2006. Comprehensive Wildlife Conservation Strategy for New Mexico. http://fws-nmcfwru.nmsu.edu/cwcs/New_Mexico_CWCS.htm

Oklahoma Department of Wildlife Conservation. 2006. Oklahoma's Comprehensive Wildlife Conservation Strategy. http://www.wildlifedepartment.com/CWCS.htm

Anderson, J.E. (Ed) 2006. Arkansas Wildlife Action Plan. Arkansas Game and Fish Commission, Little Rock, Arkansas. 2028 pp. http://www.wildlifearkansas.com/strategy.html

Louisiana Department of Widllife and Fisheries. 2006. Louisiana Comprehensive Wildlife Conservation Strategy. http://www.wlf.louisiana.gov/wildlife/wildlife-action-plan-details

US Geological Survey, National Biological Information Infrastructure Program. 2011. National Fish Habitat Action Plan habitat risk assessment viewer. http://www.nbii.gov/far/nfhap/

Most of the fine-scale habitats listed in Table 2 cross into a *particular* Texas ecoregion (e.g. longleaf pine savanna in Louisiana, which crosses into the WGCP ecoregion - east Texas); these kinds of specific habitats which are not multi-ecoregional in Texas will be addressed in relevant ecoregion handbooks. Conservation actions and partnerships in those areas are more *locally* effective. And, because there are several of these occurrences, this plan focuses on the more general habitat types of concern which we share with our state boundary neighbors: intact native riparian zones and floodplains, high quality instream habitats, wetlands of all types, and native grasslands.

Mexico

Texas shares its southwestern border and many resources with Mexico in three ecoregions – Chihuahuan Desert, South Texas Plains, and Gulf Coast Prairies and Marshes (including the Gulf of Mexico). Certain habitats are important to both Texas and Mexico for migratory species (black-capped vireo, Bairds' sparrow)[24]; resident wildlife (e.g. black-tailed prairie dog, burrowing owl, native desert fishes of the Rio Grande/Rio Bravo system) in decline that have highly threatened habitat types such as grasslands, wetlands and instream aquatic habitats[25]**;** and wildlife that have trans-border seasonal or daily movements through riparian areas, and other uninterrupted habitat corridors (e.g. jaguarondi, black bear).[26] Of course, there are numerous bird species which traverse the border and use a broad range of wetland, shoreline, island and brush habitats, and/or rely on the riparian zones of the Rio Grande/Rio Bravo and its tributaries, creating interesting opportunities for bird watchers and scientists alike.[27] The National Fish Habitat Action Plan data viewer[28] has not mapped watershed risks across the border in Mexico; however, because similar issues (primarily development and agriculture, with associated impacts) and similar habitats lie on both sides of the border, it is reasonable to think that the aquatic resources and associated upland habitats which occur in the Rio Grande/Rio Bravo, southern Texas Gulf coastal zones, and Laguna Madre habitats could benefit from collaboration between Texas and Mexico.

Through the work of the TPWD Borderland Affairs liaison[29] with Mexico, several meetings, discussions and initiatives have resulted in identification of habitat conservation priorities shared between the two (see also *Issues* section):

- Habitat Corridors/Conservation Areas: native terrestrial and aquatic habitats - El Carmen – Big Bend, Sierra Picachos (Nuevo León)-to-Rio Grande, Rio Conchos to upstream of Falcon Reservoir and the Rio Grande above its confluence with the Rio Conchos, in a network of public-private corridors providing protection and habitat restoration opportunities to benefit wide-ranging terrestrial species and watershed protections for important desert fish assemblages
- Instream habitats below Falcon (need water quality improvements)
- Wetland protection, restoration and construction (where appropriate)

[24] Partners in Flight. 2010. *Saving our Shared Birds.* http://www.savingoursharedbirds.org/final_reports_pdfs/PIF2010_English_Final.pdf

[25] CEC. 2011. *North American Conservation Action Plans*.
http://www.cec.org/Page.asp?PageID=1291&ContentID=2300&SiteNodeID=241&BL_ExpandID=&AA_SiteLanguageID=1

Desert Fish Habitat Partnership. 2008. *Framework for Strategic Conservation of Desert Fishes*.
http://www.nature.nps.gov/water/assets/docs/DFH/strategicPlan.pdf

[26] IUCN Cat Specialist Group. 1996. *Wild Cats: Status Survey and Conservation Action Plan*. Kristin Nowell and Peter Jackson, Editors.

Onorato, D.P., E.C. Hellgren, R. A. Van Den Bussche, D.L. Doan Crider and J.R. Skiles Jr. 2007. http://www.mendeley.com/research/genetic-structure-of-american-black-bears-in-the-desert-southwest-of-north-america-conservation-implications-for-recolonization/

[27] TPWD. 2007. Birds of the South Texas Brushland. John Arvin, Editor. PWD-BK-W7000-1033 (6/07).
http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_w7000_1033.pdf

[28] USGS NBII. 2011

[29] TPWD Borderlands/International Affairs internal program reports, December 2008 and June 2009

- Riparian woodlands and floodplains (e.g. Texas ebony – anacua/brasil forest, Texas sabal palm forest) and *lomas* (e.g. Texas ebony – snake-eyes shrubland)
- Laguna Madre –to support shared species: coastal waterbirds shared with Laguna Madre of Tamaulipas, including reddish egret, red knot, piping plover, brown and white pelican (large nesting colonies monitored by Audubon Society and Pronatura on Tamaulipas barrier islands) (issues with freshwater inflows, water quality, salinity)

## Gulf of Mexico

The Gulf of Mexico is under the jurisdiction of 5 states (Texas, Louisiana, Mississippi, Alabama, Florida), several U.S. national agencies, Mexico and Cuba. One catastrophic event (e.g. hurricane or oil spill) or regional conservation action can negatively or positively, respectively, affect the function, conservation and management of habitats within and adjacent to the entire system. The Texas Commission on Environmental Quality (TCEQ) recognizes 44 segments[30] of the seven (7) major bays in Texas's portion of the Gulf of Mexico: Sabine Lake, Galveston Bay, Matagorda Bay, San Antonio Bay, Aransas Bay, Corpus Christi Bay, and Lower Laguna Madre.[31]

The Gulf is influenced by all river and coastal basins that feed into it, through complex habitats called estuaries, which may be one of the most threatened habitats of our state.[32] The Mission-Aransas estuary in Texas is a National Estuary Reserve – nearly 186,000 acres of public and private lands of coastal prairie, oak mottes, riparian freshwater and salt marsh habitats with three large, open and shallow bays that support extensive tidal flats, seagrass beds, mangroves, and oyster reefs. One of the area's largest (24,400 acres) wetlands is part of the Aransas National Wildlife Refuge and is the winter home to the critically endangered Whooping Crane. This site is representative of the one of the best western Gulf of Mexico's estuaries.[33] Estuary function is critical to nearshore and offshore habitat quality and these areas function as nurseries for many Gulf fish species. Freshwater inflows, sediment and nutrients from all ecoregions' river basins are important contributors to estuarine health – what we do upstream the entire length of a river or its tributaries eventually affects bay systems.

All of the Gulf SGCN marine fishes rely on cooperative management by all national and international partners. The Texas General Land Office (GLO) has jurisdiction for 367 miles of Gulf beaches and more than 3,300 miles of bays, estuaries, and other submerged lands out to a distance of 10.3 miles in the Gulf of Mexico.[34]

## Non-Adjacent States and Canada

Certain habitats throughout Texas within seasonal migratory bird pathways are important stepping stones which allow these species to make progress toward their destinations safely, with food stores for the journey. While the particular pathway will vary a bit each year dependent on weather and other conditions, there are some characteristic habitats that are always important along the way: wetlands, reservoirs, riparian areas, grasslands and dense-canopied woodlands (even "pocket woodlands" – smaller isolated patches – such as oak mottes which dot the Gulf coastal prairies).[35] Whooping cranes,

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[30] TCEQ http://www.tceq.texas.gov/publications/gi/gi-316/gi-316_basin24.html/at_download/file

TWDB. 2010. Freshwater Inflows. http://midgewater.twdb.state.tx.us/

[31] TPWD. 2007. Texas Coastal Ecosystems Map. http://www.tpwd.state.tx.us/landwater/water/habitats/bays/ecosystemmap.phtml

[32] National Wildlife Federation. 2004. *Bays in Peril* http://www.texaswatermatters.org/resources_bays.htm

[33] NOAA Mission Aransas National Estuary Reserve http://nerrs.noaa.gov/Reserve.aspx?ResID=MAR

[34] Texas General Land Office. 2010. *Fact Sheet*. http://www.glo.texas.gov/glo_news/agency-facts/glo-fact-sheet.html

[35] Igl, Lawrence D., and Bart M. Ballard. 1999. *Habitat associations of migrating and overwintering grassland birds in southern Texas*. Condor 101:771-782. Jamestown, ND: Northern Prairie Wildlife Research Center Online. http://www.npwrc.usgs.gov/resource/birds/ngbird/index.htm (Version 06APR2000).

neotropical migrants, and several waterfowl species on the SGCN list rely on these **migratory stopovers** through Texas and their destination habitats in other states, Canada, Mexico, and Central America. [36]

Statewide/Multi-Region Priority Habitats from the Survey

Broad habitat types have been defined for the TCAP and are discussed in the Overview handbook. These broad types were the basis for the survey responses collected in April – May 2011. The survey did not receive much response from the distribution (see Overview handbook); however, the respondents provided valuable information which matches with much of the general habitat information discussed in ecoregion workshops, other states Action Plans, and other conservation plans.

The most vulnerable broad habitat types identified in the survey include the following

| | | |
|---|---|---|
| Grasslands | Riverine | Riparian |
| Freshwater Wetland | Aquifer | Estuary |

*Cave/Karst*, *Coastal,* and *Marine* received equal votes for vulnerability less than the above categories; however, their ranks were not far removed from these other categories. With the exception of grasslands, caves and karst features, most respondents selected aquatic or water-dependent habitats as most vulnerable (caves and karst are not necessarily wet environments).

A few of the other habitats received a few more "votes" than those which received none: forest, desert scrub, and lakes. Forest and desert scrub habitats will be discussed in east and west Texas ecoregions, respectively. The "lakes" comment was primarily related to playa lakes. These are covered under wetlands as an overarching priority habitat in this handbook and playas are covered specifically in the HIPL and SWTB handbooks.

## PRIORITY HABITATS IN THIS HANDBOOK

Based on the general habitat types which span ecoregion, state and/or international boundaries that are important to SGCN and rare community conservation, this handbook will address the following habitats in the Actions section:

- Native Grasslands
- Surface water (wetlands, springs, seeps, bogs, playas, rivers, streams, swamps, estuaries)
- Groundwater
- Riparian and Floodplains
- Gulf of Mexico and associated bays and estuaries
- Seasonal and Daily Movement Corridors and Stopovers
- Colonial Habitats – rookeries, hibernacula, other gathering areas
- Caves and Karst

Some of these broader habitats also have ecoregional contexts; for example:

- The Upper Red River ecological drainage unit for surface water resources has a relationship to the Oklahoma Action Plan and Southeast Aquatic Resources Partnership, where habitats and resource needs have been identified, and this EDU intersects several Texas terrestrial ecoregions (HIPL, SWTB, CGPL, CRTB, TBPR, ECPL, and WGCP);

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Anderson, J.T. and P.J. Dubowy. 1996. *The importance of coastal Texas wetlands for wintering and migration waterbirds*. The Wetland Journal. Winter 1996, Vol 8, No. 1. http://www.wetland.org/jrnlback.html

TPWD. 1994. *Texas Wetlands Conservation Plan*. http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_pl_r2000_0005.pdf

[36] Shackelford, C. E., E. R. Rozenburg, W. C. Hunter and M. W. Lockwood. 2005. *Migration and the Migratory Birds of Texas: Who They Are and Where They Are Going*. Texas Parks and Wildlife PWD BK W7000-511 (11/05). Booklet, 34pp.

- Riparian and floodplain protection is a statewide need, with best management and restoration practices that may vary across all ecoregions;
- Migratory bird stopover habitat along various species' pathways may have critical junctures or patches of importance within a specific ecoregion;
- Unprotected by regulation, "isolated" wetlands conservation is a statewide issue, but may have particular significance to playas in the High Plains and some bogs in east Texas.

Habitats with ecoregion connections will be also addressed in ecoregion handbooks where applicable.

## WATER WATER WATER

Ground water[37] and surface[38] and quality and quantity support nearly every SGCN, rare communities and the habitats on which they rely. Native fish communities consist of warmwater species, and their diversity reflects transitions from a Mississippi Valley fauna to the north and east to a Rio Grande fauna to the south and west.[39] In addition, more than 50 unionid mussel species are know from Texas rivers, streams, canals, reservoirs, lakes, and ponds.[40] Aquatic macroinvertebrates in Texas streams are diverse, but this fauna remains lightly documented by comparison to fishes. Aquatic fauna generally are most diverse in the eastern half of the state, while rivers in west Texas are more depauperate.[41] Waters are affected by nearly every action taken by people, both positive and negative. These waters provide people with drinking water, hydropower, transportation, wastewater treatment, irrigation of food and fiber crops, commercial and recreational fisheries, other recreational opportunities (kayaking, swimming, wildlife viewing) and many commercial and industrial uses critical to the way we live. The sustainability of the various types of waters in Texas is a constant issue in the public mind, coffee shop discussions, business and politics.

*Health and function of aquatic and terrestrial ecosystems throughout Texas rely on how and if good quality freshwater makes its way from raindrop to river to estuary to Gulf of Mexico.*

*Groundwater*

"Groundwater resources" in Texas refer to major and minor aquifers (Figure 3, Figure 4) and their recharge areas. Groundwater may be deep features that are typically hidden (unless we happen to be cavers in Central Texas) like the Edwards Aquifer and perched water features like playas in the Plains. All groundwater is sourced from rainfall and runoff, with varying storage times in its substrate – some are very porous or highly utilized so the water doesn't stay in the groundwater feature long. As of 2003, aquifers provided approximately 60 percent of the 16 million acre-feet of water used by humans in Texas. [42] In some areas, groundwater resources are tangled with surface water resources (e.g. Edwards Aquifer withdrawal effects on spring outflow in the Comal and San Marcos Rivers and the subsequent consequences to sensitive, rare invertebrates, plants, and fishes in those systems).

In some areas, we understand well how surface expressions of groundwater features – springs, seeps, playas, cienegas, saline lakes and even their connected streams and rivers-- support a wide range of SGCN and rare plant communities (to name a few):

- Pecos gambusia, Leon Springs pupfish, rare snails and crustaceans, and the Pecos sunflower in west Texas;

[37] Texas Water Development Board. 2006. *Major Aquifers of Texas*. http://www.twdb.state.tx.us/mapping/maps/pdf/aqu_maj_8x11.pdf

[38] Texas Commission on Environmental Quality. 2004. *Atlas of Texas Surface Waters*. http://www.tceq.texas.gov/publications/gi/gi-316

[39] Conner and Suttkus 1986

[40] Howells et al. 1996

[41] Edwards et al. 1989; Linam et al. 2002

[42] Texas Water Development Board. Groundwater Resources Division homepage. http://www.twdb.state.tx.us/GwRD/pages/gwrdindex.html

- a plethora of Eurycea sp.,a troglobitic crustacean, Guadalupe darter, roundnose minnows, canyon sedge and springmoss in central Texas; and
- bog coneflower and rough-stem aster in east Texas.

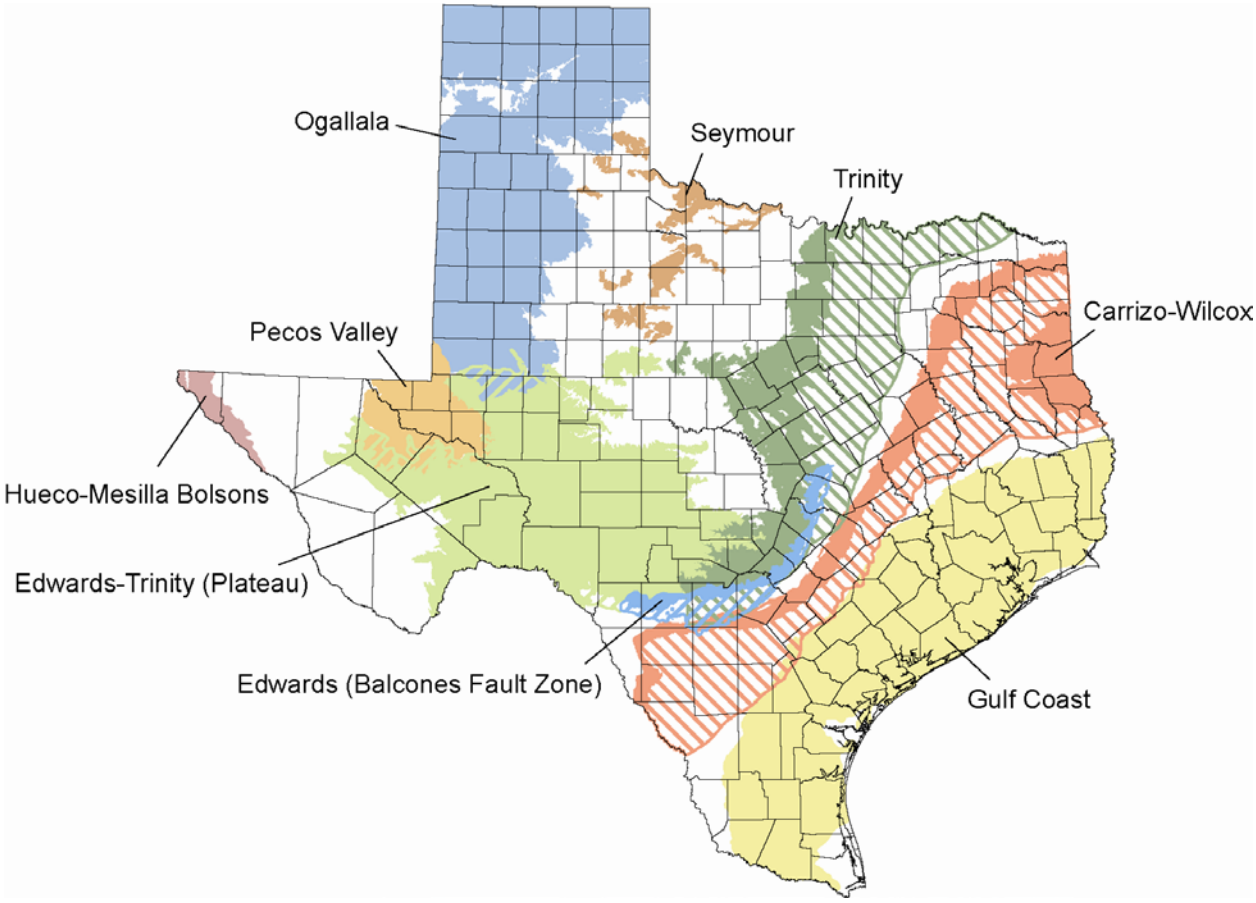
In other areas, our knowledge of groundwater surface expression locations, understanding of the groundwater contributing and release systems, impacts to their quality and quantity, and the effects to SGCN and rare communities is not well-understood.

Impacts to groundwater resources include impervious cover which prevents infiltration into recharge features, poor quality runoff from agricultural lands or developed areas with insufficient stormwater pollution prevention facilities, and over-extraction of the water resource. These impacts can affect

- physical changes to karst, springs, cienegas (water amount and quality) adversely impact some species' thresholds for survival and/or sustainable life history (reproduction, foraging, resting)
- instream aquatic habitats which rely on springflow through decreased amount of water coming into the stream (flow, depth, substrate changes, adjacent riparian habitat changes from dry conditions) and changes in instream water conditions such as temperature, oxygen availability, and other nutrient and chemical factors (such as the age of water source that comes from the aquifer)
- decreased and degraded aquifer recharge capacity ("drying out the sponge or seive" at certain levels within the aquifer can affect the flow quantity and quality into the aquifer from recharge events).

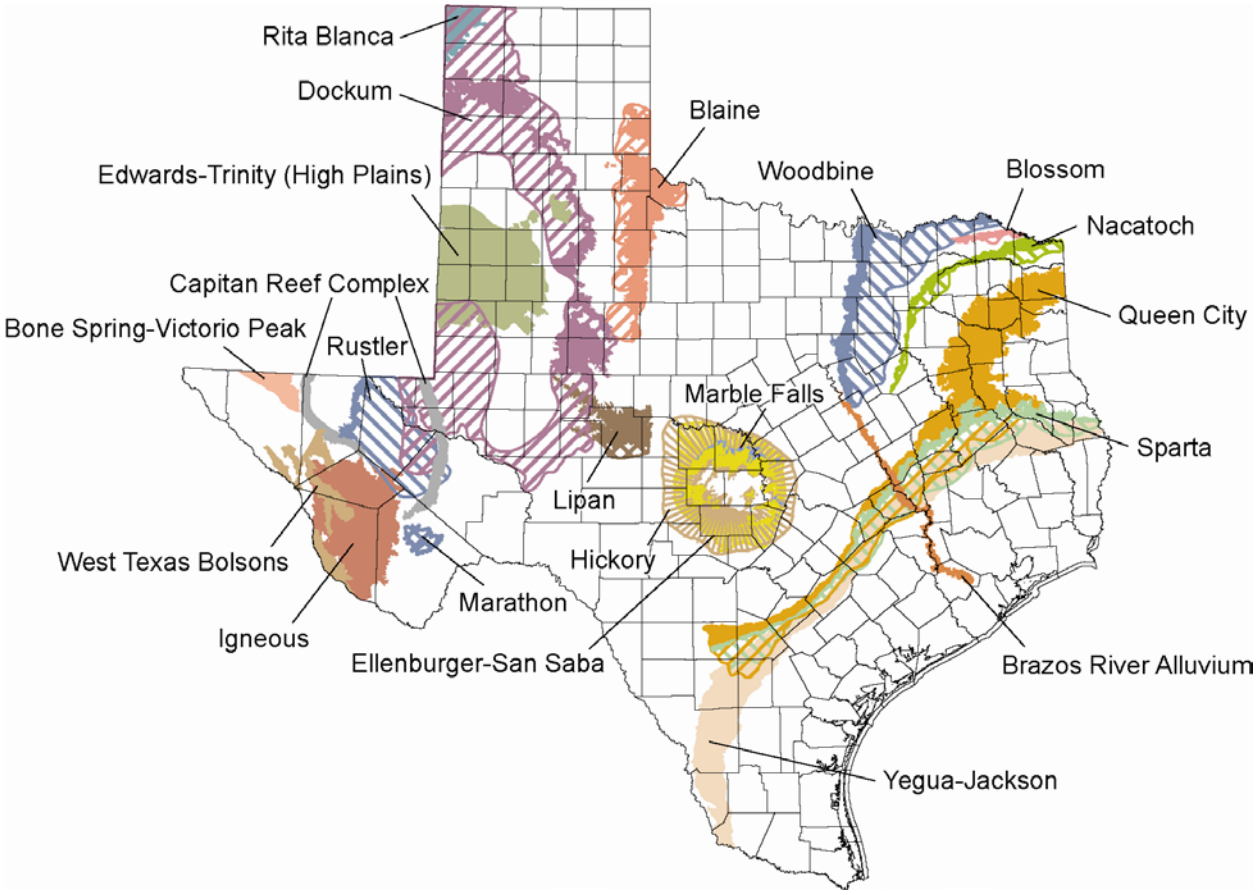
Beyond aquifer management, aquifer health and function are dependent on recharge, which varies by rainfall, soils, geology, and ongoing use, plus the surface activities which may threaten quality (e.g. pesticides in runoff, episodic oil or natural gas pipeline releases). So, groundwater habitats are not just dependent on who is managing the resource or what factors are considered in management, but also dependent on protecting the quality of potential contributions to aquifer systems. Stormwater management and recharge protection are key issues affecting aquifer health.

**Figure 3. Major Aquifers of Texas**




Source: Texas Water Development Board

**Figure 4. Minor Aquifers of Texas**




Source: Texas Water Development Board

*Surface water*

Surface waters – seasonal and permanent, arroyos, creeks, streams, rivers, ponds, resacas, oxbows, cienegas, springs, seeps, wetlands, playas, etc. – are connected to nearly every resource issue.[43] Texas has about 191,000 miles of rivers and streams, with fast sandy to cobbled riffles to deep slow rocky to muddy pools, which provide habitat for over 255 species of fish – 150 of which are freshwater natives. Approximately 20 percent of Texas native fishes are threatened with extinction and/or extirpation from their native ranges.

Several surface water *types* are considered most at risk across the state and important to SGCN (freshwater fishes, freshwater mussels, all aquatic insects) and rare instream, riparian, and bottomland plant communities:

- Springs
- Ecologically Significant Stream Segments[44]
- isolated "unregulated" wetlands (including but not limited to seeps, playas, saline lakes, off-channel freshwater marshes, natural oxbow lakes; swamps, bogs, fens, …).
- any stream segment supporting a currently intact and functional riparian area (see *Riparian and Floodplains* section)
- Estuaries (covered in the next section).

Currently, the most recent published account of springs in Texas is Gunnar Brune's *Springs of Texas* (1981). This privately published book represents a lifelong labor of love and provides the only thorough treatment of more than twenty-nine hundred springs in 183 Texas counties; however, this is just a sampling, based on access and the ability to collect this information.[45] Springs all across Texas support many endemic and rare SGCN – salamanders, aquatic invertebrates, pupfish and minnows – in desert and forest ecoregions. Plant communities surrounding these features are also highly specialized. These sites occur across the landscape and/or within or adjacent to rivers and streams. They are *very* sensitive to human and livestock disturbance and groundwater impacts.

Wetlands are incredibly diverse habitats in Texas – desert cienegas to plains playas to forested bottomlands, bogs and fens, freshwater and saltwater marsh. Many wetlands are unique to a certain degree, as their individual characteristics are determined by a combination of factors such as climate, soils, hydrology, and vegetation. Most wetlands experience a fluctuating water level on a seasonal or even yearly basis, so some areas that are difficult to identify as wetlands during the summer may be completely inundated during the winter.[46] Influencing factors and wet period duration influence the types of SGCN and rare communities which can thrive in these highly unique habitats. Wetlands have been filled in for development or converted to agricultural uses, degraded by contaminated surface runoff or saltwater intrusion, and depleted by loss of groundwater and/or surface water connections. Only recently have their values for flood control, water quality protection, and connection/support to many other terrestrial and aquatic ecosystem been recognized. One "classification" of wetlands is at highest risk – those considered non-jurisdictional and isolated. These are not protected under any regulation and typically are some of the most unique, important wetlands, disconnected from river and stream systems as stand-alone features – playas, bogs, and fens are examples. Most aquatic ecologists who commented for this plan also stated regulated, jurisdictional wetlands are also imperiled habitats. At some point, wetland loss of either kind depletes the ecosystem function to an irretrievable point; in

[43] Estuaries are a special class of surface water covered in this section.

[44] TPWD. 2002/2005. Ecologically Significant Stream Segments.
http://www.tpwd.state.tx.us/landwater/water/environconcerns/water_quality/sigsegs/

[45] A second volume has been in the works, dependent on funding availability, willingness of landowners, limited personnel, and time.

[46] TPWD http://www.tpwd.state.tx.us/landwater/water/habitats/wetland/ecology/index.phtml

some areas, take of regulated resources is unsustainable and mitigation measures are inadequate to replace that function in the system.

River, stream and creek watersheds most at risk have been identified through the National Fish Habitat Action Plan processes, including the 2010 report and companion data viewer already discussed.[47] These waters represent those most potentially impacted by the following human activities:

- Urban/Human settlement (urban land use, human population density, road density)
- Livestock and grazing (pasture and hay in the watershed)
- Agriculture (row crop agriculture in the watershed)
- Point source pollution data (National Pollution Discharge Elimination Sites, Toxic Release Inventory sites, and National Superfund sites);
- Habitat fragmentation (dams and road crossings) and
- Mine density.

Development that occurs along the bottom of or adajcent to streams, wetlands, marshes, such as water and wastewater lines and other pipeline crossings, also contribute to habitat degradation. Because aquatic and terrestrial resources are ecologically related, and the impacts assessed through the NFHAP process include many terrestrial sources, these sites also represent opportunities for terrestrial conservation actions.

In many instances, surface water has its origins below the surface, just as the water stored in the aquifers below the ground has flowed or percolated downward from the land's surface at some point in the past.[48] Instream *water quality and quantity* from all surface waters are extremely important as they eventually support estuary health.[49]

*Estuaries, Bays and the Gulf of Mexico*

Estuaries are the complex systems where freshwater rivers flow into the saltwater bays and Gulf of Mexico. There is wide salinity-gradient from river influence to the Gulf proper which influences vegetation communities at the edge and within these systems. A few examples of SGCN which depend on these resources for some portion or all of their life needs:

- Bay and estuary fishes
- White-faced ibis, reddish egret, whooping cranes (which rely on blue crabs, other benthic organisms, and estuary-supported vegetation)
- Diamond backed terrapin
- Young of (list appropriate SGCN marine fishes)

These bays and estuaries are vital for fish, shrimp, oysters, crabs and many species of birds and they are the engine behind the $2+ billion recreational and commercial coastal fishing economy.[50] The Texas coastline also has one of the highest diversity of bird species in the world. A birding destination near Matagorda Bay, for example, regularly tops the Audubon Society's prestigious Christmas Bird Count. Probably the most famous bird species in Texas is the endangered whooping crane, which winters along San Antonio Bay near the mouth of the Guadalupe and San Antonio rivers. Total impact on the state's economy from commercial fishing, sport fishing, hunting, and other recreational activities. In 1991, sport

[47] National Fish Habitat Board, 2010. *Through a Fish's Eye: The Status of Fish Habitats in the United States 2010*. Association of Fish and Wildlife Agencies, Washington D.C. 68 pp. http://fishhabitat.org/images/documents/fishhabitatreport_012611.pdf

[48] Environmental Defense. 2009. *Down to the Last Drop*. http://www.texaswatermatters.org/pdfs/lastdrop.pdf

[49] US Environmental Protection Agency. National Estuary Program. http://water.epa.gov/type/oceb/nep/index.cfm

[50] Texas Water Resources Institute. 2001. *Impacts of Recreational and Commercial Fishing and Coastal Resource-Based Tourism on Regional and State Economies*. http://twri.tamu.edu/reports/2001/tr184/tr184.pdf

Texas Water Matters. 2007. http://www.texaswatermatters.org/pdfs/texas_water_legislation.pdf

fishing—salt and freshwater—brought in about $2.8 billion to the Texas economy. Of that total approximately $320 million were on saltwater fishing, and $770 million in expenses related to food lodging, transportation, and boat rentals. Half of the seafood consumed in the US comes from the Gulf. The state's annual catch of shrimp, other shellfish and finfish pumps $400 million into the economy each year and provides jobs for 30,000 coastal residents. None of this economy would be possible without healthy estuary systems which support commercial and recreational fisheries nurseries; resident, migratory and overwintering bird habitat; waterfowl hunting opportunities; and other recreational pursuits such as kayaking. Additionally, bays and estuaries provide flood protection from storm surges and filtration of river sediments and nutrients to keep bay and Gulf water quality suitable for fisheries, recreation, and tourism economies.

Four general types of marsh – freshwater, intermediate, brackish, and saline – are based on the salinity gradient. These are not "hard boundaries" of species and vegetation types for the most part; although, Texas marsh zone vegetation communities appear to create areas of high localized diversity.[51]

In addition to all marshes, priority estuary, bay and Gulf habitats include[52] the following:

- seagrasses
- hard bottom (oyster and coral reefs) and softbottom (mud and sand);
- barrier and spoil islands
- coastal shorelines
- wind, tidal and mud flats.[53]

Because so much of what happens "on land" flows eventually into the Gulf and the Gulf Coast is a major economic engine for the state[54], there are many potentially adverse issues affecting these habitats:

- surface water extraction, flood control and reservoir (hydropower, drinking water) development and operations reduce the "right kinds" of nutrients and sediments and cause a significant change in the quality and amount of freshwater contributions from streams and rivers
- runoff contaminants from agricultural production and urban stormwater can cause significant water and sediment changes that can cause nitrification, hypoxia, harmful algal blooms, and hypoxic dead zones

[51] Stutzenbaker 1999 a

S.C. Pennings 2004 *Environmental Variation and the Diversity of Texas Salt Marsh Plant Communities* http://prtl.uhcl.edu/portal/page/portal/EIH/archives/INCLUDES/04pennings.pdf Environmental Institute of Houston.

[52] USGS. Seagrass Status and Trends in the Northern Gulf of Mexico: 1940 – 2002. Scientific Investigations Report 2006-5287. http://pubs.usgs.gov/sir/2006/5287/pdf/

Edgar, G.J., Barrett, N.S., Graddon, D.J. & Last, P.R. 2000, 'The conservation significance of estuaries: a classification of Tasmanian estuaries using ecological, physical and demographic attributes as a case study' , *Biological Conservation*, vol. 29 (2000), pp. 383-397.

Beck, M.W., M. Odaya, J.J. Bachant, J. Bergan, B. Keller, R. Martin, R. Mathews, C. Porter, G. Ramseur. 2000. Identification of Priority Sites for Conservation in the Northern Gulf of Mexico: An Ecoregional Plan. The Nature Conservancy, Arlington VA. http://sdms.cr.usgs.gov/pub/ngom/gulf.pdf

Trinational Initiative. 2009. A Blueprint of Collaboration — and Friendship: Third Trinational Initiative Workshop: Havana, Cuba. http://trinationalinitiative.org/en/a-blueprint-of-collaboration-and-friendship-third-trinational-initiative-workshop-havana-cuba

Gulf of Mexico Alliance (GOMA). 2006 and 2009 http://gulfofmexicoalliance.org/welcome.html

Gulf of Mexico Foundation (GOMF) n.d. http://www.gulfmex.org/conservation.htm and http://www.gulfmex.org/gems.htm

Gulf of Mexico Restoration (GOMR). n.d. Habitat Restoration Portal. http://webportal.gulfmex.org/Intro2.html

[53] Dunes are covered in the GCPM ecoregion handbook; see also Climate Change section.

[54] Texas State Comptroller's Office. 2010. Texas in Focus: Gulf Coast Region. http://www.window.state.tx.us/specialrpt/tif/gulf/pdf/GulfCoastFullReport.pdf (this report really only covers the upper coast, but is somewhat respresentative)

- navigation waterway maintenance (dredging, widening, deepening, dredge material use) and shipping channel/port operations can degrade marshes through saltwater intrusion and wave action which damages vegetation
- human disturbance of sensitive species (sea grasses impacted by propellers, barrier and spoil island bird rookeries affected by fishing activities too close to their breeding areas)
- climate change causing sea level rise (shoreline, island and marsh loss) and ocean acidification (decreasing the ability of oysters and corals to form calcified bodies)
- energy development projects can cause marsh, soft bottom, and hard bottom impacts through exploration, structure placement, and transmission (pipeline, other lines) placement.

The Gulf Coast states of Texas, Louisiana, Mississippi and Alabama make up four of the five top states for the greatest surface water discharge of toxic chemicals in the USA from various sources, such as agricultural runoff and urban development.[55] Up to 30% of Gulf coastal waters are closed to shellfish harvest in large part due to pollution from municipal water treatment plants and non-point discharge from urban areas.[56] Nutrient source and impact studies are a frequently cited need.[57]

The timing, volume and quality of fresh water inflows have direct effects on the overall health of an estuary and its living marine resource habitats. Fresh water inflows to Texas bays have been drastically reduced through the construction of large reservoirs. For example, Nueces Bay often goes hypersaline. This condition has been attributed to reduced fresh water in the drainage from the construction of the Choke Canyon Reservoir. Continued population growth will place more demand on the state's limited fresh water supply. Reduced inflows will significantly alter salinity gradients, circulation patterns and nutrient levels within the bays and can affect habitat such as wetlands and oyster reefs. These alterations can also alter the distribution and abundance of fish and shellfish species that inhabit the bays.

See also the *Issues: Water Development, Management, and Distribution* section.

### Riparian and Floodplains

Riparian zones and floodplains are often linked with water resource quality and quantity, as they are water-dependent assemblages of plants and animals with important functions in stream, river and (eventually) estuary health. Riparian and floodplain habitats are connected and adjacent to waterways and/or the abandoned channels isolated by a river's change in course, located between instream aquatic and upland habitats. There are shades of gray in riparian, floodplain and wetland definitions (such as bogs, swamps, and bottomlands) as all of these may be supported by surface or subirrigated flow, overbank flooding or backwater.

The importance of intact, healthy native vegetation in riparian areas and floodplains cannot be overstated[58] – riparian areas and floodplains in natural condition create high quality instream and stream-adjacent habitats. They retain soils and substrates to stabilize banks, filter potentially hazardous runoff to preserve instream water quality, slow floodwaters to prevent bank erosion and sedimentation, provide important nursery areas for many species of fishes and invertebrates, regulate water temperature, slow surface water evapotranspiration, recharge alluvial aquifers, provide movement corridors and stopover habitats for wide-ranging (e.g. black bear, ocelot) and migratory (e.g. neotropical songbirds) wildlife, and are important to resident SGCN (e.g. common blackhawk, common yellow throat, Coues' rice rat). Rivers with native intact floodplains and riparian areas positively impact the

[55] TNC 2000

[56] HRI 2011

[57] NOAA NMFS 2010 http://www.st.nmfs.noaa.gov/st4/documents/habitatAssesmentImprovementPlan_052110.PDF

[58] (TPWD 2004, TNC 2010, NRCS 1996, NRC 2002)

water quality that eventually feeds the estuaries of the Gulf of Mexico. Some of the rare riparian plant communities in the TCAP 2011 list are Freemont Cottonwood – Velvet Ash Woodland, Freemont Cottonwood – Goodings Willow Woodland, Netleaf Hackberry – Little Walnut, American Sycamore - (Black Willow) / Little Walnut - Mule's-fat Woodland, Edwards Plateau Bald Cypress - Sycamore Gallery Forest, Subtropical Texas Palmetto Woodland, among others. These communities follow some of the remaining intact floodplains as mapped by the Federal Emergency Management Agency, but are better identified using the vegetation types mapped by the Texas Ecological Mapping Systems Project.

Riparian area, floodways and floodplains, are heavily impacted throughout the state:

- clearing to waterway edges for recreational and livestock watering access
- concentrated livestock grazing (more grass production favored over woody species)
- non-native species invasion (salt cedar, tree of heaven)
- altered stream channels for floodwater transfer (armored bank, channelized floodway, culvert)
- lack of or insufficient streamside buffer Best Management Practices in timber removal
- construction that removes riparian habitats (bridges, some transmission lines, border fence)
- reservoir construction which inundates these areas (even if mitigated, cannot replace the ecological function of what was lost)
- loss of surface water flow and naturally subirrigated substrates (groundwater near the surface) from extraction.

See also the *Issues: Water Development, Management, and Distribution* section.

### Native Grasslands

Once abundant habitat for some of Texas's charismatic fauna – pronghorn, bison, lesser prairie chickens – and SGCN that reward more patient observation – Swift tiger beetle, American burying beetle, Brilliant forester moth, Sage sphinx moth, dicksissel, grasshopper sparrow, Texas prairie dawn – Texas grasslands are now few and far between: highly fragmented, compromised in quality, or such tiny patches as to be barely functional habitat at all. Most of Texas's expanses of flat and gently rolling terrain was historically covered in coastal and blackland prairies, plateaus and plains, short- mid- and tall grasses[59], maintained by wildfire and unfenced wide-ranging herbivores. Fewer than five percent of the world's grasslands are well-managed or protected; in Texas, less than 5,000 acres (some estimates say less than 3,000 acres) of Blackland Prairie remain out of 12 million historic acres - less than one percent![60]

Our native prairies and grasslands are desired for livestock grazing and some are well-conserved; however, most heavily impacted or lost:

- converted to crop agriculture, non-native pasture grass, and urban development (relatively flat, easy to access)
- overgrazed or improperly grazed (parcels too small to sustain healthy operations, fencing and water development concentrate too many animal units in a season or area)
- improper tillage and/or overhaying (disturbs critical root zones, removes natural seedheads and native regeneration source)
- non-native (e.g. tree of heaven) and native problematic (juniper, mesquite) brush encroachment due to lack of natural fire and/or overgrazing/overbrowsing

[59] F. Smeins, and D. Diamond. 1985. Composition, Classification and Species Response Patterns of Remnant Tallgrass Prairies in Texas. American Midland Naturalist: Vol. 113, No. 2, Apr., 1985

[60] Native Prairies Association of Texas. http://texasprairie.org/index.php/learn/about_prairies_entry/why_protect_and_restore_prairie/
World Wildlife Fund. 2001. http://www.worldwildlife.org/wildworld/profiles/terrestrial/na/na0814_full.html

- fire ant infestations (cause local extinctions of other ant and insect species that are pollinators and/or food sources).

In 2004, 55 Grassland Priority Conservation Areas (GPCAs) were identified by biodiversity experts through research and a workshop co-organized by the CEC.[61] This map was updated in 2010; however, few sites were included in Texas due to the nature of highly fragmented landscapes of the blackland prairies and largely privately held (and unknown) grassland sites in the remainder of Texas. Some grassland and prairie mapping in the state has been led by the Native Prairies Association of Texas (NPAT) citizen science effort; however, their efforts to date have been focused to map last remaining blackland prairie remnants. NPAT currently protects over 1200 acres of native Texas prairie, including over 100 acres of endangered/threatened tallgrass prairie. The Texas Ecological Mapping System project, NPAT's mapping effort, prairie conservation efforts of local land trusts like the Katy Prairie Land Trust, management of conservation prairies like Clymer Meadow (TNC) and future efforts with interested partners will be crucial to determine how to map remaining intact functional grasslands, identify opportunities for private lands participation, and manage remaining native areas to prevent prairie and grassland system extinction.[62]

There are needs across the state to conserve remaining grasslands (representative SGCN in parentheses): montane in west Texas (pronghorn), mid-grass and short-grass in the High Plains (burrowing owl, black-footed ferret, Lesser prairie chicken), mid-grass and tall-grass in central Texas (scissor-tailed flycatcher), coastal prairies (Attwaters prairie chicken, LeConte's sparrow), and mosaic prairies throughout our wooded and forested regions (many isolated plants).[63]

### Seasonal and Daily Movement Corridors and Stopovers

Texas is considered important in many migratory pathways (flyways) for many migratory bird species.[64] Our state provides key habitats to SGCN birds on migration routes to/from other states (some which do not share our border), Central and South America, Mexico and Canada. Additionally, Texas provides overwintering habitats for SGCN birds which breed outside of Texas. In Texas, priority habitats of all types occur along these routes and as overwintering grounds – coastal shorelines, marshes, and prairies; agricultural fields and native grasslands; woodland mottes; rivers and riparian zones; wetlands and lakes; and parklands/preserves within and adjacent to urban areas – used as resting and restoration areas for days to months at a time. SGCN benefitting from these areas include eastern kingbird, bobolink, mountain plover, piping plover, many neotropical migrant warblers, peregrine falcon, whooping crane, ferruginous hawk.

### Colonial Habitats

Colonial habitats are a special category, representing a wide cross-section of animal assemblages and substrates (islands, shrubbery, mature tree mottes, caves, crevices, bridges, soils, etc.). These may be roost sites, rookeries, hibernacula, or other congregational breeding, feeding and/or sheltering areas. Overwintering bald eagles will typically gather in groups near lakeshores in mature trees, including dead snags. Many egret and heron species congregate to mate and raise young in dense riparian, shrub or tree "islands", marshes, and other wetlands. Spoil, barrier, and midchannel river islands provide tern

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[61] CEC 2004 and 2010. *Grasslands: Toward a North American Conservation Strategy* (and map). http://www.cec.org/Page.asp?PageID=924&ContentID=5609&AA_SiteLanguageID=1

[62] Finch, Deborah M. 1996. Ecosystem Disturbance and Wildlife Conservation in Western Grasslands: Symposium Proceedings. DIANE Publishing.

[63] Partners in Flight. *Bird Conservation Region (BCR) Plans*. http://www.partnersinflight.org/bcps/pifplans.htm

[64] USGS DATE http://www.npwrc.usgs.gov/resource/birds/migratio/routes.htm

TPWD 2005 weblink

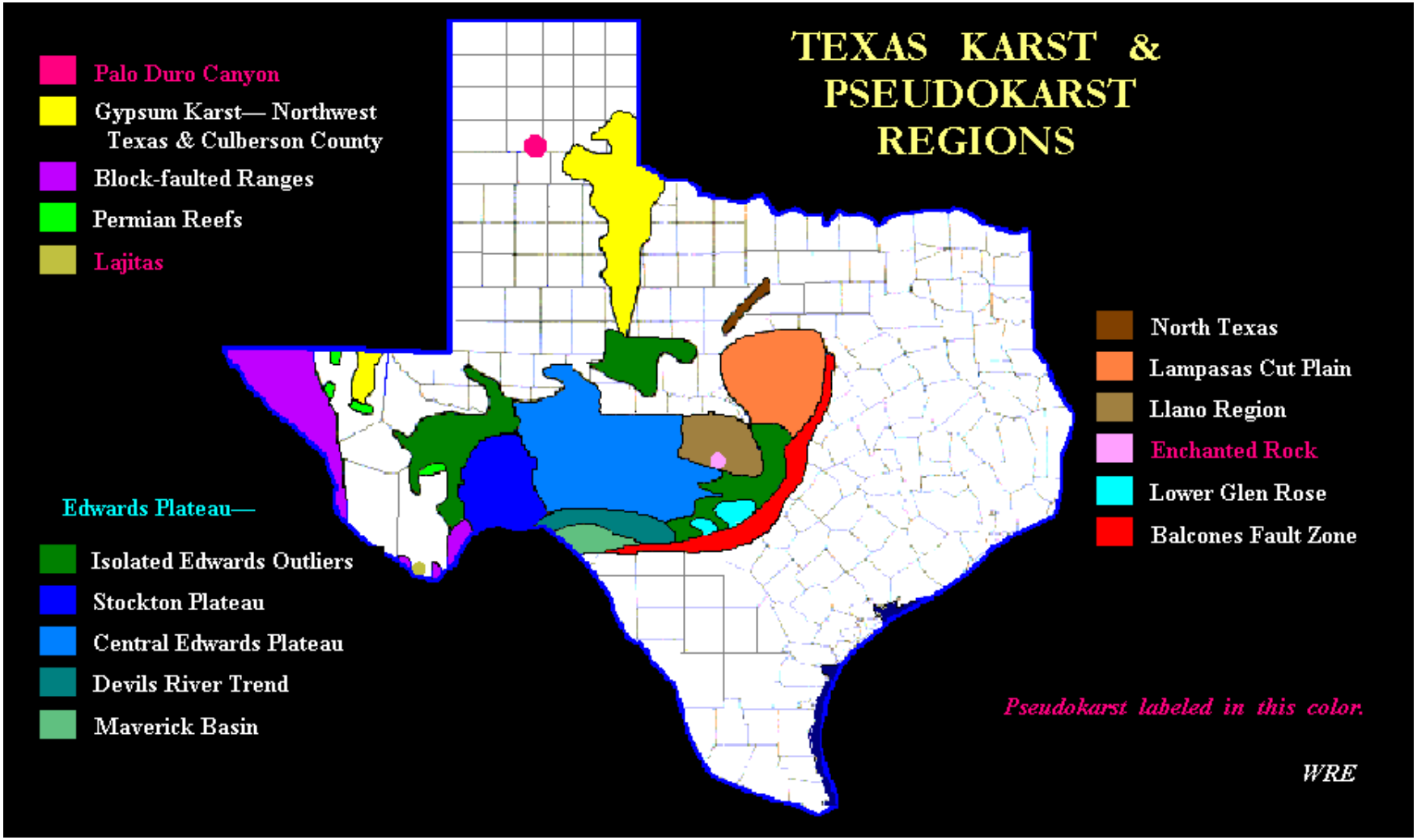
nesting areas for different species. Maternal colonies of some bat species will gather to raise their young in caves or under bridges; young "bachelors" will also congregate, in separate areas. Harvester ants, many bee species and wasps have highly organized social colonies. Western diamondback rattlesnakes congregate to breed and conserve energy through the winter. Mountain plover and some hawk species will gather during migration and winter in shortgrass plains, agricultural fields and pastures. Some of these sites are repeatedly visited, every year; some are more transitory. The primary threat to the habitats is simply human disturbance – physical presence, harvesting, and harassment – during the use periods by these colonies.

### Caves and Karst

When most of us think of caves in Texas, we think about "show caves" like Natural Bridge Caverns or the Caverns of Sonora; but, there's more to this habitat type than those we can visit. Caves are a type of karst or pseudokarst. Three types of karst features are known in Texas: carbonate (solution-formed in limestone or dolomite); evaporite (solution-formed in gypsum); and pseudokarst (not soulution-formed in volcanic or unconsolidated materials).[65] Crevices, cracks, sinkholes, caverns and grottos occur in certain regions in Texas (Figure 5) and provide some very unique, sensitive habitats in most of these areas for solitary and colonial bats, *many* unique isolated invertebrates, and colonial birds like swifts and swallows. These fissures also provide a conduit for surface waters to reach groundwater aquifers and for artesian groundwater resources to surface (e.g. over the Edwards Aquifer recharge zone, or springs that feed the Comal River), which are very important for many species at that interface such as Eurycea salamanders, spring-dependent river system fishes, and several rare plant communities. Many of these karst or pseudokarst features are large, open in variable degrees to the environment which surrounds them, and are an integral part of a complex system. Inputs to these features from the surrounding landscape – leaf litter, animal activity (foraging, defecating, hibernating, mating and breeding), runoff (from undeveloped and developed areas) and direct rainfall, proximity to the groundwater resources below, human activity (from harmless exploration to toxic chemical dumping) – all affect the interior environment of these features and their suitability for certain karst-dependent SGCN.

[65] American Geological Institute. 2001. U.S. Karst Map. http://www.agiweb.org/environment/karstmap.pdf
Smith, A.R. and G. Veni (with minor additions by W.E. Elliot). 2010. Karst Regions of Texas (online, Texas Speleological Socieity). http://www.utexas.edu/tmm/sponsored_sites/tss/cavesandkarst/tsskarstregions.htm

**Figure 5. Karst and Pseudokarst in Texas**




Source: *Cave and Karst Regions of Texas*, as found on the Texas Speleological Society website: http://www.utexas.edu/tmm/sponsored_sites/tss/images/tk1.gif

## PRIORITY ISSUES

Not all activities which *can* impact fish and wildlife resources *do*. All municipal, commercial and industrial developments are not bad – people must have places to live and work. All infrastructure development is not bad – we like flipping a switch to turn on a light, flushing a toilet, taking a roadtrip for vacation. All grazing and agricultural practices are not bad – we like eating! Human life is an integral part of ecological conservation – we take care of our lands and waters, they take care of us.

The "issues" arise when our activities are not thoughtful about the full extent of impacts we can predict or understand, now and in the future, based on the best science available. We cannot keep deriding the "sins of our fathers" who acted with the best information they had at hand; we now *must* all must move forward deliberately, with current knowledge we can support, and take a collaborative approach to problem-solving.

Certain **actions and conditions** can negatively affect SGCN populations, rare communities, and the habitats on which they depend. These issues can include **direct or indirect harm** (e.g. inappropriate mining reclamation which uses non-native vegetation or indirectly provides an opportunity for non-native invasive vegetation, streambed gravel mining that directly removes spawning habitat and/or indirectly creates poor water quality downstream) **plus basic "gaps" that prevent us from acting most effectively** (e.g. lack of information, lack of coordination to share current data, incompatible practices among land managers, lack of funding). Interestingly, an issue in one area may be solution in another; for instance, wind energy development which impacts lekking habits of lesser prairie chickens and causes barotrauma in bats is a "green" energy alternative that could reduce the need for other types of impactful energy production and some of the causes of climate change. Conservation actions in this document are aimed at improving the status of species and communities' populations and their habitats and/or *reducing the negative effects of issues on species, communities and habitats*.

**Habitat fragmentation and habitat loss, including open-space land conversion,** are frequently cited very broad issues that need to be addressed, at various scales – local, regional, statewide, interstate, and international. These are such broad categories and, depending on the scale of the problem, these three issues can be symptoms or causes of many other issues. The issues covered in the TCAP attempt to present more of the specific context for conservation issues to help target our actions.

Issues included in this handbook are those which affect an area larger than an ecoregion and require cooperation across ecoregions, state boundaries, and/or perhaps international boundaries. Several of these larger issues are also "emerging" conservation issues – those which have appeared or significantly amplified in the last few years since the 2005 Plan. The broad categories are organized by the definitions provided in the Overview handbook and on the TCAP 2011 website - Supporting Documents: Issues Categories Descriptions.

Out of the nineteen categories, the Core Statewide/Multi-region Team survey, stakeholders in ecoregion workshops and public input have identified several of the most significant (this may change a bit based on public comments June 10 – July 8, 2011). Because of the broad nature of the Statewide/Multi-region handbook, some of the Issues categories have been combined below. Several of the comments to date are addressed in ecoregion handbooks as they are more localized issues.

There are direct relationships among many of these issues and the priority habitats discussed in the previous section (e.g. **Issue**: Water Development, Management and Distribution related to **Priority Habitat**: Surface Water or Groundwater).

The most significant issues for the Statewide/Multi-Region Handbook are:

| | |
|---|---|
| **Water Development, Management and Distribution** | **Invasive Species** |
| **Population Growth and Demographic Changes** *(and Land and Water Management – Municipal)* | **Conservation Practices and Funding** [1] |
| **Land and Water Management – Farm and Ranch** [2] | **Energy Production**[3] |
| **Climate Change** | |

*1* ***Conservation Practice and Funding****: this is compiled from many related comments about communication, habitat connectivity, and funding opportunities/partherships. This section cross-cuts the following Broad Issues: Land and Water Management-Recreation and Conservation, Lack of Information and Resources, Inadequate Policies, and Other Broad Cross-Cutting (Economy).*

*2* ***Land and Water Management – Farm and Ranch****: Respondents did not usually distinguish between farm or ranch working lands in their comments for this handbook; distinctions were more evident in the ecoregion handbooks.*

*3* ***Energy Production****: Most comments to date lumped concerns into "Energy Production" containing both Power Development and Transmission AND Oil and Natural Gas Production and Delivery; distinctions are more evident in ecoregion handbooks.*

## WATER DEVELOPMENT, MANAGEMENT AND DISTRIBUTION

Water development, management and distribution is a huge category, with some common themes related to surface and groundwater planning and policies, impoundment and release, quality control, and basin transfers. Our water resources are interconnected and that understanding is key to successful conservation.[66] Texas is predominantly an arid state and drought is a regularly occurring condition, sometimes more intense than others. We can't do anything about the weather, but we can do something about how water is treated once it gets here!

From stream headwaters to the estuaries and bays of the Gulf of Mexico, from the aquifer recharge zones to the springs and rivers dependent on groundwater, water development, management and distribution are (according to most conservation practitioners and the public) the most important issues in the state for fish, wildlife and humans. These touch on many of the other issues mentioned in handbook and throughout ecoregion handbooks.

### Instream Flows

Many of the themes in this section are related to the key concept of instream or environmental water flows. [67] The quality and quantity of water in our creeks and rivers affects everything from instream life to the riparian zones and wetlands in the area, groundwater resources, and estuary health. Instream flows combined with the physical features of the stream (substrate composition and distribution, cover) provides instream habitat for fish and other aquatic organisms. Streamflow also functions to clean and

[66] Texas Water Matters. 2011. Special Topic: Interconnectivity. http://www.texaswatermatters.org/groundwater_interconnectivity.htm

[67] Much of the information for this section was compiled by the TPWD River Studies Program (Doyle Mosier, ret.) in 2011. Other references are inserted where appropriate.

maintain channel features, replenish nutrients and sediments along river corridors for riparian zones, and cue spawning/reproduction for many river species.

While there has been a long history of state agencies and their partners voicing and working on this concern[68] and Senate Bill 1 in 1997 provided a regional framework for planning and developing the state's water resources (Regional Planning Groups), the real impetus for dealing with water availability for all interests – human, fish and wildlife – came in 2001, through Senate Bill 2 (SB2).

SB2 directed the state agencies with responsibility for the management of state's water resources (Texas Parks and Wildlife Department, Texas Commission on Environmental Quality, and Texas Water Development Board) to "jointly establish and continuously maintain an instream flow data collection and evaluation program and shall conduct studies and analyses to determine appropriate methodologies for determining flow conditions in the state's rivers and streams necessary to support a sound ecological environment" (Section 16.059(a)), and to "establish a work plan that prioritizes the studies and that sets interim deadlines providing for publication of flow determinations for individual rivers and streams on a reasonably consistent basis throughout the prescribed study period" (Section 16.059(d). This resulted in the Texas Instream Flow Program (TIFP). The methods were reviewed by the National Research Council of the National Academies of Science and changes were made based on tha report. [69] SB3 in 2007 authorizes the creation of a stakeholder-based process to develop environmental flow standards for the entire state within a very short timeframe. SB2 required the priority studies to be completed by December 31, 2010, but was subsequently amended by SB 3 to a December 31, 2016 completion date. Key to SB3 legislation is the incorporation of an adaptive management strategy. New or certain amended water right permits issued post SB3 and subject to these environmental flow standards can be modified by 12.5 per cent as better information or science is developed. Many people see this as the bridge between SB3 and SB2 as the results of the instream flow studies mandated by SB2 become available.

Biologists no longer consider the recommendation of a minimum flow protective of fish and wildlife habitat. It is currently recognized that instream flows not only maintain physical habitat features, but play a key role in protecting water quality under low flow conditions, clean and maintain the stream channel during short duration high flow events, and finally, plays a vital role in maintaining channel dimension and floodplain features during overbanking events (flood flows). Consequently, it is now typical for TPWD to recommend a flow prescription that provides a range of flows (subsistence, base flow, high pulses, and overbank event) to addresses the complex interaction among flow, instream habitat, and water quality as a long term prescription. Groundwater from underlying aquifers is a very important contribution to flow during low-surface-flow (drought and low rainfal seasons) conditions. [70]All of this also contributes to estuary health.

One of the important characteristics of instream flow is to ascertain how to meet the headwater-to-estuary streams' beneficial uses for fish and wildlife species' and habitats' sustainability and resiliency in

[68] Bounds and Lyons. 1979

In 1985, the agency now called Texas Commission on Environmental Quality, began formally considering the effect of issuing new water rights permits on fish and wildlife habitats and limiting times of diversions by water rights permit holders for environmental considerations

[69] Longley, W.L., ed. 1994. Freshwater inflows to Texas bays and estuaries: ecological relationships and methods for determination of needs. Texas Water Development Board and Texas Parks and Widllfie Department, Austin TX. 386 pgs.

NRC. 2005. The Science of Instream Flows: A Review of the Texas Instream Flow Program"
http://www.twdb.state.tx.us/InstreamFlows/pdfs/NAS_Report.pdf

TCEQ, TPWD, and TWDB. 2008. Texas Instream Flow Studies: Technical Overview"
http://www.twdb.state.tx.us/publications/reports/GroundWaterReports/GWReports/R369_InstreamFlows.pdf

[70] Bureau of Economic Geology. 2005. Groundwater – Surface Water Interactions in Texas.

addition to the realistic water needs for people.[71] Each stream is different – different species, different bottoms, different native vegetation alongside. All instream/environmental flows are affected by the issues presented in this section below.

## Planning and Policies

Texas water law is somewhat complicated, frequently in the news and political debates, and extremely important to consider when developing fish and wildlife conservation approaches. While surface and groundwater connectivity is well-documented in Texas, our water laws which govern planning, use and management of these resources frequently treat these separately.[72] Two separate state agencies – Texas Water Development Board and Texas Commission on Environmental Quality– are responsible for various levels of water quality control, extraction permitting, and regional stakeholder-based planning. Texas Parks and Wildlife Department, with these two agencies, has a role in determining the instream flow thresholds for fish and wildife needs from headwaters to estuaries.

Currently, surface water use planning in Texas is accomplished through 16 Regional Water Planning Groups, authorized under Senate Bill 1. Regional plans roll up to the 2012 State Water Plan, designed to meet the state's human population water needs for 50 years; the current water plan was approved in 2006.[73] The Texas Water Development Board coordinates this process. For more information about instream flows and the effects of SB 2 (2001) and SB3 (2007) on surface water planning, see the previous *Instream Flows* section.

The "rule of capture" is still the guiding principle in groundwater use and Texas stands alone as the only western state that continues to follow the rule of capture for groundwater. Groundwater districts, *where implemented*, can regulate spacing and well production to ensure the availability of groundwater within the district's boundaries and deny a permit to withdraw groundwater based on the effect it may have on aquifer conditions; however, they cannot deny the permit based on the groundwater's destination and they cannot adopt rules to limit exports (out of basin transfers). Strides have been made in the last ten years to regionalize aquifer-sourced groundwater planning (i.e. Senate Bill 2, 2001; House Bill 1763, 2005) and require coordination across political boundaries in Groundwater Management Areas to establish desired future conditions (DFC). Of all groundwater used in Texas (approximately 15.6 MM acre-feet), approximately 80 percent irrigates crops.[74] Core to the groundwater issues for fish and wildlife is that DFCs and the Groundwater Availability Modeling are not *required* to consider natural resources' (except listed species') *sustainability and resiliency* as a "use" for groundwater; not all groundwater withdrawals are accounted; and, "rule of capture" can have deleterious effects on localized and regional species and habitats. A few Groundwater Management Areas have considered natural resources in their DFC, but primarily as a compliance measure with the Endangered Species Act. This does not begin to address SGCN or sensitive habitats.

Boundaries for both the surface and groundwater stakeholders regions or districts are based on *political* boundaries and are not matched to boundaries of the natural resources they are intended to manage. Not all counties participate in a groundwater district, not all aquifers are covered by a managing participant, and there's very little coordination between the two processes (data sharing, decision making, boundary coordination).

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[71] Gordon, N.D., T.A. McMahon, B.L. Finlayson, C.J. Gippel, R.J. Nathan. 2004 (2nd ed.). Stream hydrology: an introduction for ecologists. John Wiley & Sons, Hoboken NJ.

[72] Texas Water Matters. 2011. Special Topic: Interconnectivity.

[73] Texas Water Development Board. 2006. Texas State Water Plan 2007 (adopted November 2006). http://www.twdb.state.tx.us/wrpi/swp/swp.asp

[74] TAMU. 2011. NEED LINK

For both surface and groundwater, there is a lack of transparent, complete extraction accounting (regulated and unregulated, permitted and unpermitted) across political boundaries based on the best knowledge available which considers the permitting and "accounting" processes of the other.

Because ecologists know that surface and groundwater systems – and therefore, both resources' use and planning – are connected, it is important in the future to find ways to participate in these planning processes in a way that brings that relationship to the decision-making table.

Another policy issue affecting waters important for SGCN is the protection of isolated (vs. jurisdictional) wetlands during development processes. This is discussed in the *Surface Water* section above.

### Impoundment and Dam Operations

Reservoirs are constructed throughout the state serving our populations with drinking water supplies, recreational opportunities, and flood control. Statewide, the amount of forested river and creek floodplain vegetation has declined from an estimated 16 million acres to 6 million acres; a significant portion of this loss is due to the roughly 200 major reservoirs that have already been built. The 2007 State Water Plan[75] proposes building sixteen major dams (Figure 6) and hundreds of miles of water conveyance pipelines to serve burgeoning population needs in mostly urban areas.

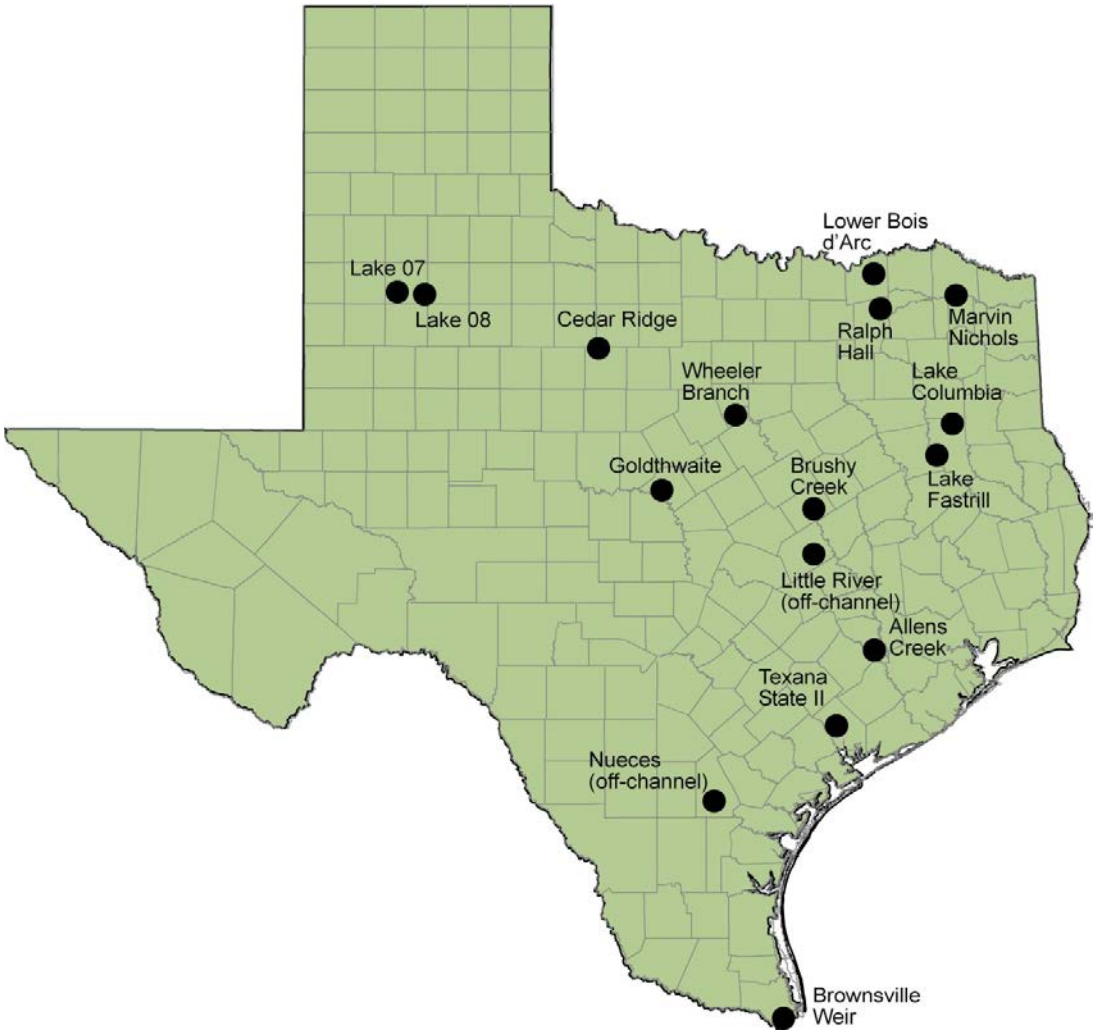
While frequently beneficial to recreational fisheries, wildlife viewing activities and other kinds of recreation, property values and aesthetics, reservoirs or impoundments of any size can be detrimental to many aquatic and riparian SGCN (freshwater, bay and estuary fishes; aquatic invertebrates; amphibians and turtles), communities and their habitats. The proposed Laredo Weir will impact recently discovered population of Texas hornshell in the Rio Grande. The TPWD Borderlands program has worked with partners and identified a lack of natural flooding cycles (flood control structures upstream and lack of instream flow from overallocation of water) to resaca senescence and loss of high priority riparian woodlands – Texas ebony – anacua/brasil forest, Texas sabal palm forest, and Texas ebony – snake-eyes shrubland. A few exceptions to the negative effects of reservoirs on fish and wildlife resources may be those aquatic SGCN or diving birds which rely on deeper water habitats created throughout the lake-influenced system.

Damming a free-flowing or periodically flooded river or creek, from low water crossings to major hydroelectric projects, causes instream habitat and/or riparian loss through innundation. The structure and the impoundment behind it fragment the connectivity of riparian area and flowing habitats. Structures are barriers to natural amounts and periods of water flow, sediment and nutrient movement important for downstream systems all the way to estuaries, and seasonal or daily movements of instream species for breeding, spawning congregations or individuals, or young dispersal to colonize other stream stretches. The pooled water behind these structures changes temperature, chemistry and turbidity of the waterway, to which many species cannot adjust.

Dam releases (part of operations) are frequently for human needs – electrical generation, irrigation periods, contracted drinking water allocations downstream for surface water extraction. Releases are rarely in sync with the natural flood or flow period or intensity, which can scour downstream habitats. Altered chemistry and turbidity of the released water can created unsuitable conditiosn for fishes and aquatic invertebrates. Some riparian plant communities are flood-dependent in appropriate seasons to trigger seed release and deposition. Some fishes are cued by floodwaters in appropriate seasons to migrate to congregation and breeding areas.

[75] Texas Water Development Board. 2006. Texas State Water Plan 2007 (adopted November 2006). http://www.twdb.state.tx.us/wrpi/swp/swp.asp

**Figure 6. Proposed Dams/Reservoirs in the 2007 State Water Plan**




Source: Texas Water Matters. http://www.texaswatermatters.org/conservation_reservoirs.htm

Development which typically follows reservoir construction has potential hazards for upland, riparan and instream fish and wildlife:housing developments remove habitat; lake edges are typically cleared of native vegetation for recreational access and views which can cause increased erosion and sedimentation; unregulated on-site wastewater facilities (septic systems) can cause elevated levels bacteria and other toxic leaching events. Invasive species – plant and animal – typically follow reservoir construction by equipment transfers and colonization of disturbed areas, increased use by recreational boaters which can bring in exotic aquatic plants (hydrilla, giant salvinia) or animals (zebra mussels) from other "infected" waterbodies, landscaping with non-native plants by homeowners wanting a more "landscaped" look to their yards, and feral cats and dogs which become introduced predators (see also *Population Growth and Changing Demographics* section).

## Water Quality Control and Improvement

Texas has 651 Impaired Waters, documented by TCEQ and USEPA.[76] Some of these waters have had a Total Maximum Daily Load (TMDL)[77] calculation performed to identify and regulate the maximum

[76] US EPA. 2011. National Summary of Impaired Waters. http://iaspub.epa.gov/waters10/attains_nation_cy.control?p_report_type=T And http://iaspub.epa.gov/waters10/attains_state.control?p_state=TX&p_cycle=2008

amount of a pollutant that a waterbody can receive and still meet water quality standards for its use (e.g. recreation, water supply, aquatic life, agriculture), and an allocation of that load among the various sources of that pollutant.

Water quality impacts to fish and wildlife resources and their habitats are typically associated with water quantity (amount of instream flow) AND the discharges to the stream which may introduce pollutants that decrease oxygen availability, add toxins, or overload the system with unhealthy levels of sediments (includes dam releases discussed above). Too little flow in the stream, and even a "minor" episodic spill or toxin release can cause major adverse effects. This issue is also an international concern: the TPWD Borderland Affairs liaison, through meetings, conversations, and initiatives with Mexico biologists and policy representatives, has identified water quality the stretch of the Rio Conchos to upstream of Falcon Reservoir and the Rio Grande above its confluence with the Rio Conchos as an opportunity to work together on water quality issues.

Five types of water quality impacts were discussed in comments for this plan which adversely affect SGCN, rare communities, and/or their habitats:

- wastewater discharges (accidental breaches from poorly maintained systems, unregulated on-site treatment, and violated permitted releases)
- stormwater runoff [municipal, ranch and farm, concentrated animal feeding operations (CAFO), roadways, construction, mining and logging operations] without adequate prevention or catchment controls
- mining and energy production (sand and gravel operations in and near streams, uncontained chemicals in frac-ing or other drilling which can contaminate groundwater, high water use in some solar operations)
- navigation channel and port operations and maintenance (wave action, dredging, placement) and
- desalination (which may be more feasible and appealing as water scarcity drives up surface and groundwater extraction and distribution costs).

These water quality impacts can contribute excessive nutrients (agricultural and municipal fertilizers, fecal material leaked or discharged from CAFOs) and sediments (eroded soils from unvegetated areas, sand/gravel mining in and near streams), toxic chemicals (herbicide, pesticide, drilling fluid additives such as chloride, sulfates, petrochemicals, and petrochemical runoff from roadways.), increased salinity in freshwater systems (deposition and releases of salt waste from de-sal ination operations; physical channel manipulation and wave action in navigation projects can introduce incompatible salinity into fresher systems).

### Basin Transfers

There are 51 proposed inter-basin transfers in the 2007 Texas State Water Plan, all of which need evaluation for economic, environmental and water quality impacts.[78] Ecologically, pitfalls of interbasin transfer of both ground and surface waters lie in water chemistry and other water quality parameters that are different among basins/aquifers, in addition to the environmental flows needed in each stream segment, not just the basin as a whole. Groundwater interconnectivity also needs to be part of this equation. The driver behind this issue is an increase in water demand from the ever-growing Texas population.

[77] US EPA. 2011. What is a TMDL? http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/overviewoftmdl.cfm

[78] Cai, Y. and B.A. McCarl. 2007. Economic, hydrologic, and environmental appraisal of Texas inter-basin water transfers: model development and initial appraisal. Texas A&M University and the Texas Water Resources Institute, with funding through US Geological Survey.

## INVASIVE SPECIES

See also *Climate Change* section

Non-Native

Of the estimated 750,000 species of organisms in the United States (US), an estimated 50,000 species of plants, animals, and microbes have been introduced into the nation (Pimentel et al. 2000). Most of the vertebrate and plant species that are invaders were intentionally introduced, whereas most of the microbes and invertebrates that have invaded the US were accidentally introduced. The total damage and control costs from all invading species in the US are estimated to be about $120 billion per year (Pimentel 2005). Many of the comments for this Plan named invasive species as one of the top two negative impacts to native species and habitats.

According to the Union of Concerned Scientists, the count of non-native invasive species in Texas in 1999 was 67 terrestrial plants, 12 aquatic/wetland plants, 10 mammals, 4 birds, 7 fishes, 11 insects, and 11 mollusks and crustaceans.[79] Today that count is higher and growing with greater globalization in travel and commerce, lack of awareness of the seriousness of the threat to our lands and waters, and deliberate introduction. About 6000 species of vascular plants grow outside of cultivation in Texas; of these, more than 800 (nearly 15%) are not native to the state and can wreak havoc on agricultural lands, ranch operations, and native wildlands.

Non-native invasive species are an economic (across the U.S., costs to track, prevent and control invasives run upwards of $13 BILLION a year) and an ecological threat. Our understanding of the longterm ecological damages runs a gradient from well-understood - known native species' extinctions due to invasive species' habitat destruction, competition and predation - to unknown. Invasive plants degrade the strucutre of the native plant community, affect the soil chemistry and microclimate, which can adversely affect all plants with narrower habitat tolerances, including some SGCN such as Correll's false dragon-head, Bracted twistflower, Glass Mountains coral-root, Warnock's coral-root, Texas prairie dawn, Texas meadow rue.

With our temperate climate, diverse habitats, recreation destinations for wide-ranging travelers, and national and international ports, we are prime colonization territory for just about any non-native invasive that can get a foothold.

Terrestrial invasives enter natural and recovering habitats in many ways:

- adjacent developed areas' - tropical or xeric-adapted landscaping from other countries, feral cats and dogs, starlings
- direct/purposeful introduction - exotic ungulates released for recreation and hunting, planting for erosion control, pasture grass improvement such as bufflegrass which outcompetes star cactus
- seed dispersal by birds and other animals
- accidental introductions - most pathogens, like White-Nose Syndrome in bats, oak wilt, oak decline
- opportunistic colonization into disturbed open areas – uremediated construction zones, mining areas

Invasives enter our waterways through aquarium dumping, transfer on boats and other recreational equipment, bait-dumping, and runoff/downstream carrying from other "infected" areas (primarily riparian transfers).

[79] UoCS. 2003. Invasive Species: Texas. http://www.texasinvasives.org/resources/publications/UOC_texasinvasives.pdf

The list of those we are already battling is long (e.g. oak wilt, zebra mussels, emeral ash borer, formosan termite, gypsy moth, nandina, ligustrum, china berry, chinese tallow, armored catfish, feral hog …) and every ecoregion has their own "plague." The Border Governors' Conference (Texas – Mexico) has a identified a list of 20 shared priority and invasive species. Some of the plant pests with direct agricultural impacts are regulated through the Texas Department of Agriculture; however, there are many unregulated invasive plants and animals – the prevention and control of these rely on the awareness and voluntary actions of all Texas citizens.

Every conservation organization in Texas has some level of invasive species program – outreach, field control, mapping, prevention – in their stewardship toolbox. It is a widely recognized threat. Sponsored and supported by a Texas-wide network, TexasInvasives.org has involved state and federal agencies, conservation organizations, green industry, academia and other private and public stakeholders who share in the common goal of protecting Texas from the threat of invasive species. This group is making significant headway to involve communities and scientists to collect data, identify best practices, and notify the public in each ecoregion about non-native invasive species (plants, animals, pests and pathogens). An additional resource for invasive plant lists, including "invasiveness" ranking, is TexasNonNatives.org. This organization also provides a list of species to watch which may be an issue in Texas in the future.

Native Problematic

In Texas, we have another class of invasive species – those which actually belong here (native), but may be out of place or are overly abundant where they are supposed to be. Historic land management practices such as intense overgrazing after the advent of barbed wire fencing and water development contributed to open lands ripe for native (and nonnative) brush invasion. Fire suppression contributes to brush invasion in grasslands as the land is privatized into parcels, native forests are converted to timber production, and urban areas begin to encroach into natural and working landscapes (urban-wildland interface).

Insufficient harvest and management levels for native game species (e.g. white-tailed deer) in some areas has contributed to overbrowsing and a loss of upland and bottomland hardwood regeneration (especially important in systems where SGCN rely on hardwood diversity in various stages of maturity). Some native species have expanded their distribution and impacts, like brown-headed cowbird, which parasitizes nests of grassland and shrubland species primarily.

Native brush encroachment – juniper, mesquite, yaupon, oak and others – where it's not supposed to be in grassland habitats can degrade habitats for dickcissels, prairie chickens, many other grassland birds, pronghorn, small mammals and reptiles. In our diverse forests and monotypic stands managed for timber, yaupon and juniper can become thicketized and choke out natural forest regeneration and make maturing forest sites unsuitable for some forest birds. Where savanna is the natural community, brush encorachment can remove habitat suitability entirely (e.g. Bachman's sparrow). And, rare communities (need example) are fire-dependent for regeneration.

In many of our plains, grasslands, prairies, woodlands, and forests a mosaic of grassland with varying tree and brush coverage was natural -- isolated mottes in a vast sea of grass and forbs in western systems to mostly closed canopywoodland or forest with prairie or bog openings in central and eastern systems. Closed canopy in Texas was primarily limited to mature woodlands and forests (where openings were created by deadfall). Open habitats were maintained by the natural actions of large mostly-migratory wide-ranging grazing herds of bison, predator and prey wildlife populations in balance, and episodic wide-ranging fire. Today, those habitats which remain depend on the activities of ranchers and other landowners/managers within their fences – high or low – which may or may not include

proper grazing techniques, healthy balanced wildlife populations and harvest levels, and/or prescribed fire in appropriate areas to mimic those historic lands influences.

Where appropriate, mechanical removal or prescriptive fire for brush management can be a very important restoration tool in native grassland and savanna systems; however, the expectation that all brush management also leads to increased forage and water yield has, in some cases, gotten out ahead of science and healthy stewardship. Excessive brush management on inappropriate sites (too steep, little cover remaining, hot exposure, in riparian or dry creek zones) can contribute to other problems – erodable soils, poor quality runoff, lack of groundwater recharge, exposed karst features, changes in microclimate for aquatic and terrestrial species). And, not all substrates once cleared provide greater water infiltration for groundwater yield.

Every site is different – there is no such thing as "one-size-fits-all" management. Part of Texans' intense attack on all brush encroachment also stems from our cultural roots – open grasslands are better for livestock production. Brush management will always be key in working lands' operations where the primary goal is livestock production. While some brush species and understory are also natural and beneficial for wildlife, restoring fire and appropriate levels of herbivory to some of these systems can increase the natural system function for grassland and savanna species.

Not all brush is "bad," anymore than white-tailed deer are "bad" – there are natural shrublands and woodlands such as oak shinnery, mesquite savanna with open grasslands understory, dense mature oak-juniper woodlands, diverse native thickets along riparian corridors, certain geologic features like karst with shrubs and brush adjacent to them, Tamaulipan thornscrub – which are beneficial and necessary to many of our SGCN and rare plant communities. Topography, rainfall, slope, aspect, soils and geology all contribute to whether shrubs and brush are a "natural" part of a particular landscape.

### POPULATION GROWTH AND CHANGING DEMOGRAPHICS

Population growth and changing demographics are interesting issues in the conservation framework. People are important to enact change to improve conditions for and of imperiled species – locally based community-initiated conservation (land trusts, Master Naturalists), with regional support and information based in the best science available, is one of the best mechanisms to deliver conservation on the ground. That said, population growth leads to more needs and demands on the resources that also affect the health and well-being of fish and wildlife, primarily water and space. Many of the comments for this Plan named population growth as one of the top two negative impacts to native species and habitats.

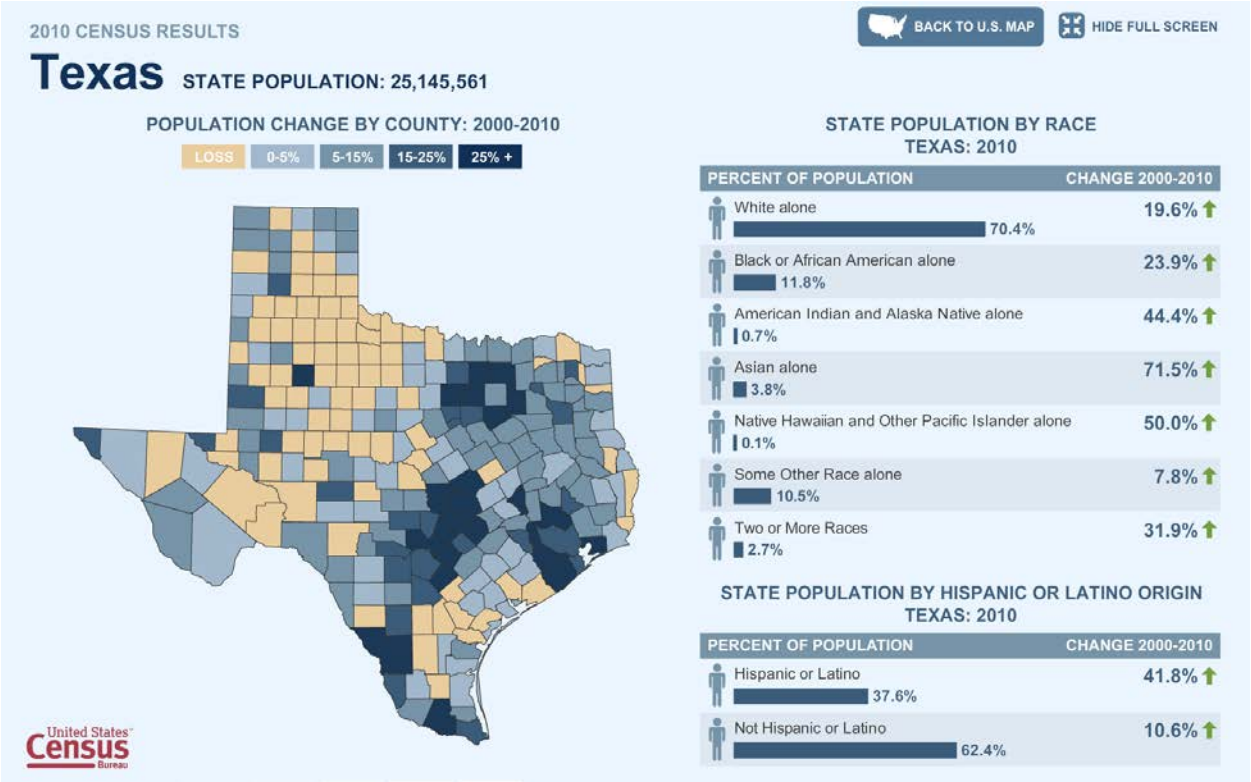
Over 25 million people live in Texas[80] (Figure 6), we are primarily urban (see also *Cultural Appeal* section), and population growth continues to be in and near urban areas with population *losses* in more rural areas. The Texas Forest Service, in its 2010 Texas Statewide Forest Resource Strategy[81], analyzed the areas of highest anticipated population growth through 2030, including "emerging communities" – those areas which will show growth beyond the expected state average in the same timeframe. The current metropolitan areas of El Paso, Temple – Waco, Austin – San Antonio, the Rio Grande Valley, and Houston will form core areas around which surrounding communities and counties will demonstrate remarkable growth. The Texas State Demographer predicts an increase in overall Texas population of **72% by 2030** and maps our population to **approaching 45 million people by 2040**.[82]

[80] US Census Bureau. 2010 Census Statistics. Also found on the Texas State Data Center website: http://txsdc.utsa.edu

[81] Texas Forest Service. 2010. Texas Statewide Forest Resource Strategy. http://txforestservice.tamu.edu/uploadedFiles/Sustainable/assessment/Texas%20Forest%20Resource%20Strategy.pdf

[82] Texas State Data Center. 2008. Maps of Population from 1850 to 2040. http://txsdc.utsa.edu/maps/thematic/typopmap_large_2008.pdf

**Figure 7. Texas 2010 Census Population Change by County**




Source: Texas State Data Center http://txsdc.utsa.edu/

This growth presents a number of issues for conservation practice across Texas and our borders. For many who live "in town," we do not have a daily working understanding of the ways natural systems work; typically, we experience the natural world in parks and open spaces within town, a few vacations (if we're fortunate), and/or a school project/field trip or community activity. In many ways, we relate to natural resources only in the context of our urban life – water, power, food, housing. Our ideas about conservation are limited to recycling and trash day, heating and cooling bill reduction, watering on our "designated days." It's not often we consider our landscaping choices, daily water use, house or office location, or even where or how we recreate as related to the natural world outside the city limits. Nor do we consider, for instance, how decisions for water supply, power generation and transmission, or landfill locations are made. We see many of Texas's natural communities as we zoom down the highway at 75 miles per hour. Knowing prairies exist, or even knowing that prairies are important, is insufficient to engage a mostly urban population in conservation solutions. People won't conserve what they don't care about.

Texas usually comes across in most cultural ways as rural – we love our small towns, a sense of community, and agricultural heritage; however, our population has been on an urban trend up since 1950. In 2010, our urban population was approximately 85% of the total population. Texas has always had a rich hispanic heritage and spanish-speaking populations; however, the trends are upticking in that aspect and other race demographics also – African American, Asian, and others.

Population growth and demographic shifts are opportunities for better planning, education and implementation of actions that make a real difference by people who care, close to the resource. The elements of population growth -- housing and commercial devleopment, energy production and power

delivery (transmission and distribution)[83], communication and transportation infrastructure, lighting choices, flood control and water conveyance, floodplain development, landscaping, no-zone sprawl – all contribute to direct habitat loss under pavement, structures and landfills; increase in invasive species and vectors for introduction; fragmentation of habitats and lack of passage for sensitive species; increased demand on surface and groundwater resources in and out of the growth area's basin; increased need for electrical power and the cross-country transmission of that power from outside of the community; contaminated (chemical and/or sediment) runoff into waterways; and other impacts. Non-attainment zones (poor air quality as measured in regulated contaminants) and unregulated air pollution enhanced by increased transportation and power use in growth areas may exacerbate climate change for the state.

Metropolitan Planning Organizations (MPOs); Councils of Governments (COGs); other regional planning authorities for transportation, surface water planning groups and groundwater districts; city and county governments; legislative bodies; regulators and others are all plan- and decision-makers who are working in these existing urban and soon-to-be-growing areas. Their planning processes are not all synced with each other, nor do they have similar requirements for natural resources considerations in their decision-making processes. Action Plans provide valuable information on species, habitat needs, and vulnerability which project planners (e.g. transportation authorities, surface and groundwater planning groups, wind and solar energy developers) can consider early in development stages to identify sensitive habitats and vegetation communities to avoid, ways to minimize the unavoidable impacts, and areas where compensatory mitigation could be most ecologically beneficial. In addition to informative plans, a human element is needed to engage communities and their planners who develop and provide services in these areas with reliable, engaged sources of **locally-applicable** enviromental information related to fish and wildlife resources needs and impacts.

While information to *planners* is key to implementation, their constituencies must also care about the connection between what they do every day and the resources their actions affect. These two concepts – community outreach and planning support – are most effective when hand-in-hand. It is insufficient to educate the homeowner about not planting nandina or ligustrum if that is not coupled with pressure on the landscaping services, nurseries, professional societies and permitting entities which continue to allow these plants as options at the local nursery. These efforts must reach all sectors of our population with a clear message about what they can do to help and why they should care.

### CONSERVATION PRACTICES

One of the issues brought to light during workshops and other communications is the lack of coordination among all of the bright, ambitious conservation practice organizations operating in Texas on the plethora of issues. While local action is the most effective for most resource issues, there are needs to coordinate larger scaled actions (e.g. riparian habitats that cut across Texas, instream flow for a variety of surface water systems, participation in groundwater planning decisions, connectivity across intact grasslands) and share information for best management practices (e.g. streamside buffers, stormwater runoff pollution prevention, brush management, grassland restoration, prescribed fire). From small land trusts to large state and federal agencies, there is a need to 1) share relevant up-to-date information (species, habitats, techniques, results) and lessons learned, in some standarized way; 2) identify regional goals and partners; 3) connect best examples of lands and waters and restoration sites for ecologically significant resiliency; 4) establish some stability in conservation funding; and 5) promote consistent policies and guidance.

[83] As of this writing, it is estimated that nearly 55,000 acres of ranchland and pastureland will be transected by mowed and maintained new construction transmission line rights-of-way through Central and Western half of Texas to bring power from the newly developed Competitive Renewable Energy Zones (wind generation sites) to the urban users.

## Information and Communication

An overarching concept in all of the issues presented so far in this document is a lack of effective information – how is it relevant to the problems we face, how is it presented and available to others, how do the project managers or developers get the information into practical *appropriate* application?

There are websites and databases maintained by conservation practitioners all over the state: fish distribution, rare species, noxious plants, conservation lands, privately protected parcels, managed areas, permit areas, planning zones, ETC. However, to date, there is not one space where a field biologist or land trust coordinator can go to see on a map what resources occur and are relevant in their area to help hone their practice.

There are few databases which track species or habitats in a complete and continuous way and all are limited their amount of access to information on the land and in the water, human and financial resources to collect that information, and the time and effort it takes to manage data once collected:

- Of the 8,600+ rare species and plant community occurrence records in the Texas Natural Diversity Database (maintained by TPWD), nearly 85% of the records covering how many species have not been monitored or updated since January 1st, 2000. Records are few, compared to the number of rare species and the need for their distribution information to better inform decision-making. Few records since 2000 exist for fishes, invertebrates, amphibians, reptiles or mammals. This database does not track all SGCN, rare communities, or actions taken on their behalf.
- The Natural History database maintained by the Nature Conservancy only covers species, communities and geographic areas where they work.
- Native Prairies Association is documenting the few intact native Blackland Prairies, but does not have access to many of the private lands on which some of these examples may occur; and, this is just a small element of needed grassland information.
- The Texas Ecological Mapping Systems project is, where completed, a valuable tool to see where certain important vegetation communities occur; but we will still have very little information about species and rare communities embedded in these larger types.
- The National Fish Habitat Action Plan is making strides to be able to map watersheds where restoration and protection incentives may be most valuable, and their work improves as more information about species and habitat distribution is available to put in the models.

Species and rare communities distribution data need to be current in order for conservation delivery programs to have a well-informed starting point.

In addition to the amount of current, available data, the data collection efforts need to be related to the most important issues of the conservation community – **spatial and attribute data practically applicable to conservation in the field, that can be shared to improve conservation practice**. While single species information is important in many instances, the practice truly needs information about population and ecosystem health, relationships among species and systems, and threats (issues) that directly impact those systems. Practitioners need some way to share some level of standardized information in a useful way to develop best management practices, sound and meaningful data sets, and trend information so that the future generations of ecologists and landowners can understand more about the resources they care about and how to *best* conserve them. There are several web-based data collection and conservation practice sharing sites available now (see Appendix IV in AFWA TWW 2011); however, Texas natural resources agencies and organizations do not use any of them in a coordinated way. Given the fiscal constraints of many organizations and agencies, conferences and meetings are not the most feasible ways to deliver the amount and type of information to all who need it. Web-based, accessible to all with a connection, one or more of these tools may be the best answer to Texas's needs.

## Connection

Connectivity among conservation lands is an issue that comes up repeatedly in workshops, conversations, conferences, and other discussions. Connectivity is important for gene dispersal, seasonal and daily movements, water quality and quantity, and habitat for those species with more "interior" habitat needs (do not function well in edge habitats). Connectivity is limited by reservoir development, high fencing, the "Border Wall"[84], transportation projects without adequate wildlife crossing or habitat island considerations, transmission line corridors maintained in an vegetation community incompatible with the surrounding native vegetation, and urban sprawl. Our development and planning activities can either enhance or completely sever habitats which need to be connected in order to provide SGCN with their life history needs. One of the limitations to connectivity in Texas is the lack of spatial data available which could map all public and private conservation lands, intact best examples of certain habitats, and locations of functional SGCN populations, giving practitioners a better picture of where landowner incentives could be most effective to connect conservation delivery areas. Without connectivity, many of our riparian, prairie and other grassland, certain aquatic habitats, and migratory corridors lose their ability to function as a system; species and the benefits they provide drop out. In many cases, complete adjacency is not needed, but rather a series of habitat stepping stones can prove to be beneficial. This is system and SGCN-need dependent, and should be based on the widest-ranging needs (black bear, rare cats, pronghorn, migratory birds).

## Conservation Delivery

In Texas, because our lands are more than 90% privately held and working lands are very important partners in conservation success, some of the best conservation delivery mechanisms are landowner incentives and technical guidance.

Most incentives come from federal agencies (NRCS Farm Bill programs, USFWS Partners Program), state agencies (Horned Lizard License Plate, state Landowner Incentive Program, and State Wildlife Grants), national conservation organizations (Environmental Defense's work to leverage federal programs and private funds on private lands, Wildlife Conservation Society grants - some of which are applied at watershed scales). Typically, these programs deliver management practices (prescribed fire, herbicide and reseeding treatments, fencing, timber harvest, water development) and education opportunities (workshops, technical guidance and training) directly to private landowners who can provide the financial match (typically 25 to 35% of the total project cost). Technical guidance may provide a site assessment, a wildlife management plan to meet the landowner's objectives, and followup with one or more of the above-mentioned incentive opportunities.

To date, both of these conservation delivery sectors have been very customer-service oriented – not a bad thing in itself, of course; however, the issues mentioned for this plan arise out of the need to be more proactive, rather than reactive, in our conservation delivery. We need ways to identify areas of highest conservation need, coordinated *conservation*-based objectives that we can deliver on larger landscapes (whether single landowners, wildlife cooperatives, through land or water trust service areas, or …), and best management practices for all (game and non-game) fish and wildlife resources and the habitats on which they depend (see also *Funding* below). With a growing urban population, greater growth in subdivided ranches and absentee landowners, and fewer large acreages to work with, being "smart" and more collaborative about where and how we work for the most conservation benefit will be more and more important in the next 5, 10, 30 years.

[84] Eriksson and Taylor *n.d*
http://www.utexas.edu/law/centers/humanrights/borderwall/analysis/briefing-The-Environmental-Impacts-of-the-Border-Wall.pdf
See also http://www2.ine.gob.mx/publicaciones/consultaPublicacion.html?id_pub=519

Issues also arise in conservation delivery working at cross purposes. Recommendations in some programs for brush removal, reseeding, fencing and water development may not be compatible with other area and regional conservation measures encouraging brush development (e.g. for black-capped vireo, golden-cheeked warbler, karst protection, mesquite savanna, oak shinnery), improving pasture or CRP lands with non-native seed sources (bermuda, KR bluestem, other Old World grasses), erosion control with non-native species, exotic species introductions for revenue generation favored over improvements and management for native fauna, stocking or harvest recommendations incompatible with the capacity of the site to generate native habitats, high fencing or panel fencing in areas where these activities are detrimental to SGCN and their habitats, developing artificial or dammed water sources over improvements to existing natural waterways. Typically, these practices are in conflict not because of conservation practitioner's malintent, but rather the landowner's specific objectives and the service providers obligation to customer service. Improvements could be made in realistic expectations for conservation vs. non-conservation delivery programs and an expansion of technical guidance that includes SGCN and priority habitats in site assessment, managment planning and menu of options in front of landowners.

## Funding

Conservation funding for non-game, rare, and declining species and habitats has always been an issue. Game species – those which are hunted and fished – have a fairly cohesive constituency and programs which provide dedicated legacy funding every year (Pittman Robertson, Dingell Johnson). No state has a secure funding source to implement conservation actions needed to stabilize or reverse the decline of their SGCN (TWW, 2007). Until FY11, Texas annually received approximately $3.5 million (MM) in SWG funding to implement their Action Plan. It has been estimated that Texas would need about $50 MM (Texas Culture Recreation and Tourism Committee presentation 2010) to implement most of the conservation actions from the 2005 Plan, and far more than that to see many of these multi-year (in some cases, multi-generational) projects to completion.

Each year, Congress determines whether or not SWG will be apportioned and a state's share of SWG may change. And, because most other conservation funding is also grant-related, these sources are variable and insecure *each year*. In Fiscal Year 2011, SWG was reduced to near 2001 levels. TWW, now a coalition of more than 6,000 organizations, continues to strive for stable conservation funding.[85]

Non-game species and habitats which provide key functions in every ecoregion and which also generate $ millions in recreational economic drivers are dependent on annual fluctuating (State Wildlife Grant) and diminishing (Landowner Incentive Program) allocations, dedicated-but-few federal and state policy makers' support, and conservation grants through non-governmental organizations (which rely on charitable contributions, ever-fluctuating with economic swings). Conservation incentive programs (like Conservation Reserve Program) struggle to be comparable with other economic drivers – subsidies, crop insurance, and competitive markets – in a longer-term framework. Habitat improvement, species restoration, recovery and resiliency are long-term investments. In Texas, non-game conservation activities are primarily supported by non-governmental organizations, universities, and a few state programs. Although the state has a very active and dedicated non-game program, the state budget for such activities is miniscule by comparison to game and other recreation programs. Dedicated, consistent, directed and new funding sources are needed to gain ground in conservation practice.

Ask any conservation program practitioner – funding is always less than what we hope for; however, increasingly, funding must be accompanied by demonstrated effectiveness. Any activity can use money;

[85] Teaming With Wildlife. 2011. Wildlife Conservation Funding.. http://www.teaming.com/funding/

conservation practice must be able to demonstrate that what it buys with the money makes progress toward a definitive conservation goal (or, if not, why not).

Policies, Guidelines, Rules, Regulations and Enforcement

Many of the other policy related issues have been stated in other sections – ground and surface water management and distribution, stormwater pollution prevention, land use planning, invasive species, wetlands. Most of the previously mentioned policies, guidelines, rules and regulations are related to resources for which some agency has a regulatory jurisdication. While regulation and enforcement are not always the best approach to resources protection, some additional themes for protection, education, and regulation arose from workshops and comments to date:

- State-listed threatened species are only protected at the individual level, with very little opportunity for enforcement, and habitats for these species are not protected
- SGCN which are not federally or state listed, rare communities, and their habitats are not protected from any kind of disturbance or removal through consultation with TPWD's Environmental Review/Habitat Assessment Program
- More enforcement is needed to address the sale of prohibited species;
- best management practices are only voluntarily implemented and may be very critical in certain areas (near isolated wetlands, riparian areas)
- invertebrates, plants and plant communities are especially vulnerable categories
- some project types – those without a federal funding or permitting nexus, or wind energy development projects, are not required to consult with or seek environmental protection (avoidance, minimization or mitigation/compensation) advice from natural resources agencies; and,
- even if consultation, at a minimum, was required, agencies currently have insufficient staff, species and habitat distribution information, and mitigation opportunity locations to deal effectively with that workload.

## LAND AND WATER MANAGEMENT – FARM AND RANCH

Texas does not have the highest percentage of private land ownership in the U.S.[86]; however, because more than 90% of Texas is privately held and managed, private landowners have always contributed to this state's stewardship. The collaboration between conservation delivery providers and the landowner is one of our most important tools. Field practice is dependent on positive outreach, service which can help the landowner meet his or her objectives and still deliver necessary conservation activities (see *Conservation Practice: Conservation Delivery* above). Working lands in Texas run a broad range – row crop, concentrated animal feeding operations, pastured livestock, range livestock – and in many instances, also co-manage wildlife and fisheries resources for additional income.

Previously mentioned issues sections related to water quality protection (erosion and stormwater runoff controls), conservation land connectivity, riparian protection, impoundments, lack of management opportunities (prescribed fire, overgrazing), incentives and conservation delivery availability, and invasive species covered most of the *Land and Water Management – Farm and Ranch* issues.

One issue not yet addressed is the subdivision of contiguous, large tracts of managed lands. The argument can be made that smaller parcels do not necessarily equate to poor management – many "smaller" acreage (might be 5 to 5,000 acres, depending on the ecoregion – small is relative) landowners have purchased these sites as their little slice of Texas heaven and want to be good stewards. Size

[86] Oaks and Prairies Joint Venture, based on updated information from a 1995 assessment of public land ownership by state (National Wilderness Institute, http://www.nwi.org/Maps/LandChart.html

doesn't matter *in intention* – it's the management of the land that matters. That said, multiple smaller tracts can equate to

- greater variance in landowner objectives across the same landscape
- more frequent fencing and potential barriers to some fish and wildlife resources
- exponential opportunities for invasive and feral species (and control is more difficult)
- fewer opportunities to apply large scale restoration (prescribed fire, brush management, farm bill programs with acreage thresholds) and
- potentially less knowledge of where to go for information on the area's desired ecological condition.

This conversion also puts a strain on conservation deliver mechanisms – human resources and funding. The time it takes for individual consultation with 40 landowners versus one landowner for the same acreage magnifies the cost per acre to provide technical guidance, management plans, field practice nad training, and monitoring.

Additional losses to conservation opportunity occur in smaller acreage timber lands, if they are managed for profit more than managed for sustainability or recreation.

Another loss in working lands is the steady, rapid conversion of farmland and pastureland to urban, paved environments – 360 acres of farmland per day and, between 1997 and 2007, 2.1 million acres of farm and ranch land.[87] While a few wildlife resources (e.g. migrating Mountain plover) benefit in some way from wildlands converted to agriculture, loss of flat developable farmland to pavement is a total loss for current AND future conservation, not to mention the food production and carbon sequestration potential of that area.

### ENERGY PRODUCTION AND DELIVERY

Texas has always been at the forefront in the nation for energy[88]:

- Texas is the leading crude oil-producing State in the Nation (excluding Federal offshore areas, which produce more than any single State).
- The State's signature type of crude oil, known as West Texas Intermediate (WTI), remains the major benchmark of crude oil in the Americas.
- Texas's 27 petroleum refineries can process more than 4.7 million barrels of crude oil per day, and they account for more than one-fourth of total U.S. refining capacity.
- Approximately three-tenths of total U.S. natural gas production occurs in Texas, making it the Nation's leading natural gas producer.
- Texas also leads the Nation in wind-powered generation capacity; there are over 2,000 wind turbines in West Texas alone.
- Texas produces and consumes more electricity than any other State, and per capita residential use is significantly higher than the national average.

Energy production issues in this handbook cover the broad impacts of the following finer scale issues - Power Generation, Power Transmission, and Oil/Natural Gas Production and Delivery. These issues have direct implications in many of the ecoregion handbooks and will be addressed at finer, relevant scales

[87] American Farmland Trust and Texas A&M Institute of Renewable Natural Resources. 2009. Land Trends Report. http://txlandtrends.org/ and http://www.farmland.org/programs/states/tx/default.asp

[88] State Energy Conservation Office. 2009. Energy Sources in Texas. http://www.seco.cpa.state.tx.us/energy-sources/
Department of Energy. 2009. Texas Quick Facts. http://www.eia.doe.gov/state/state-energy-profiles.cfm?sid=TX (October 2009)
Texas State Comptroller's Office. Date? Special Report: Energy in Texas. http://www.window.state.tx.us/specialrpt/energy/

there. The issues of hydropower production – dam development, impoundments, and incompatible operations releases – have been covered under *Water Development, Management, and Distribution* above. Other issues related to lack of environmental impact consultation on state listed and SGCN prior to development have been addressed in the *Conservation Practices: Policies and Guidelines* section above. Mining is not covered in this section as many of the mining types in Texas are very ecoregion-specific (lignite, bentonite, gypsum, oyster shell, coastal sands, caliche); sand and gravel mining was addressed in the *Water Quality Control* section above.

Power Generation: Wind, Solar, Coal-fired and Biofuels

*Note: Nuclear power was also mentioned in this section's comments; however, it appears to be a more ecoregional issue and will be addressed in those handbooks where appropriate.*

Wind generation in Texas was jumpstarted in 2005, with the state goal to meet power demands with 10,000 MW (megawatts) by 20205 from this source (we've already exceeded that future goal) and the determination of the Competitive Renewable Energy Zones (CREZ) in north, central and west Texas (Figure 8*, colored blobs are CREZ; red lines represent new transmission*). High wind potential in these areas makes Texas a prime location for this alternative to coal-fired traditional power generation. The Public Utilities Commission has not designaed CREZ in other parts of the state; however, additional developments outside of these "hotspots" is taking place in north, central, west, and coastal Texas (Figure 9).

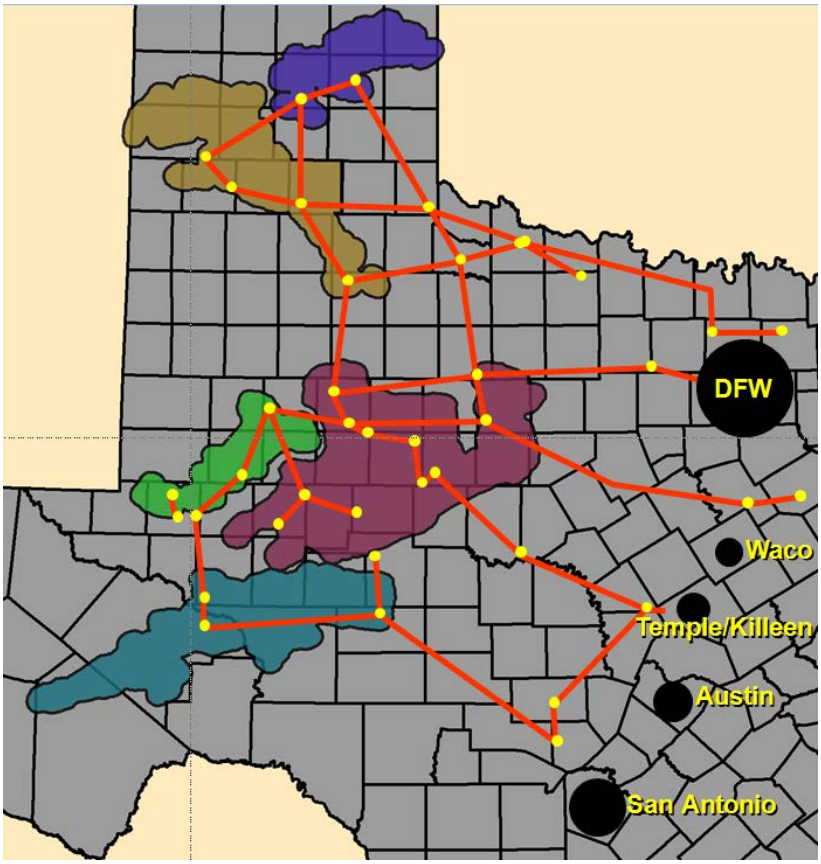
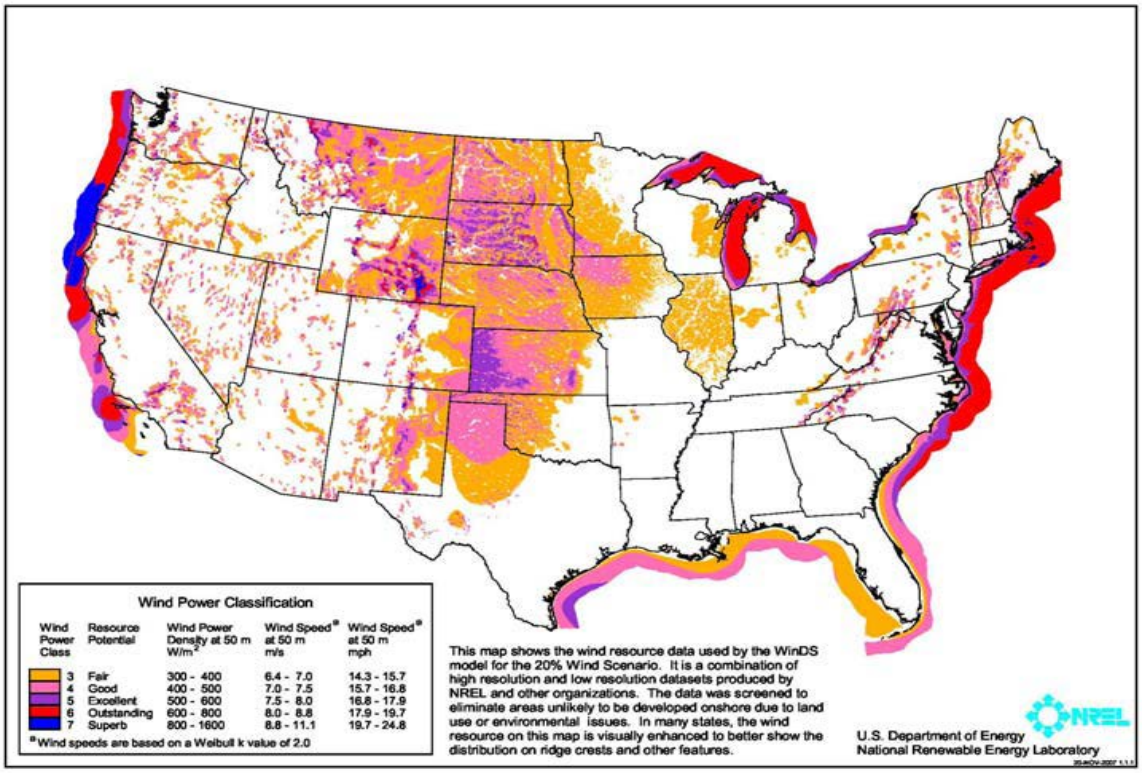



**Figure 8. Competitive Renewable Energy Zones, TX**

Source: TPWD 2011 (no claims are made to the accuracty of this information for planning purposes)

**Figure 9. Wind Energy Potential Zones, U.S.**




Wind generation facility (towers, roads, auxillary structures) siting is not regulated in Texas unless there is an intersection or nexus with a federally-regulated resource (e.g. jurisdictional wetland take that can't be addressed through the US Army Corps of Engineers' Nationwide permit process, or an endangered species impact which requires consultation with the USFWS under the Endangered Species Act). More than 7,000 towers have been constructed in Texas. Current science shows that operating wind turbines can cause direct wildlife mortality through impact and barotrauma, affecting bats, crepuscular and night-feeding birds, migratory birds and birds which congregate in updraft areas (hawks, vultures). The location of the "wind farms" also has proven to be an issue for species such as prairie chickens which do not tolerate tall structures in or within miles of their habitats (they are grassland species and tall structures potentially represent perches for predatory hawks), and rare species whose habitats are fragmented by tower and road siting (black-capped vireo, golden-cheeked warbler, tobush fishhook cactus, and others). Along the Gulf coast, wind farms are a particular concern in and near migratory bird corridors – neotropical migrants and whooping cranes – and setting the towers can cause loss of soft and hard bottom benthic and sea grass habitats.

Solar is also an energy source of which Texas has an abundance, and it is an alternative to coal-fired and other petroleum based fuels in many applications. Some advocates have said that local solar may be the best option to reduce our power generation and transmission footprint; however, large solar arrays away from load centers still require a great deal of land, water, and transmission line to produce and deliver that power source. This type of power installation is also unregulated in Texas and may impact large tracts of land through direct habitat loss, large swaths of fragmented habitats, and another significant water use source for which current stakeholder planning groups need to account. Small isolated desert and prairie plant populations, rare plant communities, reptiles and small mammals may

be disproportionately affected. Not very much is known about the long-term impacts of solar. Most of the environmental impact analyses to-date focuses on the recyclability/toxicity of the components. Beyond the initial disturbance, the operational effects increase the heat on the ground surface and immediately above the panels. The additional heat at the ground surface and shading effects of the panels hinders most vegetation regrowth; maintenance activites remove the rest. The additional heat immediately above the panels may adversely affect low flying insects.

Biofuels are a particularly new impact to Texas natural habitats, with the price of petroleum-based fuel driving land conversion to biofuels: certain rowcrops and other herbaceous monocultures like switchgrass, whole tree utilization in timber production areas, and algae "farms."[89] There are concerns that large acreages of grasslands/conservation reserve program grasslands, rangeland, and pasturelands are being or have been converted to rowcrops for ethanol production. There are currently 3 processing plants, all in the Panhandle; though there are plans for 9 more (4 along the coast and south Texas).[90] Because these are agricultural operations in effect, no consultation is required for locating, clearing, filling, or planting. The economic drivers in this instance are more powerful than the conservation delivery program or other agricultural operations' incentives. Although biofuel production is an industrial operation, it is typically implemented and regulated as an agricultural one: monoculture, unregulated water use, herbicide and pesticide application, fertilizer, complete clearing after harvest, few if any stormwater controls – impacting natural resources in ways similar to other intensive commercial traditional farm operations.

### Power Transmission: Substation, Transmission Corridors and Distribution Lines

Even when the power generation facility is sited with careful consideration of impacts to listed species, the transmission and distribution line corridors are necessary to get the power from the generation site to the load center – places where people put power to use at home and work. Transmission lines are typically miles-long, wide, straight-line segmented swaths cut through existing vegetation, with tall structures (single towers, H-structures, or insert tower type) and lines, or circuits. The installation and maintenance of the corridor can create edge in or near dense interior habitats, opportunities for non-native and native problematic species colonization, loss of riparian or mature/diverse canyon habitats where the structures or lines do not adequately span the creek or canyon feature, obstacles in flight for migratory waterfowl and other birds, electrocution hazard for perching raptors, or intrusion into karst or cave features which can change the internal climate and suitability for SGCN. Substations can present unique hazards if not appropriately sited or protected from small animal or bird entry. They can collect water in pools which serve as attractive nuisances to toads, birds, and other small mammals and reptiles seeking a water source for spawning or drinking. Distibution lines are those smaller scale line corridors which step power down from transmission to the user. The impact may be less wide and tall; but the impacts are similar and siting through natural areas is just as important.

### Oil and Natural Gas Production and Delivery

Oil and natural gas industries occur in nearly every ecoregion of Texas – from pad sites and pump-jacks to deep drilling rigs and collection sites on land and offshore. Grasslands, shrublands, woodlands, forests, estuaries, soft and hard bottoms in the bays and Gulf are all potentially affected by direct habitat loss where pad sites, drilling rigs, roads, collection lines, and delivery systems are sited. Seismic exploration is significant for wetland, riverine, and karst habitats; the shockwave can be fatal or cause permanent injury to aquatic species occurring in close proximity. All linear features associated with this industry cut straightline swaths like transmission lines and are typically unremediated/unrestored with

[89] http://algae24by7bulletin.wordpress.com/2009/12/28/petrosun-launches-first-us-commercial-scale-algae-farm-for-biofuel/

[90] http://www.dtnprogressivefarmer.com/dtnag/common/link.do?resource=/view/news/article.do&vendorReference=0702BAD4

native seed sources after disruption. Salt dome storageis generally used for natural gas storage. Salt is "washed" out of the deposit to form an open cavern; this uses large quantities of water, which then results in a brine leachate for which disposal is an issue. Activities have secondary effects too: invasive species introductions in disturbed, unrestored or inappropriately restored areas and roadsides; disruption of daily and seasonal activities for fossorial SGCN; road mortality; and ground and surface water contamination from unreported and unregulated amounts of spills, extraction chemicals (e.g. those used in frac-ing, or stored improperly on any site), saltwater injection, saltwater or brine releases/discharges, and lack of *resource-appropriate* and *adequate* spill response or remediation (e.g. Deepwater Horizon oil spill).

Traditional extraction has not been enough to keep up with fuel demand; therefore, alternatives such as hydraulic fracturing (or frac-ing)[91], tar sands extraction, and shale extraction are being employed more often than in the past. These methods have some of the same impacts with additional concerns related to groundwater extraction and greater likelihood of contamination and new types of chemicals spilled or purposefully released as part of the process. Groundwater and groundwater expresssion (springs, seeps, isolated wetlands) dependent species, karst, plants populations and plant communities, small mammals and reptiles are particularly vulnerable.

### CLIMATE CHANGE

(This section is still in development with some additional current information, summer 2011 – all references will be added)

Global climate trends indicate warming temperatures, sea level rise, and increased frequency of extreme precipitation in North America over the past century. The mean surface temperature of the Earth has increased by approximately 0.6°C in the 20th century, with a large portion of this increase occurring since 1970. These trends are expected to continue into the foreseeable future as greenhouse gas emissions continue to increase in the atmosphere. Over the past century, average temperatures in Texas and other southern states have risen much less than elsewhere in North America, from a 0°F rise in East Texas to up to 2°F in Far West Texas. But, researchers believe this anomaly is temporary, and in coming decades Texas temperatures could rise by 3 to 7°F in summer, with increases in the July heat index of 10 to 25°F. Precipitation projections through 2100 for Texas are highly uncertain. Some models show increased precipitation over parts of the state, but other models project more arid conditions. It is likely that future precipitation patterns will differ either seasonally or geographically from historical patterns.

The consequences of these climate trends will exacerbate other recognized impacts to fish and wildlife resources such as habitat fragmentation, degradation, and loss from changing land uses, exotic invasive species, pollution, and other stressors. To the extent we can reduce these other pressures and improve the resiliency of ecosystems, climate change's adverse impacts may be ameliorated.

Climate is determined by a complex interaction among the atmosphere, ocean, and land surface. General circulation models (also known as global climate models) are used to study these complex interactions, and when given information about the possible make up of the atmosphere in the future (i.e., greenhouse gas scenarios), they generate projections of future climate including temperature and precipitation. Climate projections vary among models and, in general, there is greater consensus across models on the level of future warming than changes in precipitation or extreme rainfall events. Hence, in Texas we can expect to see increased air and water temperatures, changes in precipitation patterns (including changes in seasonality, frequency and intensity of storms), and rising sea level. All of these

[91] http://www.naturalgas.org/shale/shaleshock.asp

changes are already underway and are likely to accelerate this century. The exact magnitude of these changes will depend on global emission trajectories over the next several decades. Our understanding of the climate system is constantly improving. Nonetheless, uncertainties are a part of this climate projection process and we cannot predict the climate of any particular locality in Texas 20, 40 or 60 years from now. We can, however, examine a range of likely scenarios (e.g., hotter and drier, hotter and wetter) and use those as the basis of vulnerability assessments we may conduct.

Climate is one of the most important factors influencing the distribution, abundance, and behavior of species, as well as one of the strongest forces on the distribution and characteristics of habitats and ecosystems. Climate is the key determining variable of species distributions. As the Earth warms, species tend to shift to northern latitudes and higher altitudes. Phenology is the study of the change in timing of biological behaviors such as flowering and migration. Phenological changes are being documented across taxonomic groups distributed around the globe. Some of the most pronounced changes include a general trend towards events taking place earlier in the year (such as those triggered by the onset of spring) and lasting longer (such as a lengthened growing season).

A lot of research has been directed at identifying the potential impacts of climate change on fish, wildlife, and plants. Though the majority of this work has not been conducted in Texas or on Texas' endemic species, the general lessons or findings should still apply. Those findings include:

- Changes in the timing of seasonal events, possibly leading to a potential loss of synchrony between species. There has been a general trend towards spring and summer events taking place earlier in the year. This includes earlier leafing out in trees, nesting behavior in birds, flowering, and fruiting.
- Shifts in suitable climate conditions for individual species leading to changes in abundance and range. In 2007, Audubon published a study showing the center of bird populations in the U.S. had shifted, on average, 35 miles to the north over a 40-year period. South Texas bird species are expanding northward, including the least grebe, great kiskadee, green jay and buff-bellied hummingbird. Gray snapper have been ranging farther north since the 1990s; once found only in the lower Laguna Madre and off the extreme southern shore of Texas, they are now migrating all the way up to Sabine Lake near Port Arthur, and are routinely caught by anglers there.
- Changes in the habitats which species occupy. Texas bay waters have warmed by an average of nearly 3°F over the past 25 years. Cold-sensitive plant species such as the red mangrove are moving north up the Texas coast. Early maps showed no red mangrove north of the Rio Grande estuary, and today they are appearing as far north as the edge of Matagorda Bay.
- Changes to the composition of plant and animal communities. Woody shrubs invading prairie grasslands are favored by increases in concentrations of $CO_2$.
- Changes to ecosystem processes such as decomposition rates, nutrient cycles, and growth rates

In addition, Texas coastal habitats are considered to be at a high to very high risk of adverse impacts of sea-level rise because of the relatively high mean wave height of the waters of the Gulf of Mexico and issues such as subsidence. The highest vulnerability areas are typically low-lying beach and marsh areas. Over the next century, sea level is most likely to rise 55-60 cm along most of the Gulf Coast. This will mean more frequent and longer flooding of marshes that could convert to open water. Seagrass beds will appear and disappear with changing water depths, tidal flats will spread inland and bays and estuaries will expand. Coastal plains ecosystems may be threatened by saltwater intrusion.

Climate change will undoubtedly generate indirect impacts on plant and animal communities, effects that may be just as significant as direct impacts. For example, land use change is already a large factor

in habitat destruction. As agriculture expands into new areas, or human migration patterns shift, land fragmentation may be exacerbated.

Future biodiversity will be a direct extension of the biological richness we conserve today. The most important tool in our climate change adaptation toolbox is protecting areas that already host diverse and healthy ecological communities. Moreover, now is the time to ensure that we are protecting the full range of habitats and species that are unique to Texas and that typify the biodiversity of the state, and providing an insurance policy against the unknowns of climate change by conserving multiple examples of ecosystem type.

Climate change is only one of many sources of stress to ecosystems and their inhabitants. Unless these other threats are reduced or removed, action to combat the impacts of climate change are less likely to be successful. In addition, wildlife will be more successful in adapting to climate change if these other stressors are absent then if they continue unabated. While managing these other factors are beyond the scope of this TCAP, practitioners should be aware of these threats and take action where possible. Included in this list of outside stress factors are pollution, competing demands for water, overgrazing, nutrient enrichment, introduction and spread of non-native species, and land development.

While a lot of research has examined the effects increasing temperature or altered water availability may have on organisms, many scientists are starting to suggest that the greater frequency of extreme weather events is likely to have as much, or even a greater, impact shaping future ecosystems. For example, climate scientists now think that spells of extreme winter conditions, such as much of the United States experienced during the 2009-10 and 2010-11 winters, may be as much the signature of climate change as increased average daily temperatures. Extreme conditions will make our work in anticipating how climate change will affect species and habitats that much more challenging.

Landscapes will continue to change both as a direct effect of climate change and indirectly due to the way in which Texans' may interact with and alter their environment as a result of adaptation of other sectors, such as agriculture, to climate change. This shifting and changing landscapes may result in some habitats increasing, decreasing, or changing in structure, and other appearing for the first time or disappearing. Maintaining a diversity of habitats is a goal of adaptation and may be achieved through habitat creation and restoration. An essential consideration is providing the range of habitat-patch characteristics that species need to successfully establish, survive, and reproduce. Climate, and therefore habitat conditions, can vary over very short distances and many species are highly sensitive to these very small or microclimatic differences.

The best hedge against the uncertainty that exists about exactly how climate change will manifest itself in Texas and what effects it will have on species and habitats is improving connectivity between habitat patches and giving species the room to disperse over large areas. With much of Texas' landscape under private land ownership, implementation of this strategy will require large-scale cooperation among a great many partners.

As the climate continues to change and our understanding of the extent and impacts of that change expands, adaptation strategies will need review and possibly revision. Some species and habitats may become more abundant and others less. Accordingly, some conservation measures may become inappropriate over time while others will be necessary. Monitoring of both species and strategy effectiveness will be essential.

## CONSERVATION ACTIONS

To best conserve species populations, rare communities and the habitats on which they rely, conservation participants need to collaborate at different scales, document progress, share lessons learned, and adapt approaches when necessary.[92] Conservation actions in this handbook are aimed at improving conditions for priority species and habitats and reducing the negative effects of priority issues.

To this point, this handbook has covered the individual elements which guide actions:

- Species and Communities – specific populations which are declining or at-risk;
- Habitats – physical places where we need to work; and
- Issues – direct harm or basic gaps which negatively affect our ability to improve SGCN populations and rare communities in their best contexts.

Actions are the heart of the Plan, stating what we need to work on, where, and why (what problem we can solve with that action). Well-crafted actions lay out how that work contributes to a specific desired effect –progress and success. It is important to acknowledge that one conservation action typically does not solve one conservation problem. There may be several actions employed over time to achieve a conservation goal. In some instances, defining the conservation goal *is* the action – for some things, we don't yet know enough to define what successful conservation looks like for that SGCN population or rare community. In many cases the actions which have been provided to date are good frameworks and starting points.

Actions in the Statewide/Multi-region handbook [93]are aimed at broader issues which affect an area larger than one ecoregion and require cooperation across ecoregions, state boundaries, and/or perhaps international boundaries. Actions most recommended in the survey responses include the following: Data Collection, Analysis and Management, Acquisition, Lease, Easement (including Landowner Incentives), Conservation Area Designation, Education, and Regulation, Guidelines and Enforcement.

### ACTION TYPES AND DEFINITIONS

Actions are sorted into 12 categories (Table 3). Definitions and more information about how the categories were developed can be found in the Overview handbook and the Actions Definitions on the TCAP 2011 website.

**Table 3. Conservation Action Categories**

| | |
|---|---|
| Direct management of natural resources (stewardship) | Management planning |
| Species restoration | Land use planning |
| Creation of new habitat | Training & technical assistance |
| Acquisition / Easement / Lease | Data Collection / Analysis / Management |
| Conservation area designation | Education |
| Environmental review | |

[92] Conservation Measures Partnership. 2008. Standards for Project Management. http://www.conservationmeasures.org/initiatives/standards-for-project-management

[93] Through the public comment period and until delivery to USFWS for review, Actions will be honed and added as needed. The final document after USFWS review will contain the TCAP Priority Actions for the next five years. These actions may be incremental steps to much larger goals that take much longer amounts of time.

A key document for **action development and guidance on action implementation** is the Association of Fish and Wildlife Agencies' Teaming with Wildlife *Measuring the Effectiveness of State Wildlife Grants* (2011).[94] See also the *Measuring Progress and Effectiveness* section.

Actions in the Statewide/Multi-region handbook should:

- Contribute to goals (if known) for stable, resilient SGCN populations, rare communities, and/or the habitats on which they depend (conservation targets and what "success" looks like);
- Identify where the most important work needs to occur and what problems need to be solved;
- Identify partners who are already working or could work on a particular issue (existing or new networks, working groups, advisors, peers, landowner cooperatives or individuals); and,
- Promote *effective* project criteria – stepping stones to achieve the goals and share information.

That said, it was important to encourage participants and not let a lack of information completely paralyze the desire to act ("*Don't let the perfect be the enemy of the good*" – Nick Salafsky). The lists of actions in this Plan are a guide; future regional and statewide conservation working groups will need to flesh some of these out for better results, guidance, and stakeholder engagement.

*For Implementation, Actions should include:*

- **Action Description** – type, proposed activities, description of how to make progress toward or completely meet the Conservation Goal
- **Conservation Target(s)** – SGCN populations, assemblages of SGCN, and/or rare communities that will directly benefit from the action
- **Conservation Goal** – the overarching conservation outcome(s) such as number of stable populations, number of individuals that constitute stable community, acres of habitat conserved that would reduce a threat, percentage of agencies implementing a best management practice, target audiences reached/behaviors changed, etc.) that this action contributes to or resolves; sources (e.g. other conservation plan) are included if applicable
- **Timeline for Goal and Action** – overall goal timeline and optimal timeline for a particular contributing (e.g. by 2025, in six months, in three breeding cycles, before city expands ETJ)
- **Habitat(s) Types** – broad and finer scale categories
- **Issue(s)** – specific issues which the Action would help alleviate/solve
- **Target areas** – where the action needs to take place – specific watersheds, counties, network of public or private lands, mountain range, canyon, soil or geologic substrates, stream segments, adjacent to …, connectivity with … (*specific land owners are not named in any actions without their explicit permission)* – and, why here (best opportunity for protection, best opportunity for restoration, largest contiguous area for …, best connection to other target sites, …)
- **Partners** – stakeholders, those affected by the issue, and/or project leaders who are working on the issue, could work on the issue (most knowledge, previous efforts, connectivity with the site, community-based, etc.)
- **Supporting Information** (if known) – management plan, working group guidance, peer-reviewed documentation, methodology, best management practice, etc. that needs to be used to support this effort
- **Intermediate Results – those steps which demonstrate progress or the need for adapting the project to new information (***see AFWA TWW 2011***)**
- **Monitoring** – evaluation points and elements to provide evidence that action leads to a reduction of impacts and/or an improvement in conservation target(s); sharing lessons learned.

[94] AFWA TWW. 2011. Measuring the Effectiveness of State Wildlife Grants. http://www.fishwildlife.org/files/Effectiveness-Measures-Report_2011.pdf

## STATEWIDE/MULTI-REGION CONSERVATION ACTIONS

More actions are needed to address specific issues broached in the previous sections. At "print time" to publish to website for public comment between June 10 and July 8, several interested parties had identified that they would like to provide conservation actions for this table. They were not received in time for this publication; however, those individuals and groups will be encouraged to provide that information by July 8. I*nformation in the Action Type section will be added before delivery to USFWS once the list of Conservation Actions is finalized prior to USFWS review. These actions will be reviewed prior to USFWS review and like actions will be combined, where necessary.*

*Note: Table formatted as 11" x 17"*

| Conservation Action | Action Type(s) |
|---|---|
| Instream Flows | |
| continued participation and support of environmental flows planning | |
| Evaluate the use of water treatment wetlands in the context of instream flow benefits | |
| From the TPWD River Studies Program:<br>**Background:** A starting point in any environmental flows evaluation is identifying and compiling existing data for the river reach in question to determine historic conditions and current conditions; identify knowledge gaps; and select areas where additional data should be collected. Baseline information is necessary to develop an understanding of the aquatic biology of each system to identify key physical, hydrologic, and chemical processes, and critical time periods. Data needs include information on species distributions, community composition, life history traits (e.g., spawning season and needs and foraging traits), and environmental requirements (e.g., habitat, temperature, and dissolved oxygen). Historic data are normally compiled from reports by state agencies (TPWD, TCEQ, TWDB or predecessor agencies; and agencies in Louisiana, Oklahoma and New Mexico, as appropriate); federal agencies (U. S. Geological Survey, U. S. Fish and Wildlife Service, U. S. Bureau of Reclamation, and U. S. Army Corps of Engineers); journal articles; reports from river authorities and water districts; university studies and museum records; and other sources. Substantial data has been collected on various aspects of stream ecology within Texas, but the data were collected for a variety of purposes by various public agencies, private consultants, academic researchers, and others. Consequently, sampling methods and gears may be inconsistent and data collection may not always focus on the same parameters (e.g., species enumeration, length, weight, location). Geographical distribution of samples is not systematic either. Consequently, considerable data are available in some basins, whereas the coverage in others is sparser. According to recent analysis of documented Texas fish collections by the Texas Natural History Collection, about 20 Texas counties have never been sampled for aquatic organisms and more than 50 show fewer than five sites having been collected (Hendrickson, personal communication). The Rio Grande, Brazos, Colorado, and Neches river basins have been sampled the most extensively, whereas collections are sparser in the Lavaca, Canadian, Sulphur, and San Antonio systems. Additionally, no systematic time series is available for most basins. Studies may respond to particular projects or a university researcher may collect in specific drainages year after year, but that usually spans only their individual career. The aforementioned analysis of Texas fish collections demonstrates peaks during some decade, but paucity in others (Hendrickson, personal communication).<br>The life history and ecology of lotic organisms must be considered in the evaluation of instream flows. Using fish as an example, the fundamental aspects of interest are growth, survival, and reproductive success (spawning and recruitment). Information on feeding behaviors, habitat use, and the timing of those activities (e.g., nocturnal vs. daytime) is essential to understanding growth. Data on habitat use of prey items may also provide valuable information. Ensuring reproductive success involves many habitat considerations (current velocity, depth, substrate composition and embeddedness, cover, area, etc.) for spawning adults, eggs, fry, and juveniles; spawning behavior or reproductive mode (Johnston, 1999); and water quality issues (e.g., temperature cues). Other issues (e.g., migration patterns) associated with life history strategies may be important in some systems. Temporal considerations (i.e., spawning season, timing with peak flows, photoperiod, etc.) also relate to life history strategies (Stalnaker et al., 1996). The life history of a long-lived (decades) species such as paddlefish is different from that of certain minnows, which may live, reproduce, and die in two or less years. ). For instance, short-lived fishes may require certain flows every year while populations of longer-lived ones may be sustained by meeting flow requirements on a less frequent basis. Furthermore, habitat requirements of species may shift seasonally and diurnally, and they may also differ by sex or life-stage.<br>**Strategies:** Research needs associated with instream flow determinations fall into two broad areas: distributional surveys to document current conditions relative to species assemblages and investigations into life history information for individual species that may be used as target organisms.<br>**Distributional Surveys:** Basin, region or statewide surveys of biological assemblages are critical for developing distributional information. As noted previously, historic data is somewhat sparse both spatially and temporally. Recent data may be more available, but collections are still spotty. TPWD has participated in several broad scale probabilistic studies in recent years, the data from which has been used to support environmental flow assessments. In the late 1980s the River Studies Program sampled fish and invertebrates and characterized water quality and habitat at about 70 wadeable sites statewide in cooperation with TCEQ's predecessor agency (Linam et al. 2002). In 1998-2000, an additional 91 wadeable sites in the eastern half of Texas were sampled for fish, invertebrates, water quality, and habitat (Kleinsasser et al. 2004). In 2008-2009, 25 fourth-order or greater streams were sampled cooperatively with TCEQ for fish, invertebrates, periphyton, habitat, and water quality. Basin specific collections preparatory to implementing Senate Bill 2 studies have been completed in the Sabine, Brazos, and San Antonio rivers. Those efforts focused on developing current distributional information as well as characterizing the microhabitat where the organisms were observed. A research priority should be to fund basic biological survey work on an ecoregional or basin basis that will improve current knowledge on fish distributions.<br>A next logical step research effort is to collect life history information for selected species that are undergoing population changes within the respective river basins to determine | |

| | |
|---|---|
| possible causative factors.<br>**Water Quality:** Water quality is affected by numerous factors, some natural and others man made. Traditionally, water quality has always been evaluated in aquatic systems receiving wastewater effluent in an attempt to maintain the biological integrity of the water body. Unfortunately, many instream flow studies have overlooked including specific analyses of the effect of flow change on temporal and spatial characteristics of water quality (Annear et al. 2004). Dams, diversions, and water transfers in combination and independent of adjacent land use activities all affect the thermal and chemical character of flowing waters and the effects on riverine processes can be wide ranging and significant depending on the specifics of flow change involved (Hynes 1975; Leopold 1994). In addition, many entities are now seriously considering reuse of wastewater which could have significant water quality implications in the receiving streams. The development of water quality models to simulate these effects requires empirical data on stream geometry, meteorology, hydrology, and water chemistry. Some of this data (such as flow records, weather records, and water chemistry) may be available from other sources; however, stream geometry and other associated physical habitat characterization will likely require targeted field collection efforts by individuals with specialized training. Funding of research projects directed at examining the effects of flow change on water quality in priority Texas river basins will provide very important information for developing environmentally protective instream flow regimes.<br>**Habitat:** There has been recent increased attention across the country directed at fish habitat, including the development of the National Fish Habitat Action Plan (2006). A large component of instream flow studies is modeling the affect of different stream flows on the quality and quantity of habitat. This can be a very labor intensive endeavor, but one of utmost importance to ensure: habitat is of sufficient size and connectivity for native aquatic and riparian species; biotic refugia or critical habitat exists (e.g., deep pools, seeps and springs for survival during droughts); a natural flow regime with a magnitude, frequency, duration, timing, and rate of change is maintained that creates habitat for multiple species; natural transport of sediment continues; and, stream geomorphology is maintained.<br>The dynamic equilibrium of the physical system establishes the dynamic equilibrium of the biological system, thus maintaining the ecological integrity of the system as a whole. The Instream Flow Council developed a channel maintenance policy statement that reiterates the relationship between flow and habitat. It states “Channel maintenance flow is an essential component of instream flow prescriptions for alluvial channels and maintenance, rehabilitation, restoration, and preservation of stream channel form and associated biological communities” (Annear et al. 2004).<br>Although scientists now have a better understanding of the physical concepts and processes of channel maintenance flows in natural rivers, much remains to be learned about using this information to repair previous riverine damage and rehabilitate or restore river functions that have been disrupted. Likewise, considerable research is needed to allow us to better understand and describe the complex relations between biological processes and variable channel forming flows (Annear et al. 2004). | |
| Water Planning and Policies: Groundwater, Surface Water, Estuaries | |
| Identify the barriers to natural resources information and stakeholder inclusion in regional water planning processes and remedy. | |
| Given the inability of many agencies to fund travel and/or time to participate in these very important stakeholder groups (regional surface water planning, groundwater management districts’ desired future conditions processes), form regional conservation working groups of conservation practitioners and resources experts who work in these political subdivisions to review SPECIFIC regional resources issues that should be considered during these planning processes. Share delegation participation and speak with one voice to each of these entities, through a representative of the regional conservation workgroup, to convey high priority concerns. Provide **specific guidance to the stakeholder groups about how to include this information in their planning processes and why it’s important**. Evaluate whether these recommendations are considered, included, or implemented and share with other regional conservation working groups. | |
| Provide training and information sessions for Texas Commission on Environmental Quality (setting TMDL standards), Texas Water Development Board, Metropolitan Planning Organizations, Councils of Government, transportation planners, Regional Surface Water Planning Region groups, Groundwater Management Districts, consultants, and other planning providers in the appropriate, targeted for their needs use of the National Fish Habitat Action Plan data viewer. Evaluate the use of that information in their evolving discussions and plans (see above). | |
| Identify relationships between TMDL studies and the coastal bays and estuaries health and needs. See also Instream Flows. | |
| Impoundment and Dam Operations | |
| Instream Flow working groups, TPWD River Studies, and Estuary Ecosystem Leaders need to work directly with River Authorities, US Army Corps of Engineers, Drainage Districts and other reservoir managers to understand their release schedule needs (amount, timing, seasonality) and identify **specific** changes by facility which could benefit priority habitats and SGCN identified in this plan. If no changes can be made at the hydroelectric or flood control site, work with the managers to create management and mitigation plans for areas downstream to address impacts (water treatment, instream habitat improvements, riparian restoration). | |
| Water Quality Control/Improvement | |
| Work with local planning and state regulatory entities to identify opportunities to prevent development in floodplains and riparian areas, encourage natural flood water conveyances, and improve implementation of voluntary stormwater controls where not regulatorily required. Where directly related to improving SGCN habitat, work with construction providers to understand better building practices and materials to improve water quality during construction and in the final structures. | |
| Ensure that *natural resources needs* instream and adjacent to streams in springs, seeps and other tributaries are included when developing TMDL recommendations. | |
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| Basin Transfers | |
| Craft and conduct a study evaluating the ecological impacts to individual Texas basins for the proposed transfers in the 2007 State Water Plan. | |
| Non-Native Invasive Species | |
| Encourage all public land managers to participate in a coordinated way with the TexasInvasives.org mapping project, tapping into regional experts (Ladybird Johnson Wildflower Center, Native Prairies Association, Native Plant Socieity of Texas local chapters, Texas Master Naturalists, botany departments at universities and colleges, and other interested citizen scientists from botanical gardens and/or volunteers programs at Nature Centers) to identify and map invasive species within their boundaries and identify those which are most invasive, noxious, or harmful to priority habitats in this plan.<br>Use this information to **target/focus** outreach to curb **sources** of these problems, whehter internal or external. Train local volunteers (see list of experts and citizen science groups above) to provide community-based programs to landscape companies, nurseries and other plant material providers, aquaria associations, etc..<br>Develop control and restoration plans (or sections within existing management plans) to help site manager, staff, and volunteers prioritize control sites, identify restoration resources and timing, and prevent future infestation. Use these activities to convey targeted information to other public and private lands in the area through the TexasInvasives.org site.<br>Monitor sites with control and restoration activities and document in one of the conservation effectiveness tracking web-tools; use this information to encourage state legislature to allow agencies to develop official guidelines and/or regulations for the public that are more effective to deal with the invasives problems than the existing laws. | |
| Note: commenters mentioned many specific species, pathogens, and pests in comments, further emphasizing that this is a widespread and growing problem. Mapping invasive species to determine worst offenders and best practices for control in each ecoregion will be very important to make progress. Commenters who mentioned specifics are encouraged to map their knowledge on the TexasInvasives.org website (please). | |
| Identify watershed-specific and ecoregionally approriate seed and plant material sources for restoration projects following invasive species removal. Distribute this information to plant nurseries, conservation service providers, recreation and trail grant recipients, urban planning organizations and TXDOT Districts. | |
| Texas Ecological Systems Mapping Invasive Species Distribution Project. Non-native and native problematic species' invasion degrades many important habitats for SGCN, ecological services, and other land and water use potential (recreation, agriculture, livestock production) in every ecoregion. Certain species are more important than others in each region. Modeling layers and current vegetation community layers developed for the Texas Ecological Mapping Systems Database along with field data collection and additional remote sensing inputs may be used to monitor the current status of these species and help target areas to prevent further spread, control areas of infestation, and eradicate invasive populations in critical areas with the resources available. Information developed would contribute to the Texas Invasives network initiatives to help guide community-based conservation actions (see http://www.texasinvasives.org/i101/ecoalert.php). | |
| Native Problematic Species | |
| Working across a broad section of conservation service  providers, evaluate the issues associated with and the potential soluions to ecoregionally appropriate brush management. Identify Best Management Practices by ecoregion for ecologically acceptable brush management, accounting for impacts to priority habitats and SGCN in this plan.Distribute BMPs to all conservation delivery providers, landowner and producer technical and advocacy organizations, universities and field stations, public land managers. | |
| Population Growth | |
| Form regional conservation working groups of conservation practitioners and experts who work in or near metropolitan and urban areas (including emerging areas) to review SPECIFIC regional natural resources issues that should be considered during MPO, COG, transportation and other urban and emerging urban planning processes. Come to the table with information to share, maps and data, recommendations, **specific** ways to incorporate your needs. Speak with one voice from the group (a coalition is stronger than an individual or one entity) to each of these planning process groups, through a representative of the regional conservation workgroup, to convey high priority concerns that need to be considered. (see also regional water planning above) | |
| Support the ability of counties to have zoning and planning controls, similar to or an improvement over those of incorporated areas. | |
| Changing Demographics | |
| With the "greening" of many planning processes, find ways to link into the LEED industry green building, green energy guidance development to include SGCN issues into Development Planning.  Originating in the design building industry to promote more energy efficient building and less pollutants, at least some of the priority habitats and issues can be incorporated into the land use planning and design aspects.  The guidance is a multi-stakeholder organization, the federal government has an annual summit.  Although it is nation-wide (or global) organization, it is a forum that we should use to help address our issues. This may be especially important to regionalize across state or international boundaries. | |
| Target outreach programs to address priority habitats and relevant issues in this handbook, using core concepts and conservation education messages developed by the Association of Fish and Wildlife Agencies. Keep outreach "local" – make it relevant to the way the audience perceives their world, relevant to issues they need to engage in locally to solve problems, THEN expand it to other effects (estuary water quality/quantity, flood reduction, open space and recreation). | |
| As the primary source for statewide species and habitats information, revise the TPWD website to make information easier for public to find thematic information and easier for source-staff to maintain. | |
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| Conservation Practice: Information and Communication | |
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| Texas Ecological Mapping System Data<br>▪ Sharing Website. Develop a web-based portal allowing any interested person to view the data and create maps without specialized mapping software. Maps will be downloadable in Adobe PDF format. Web portal will also allow user to extract data based on user created polygons. Data will be downloadable as ESRI shapefiles. Users will also be able to provide feedback to fine-tune the data by completing a spatially explicit site description survey.<br>▪ Species of Greatest Conservation Need and Ecological Mapping System Analysis. Each Ecological Mapping System will have all Species of Greatest Conservation Need that depends on this community explicitly identified. A database and associated query tool will be created to allow access by TPWD and other interested users.<br>▪ Texas Ecological Mapping System database updates. Data will be systematically updated to document changes in the distribution of these defined communities. Remote sensing and field investigation will identify those areas that have changed and updated landcover will be developed and modeling applied to document these changes. | |
| NOTE: this action would benefit all conservation areas. Provide training and technical guidance to field biologists, land trusts, Master Naturalists, nature centers, LANDOWNERS and other conservation partners to provide QUALITY data on SGCN and Rare Communities locations and quality to the Texas Natural Diversity Database, Texas Natural History Database, and/or (insert fishes databases) to enhance the baseline status "picture" of species and population distributions for better conservation decision-making, including delisting, recovery, and incentive programs. Review and update state and global NatureServe ranks in taxa groups where this was not accomplished prior to the TCAP 2011 SGCN list. | |
| More effort needs to be invested in identifying areas likely to have SGCN and rare communities, including endemic species. Given the size of our state, lack of access to certain areas, and limited resources for research, survey, incentives, and monitoring, predictive models which can associate SGCN with a high probability of occurrence in a particular ecological system or sub-system (using Texas Ecological Systems Mapping project data and groundtruthing where possible for finer scale habitats) would be helpful to focus conservation delivery. SGCN's that should top the list for modeling and survey should inclued invertebrates, fishes, amphibians, and small mammals as these are the taxa with the least informtion in any database. Collection of negative survey data should be encouraged and documented to dicern the difference between potential habitat and occupied habitat. All newly collected data should be used to refine any existing models | |
| With a working group of database managers and expertise from NatureServe, identify ways to input incoming data to the Texas Natural Diversity Database in a more efficient manner; time consuming data entry and a lack of human resources to accomplish this task creates bottlenecks and lack of interest to contribute. Develop a preliminary data entry system (maybe web-based?) that could simplify the data entry and use TXNDD staff for QAQC rather than entry. | |
| To promote data accessiblity for all practitioners from agency to land trust, and to share practical lessons learned, connect data with practice in a web-based format for all to access. Form a Natural Resources Data Working Group for Texas, comprised of database managers and database users, **coordinate with conservation delivery (see below)**. Conduct a review of the Texas Natural Diversity Database, Texas Natural History Database and any other species and habitat databases in Texas which could feed information into one of the **existing conservation effectiveness tracking databases** (see AFWA TWW 2011 for a review in Appendix IV of that document). Identify gaps in specific SGCN and rare communities data to fill which could be useful for grassland, riparian, instream flows, groundwater, and estuary monitoring. Identify partners and conservation groups which could help provide that data in a format compatible with one or more of these databases to improve the status picture of SGCN and enable conservation practice to better focus limited resource. | |
| Until a coordinated web application can be approved/available, host regional workshops to target technical guidance *to conservation service providers* using the Texas Ecological Mapping Systems data and avaialble TXNDD tailored around priority habitats in this plan to encourage incorporation of these resources into site assessments, management plans, permitting processes, and other incentive programs. | |
| Minimally, Update the Wildlife Fact Sheets (http://www.tpwd.state.tx.us/huntwild/wild/species/) and the Endangered Species Lists (http://www.tpwd.state.tx.us/huntwild/wild/species/endang/animals/reptiles_amphibians/) on the TPWD website to provide the most current basic species information for all the species on the list (many state threatened and endangered species are incomplete or missing entirely). Would be helpful to include threats/reasons for decline and species management/conservation measures, include direction to best management practices website (see other action) for avoiding take of these species and destruction of their habitat | |
| Using the National Wetlands Inventory, Texas Ecological Systems data, and other imaging resources, identify intact, remaining isolated wetlands to prioritize for SGCN and rare communities' values; create a data layer that can be used to help conserve these features during project development. and other conservation planning efforts. | |
| Use one of the existing conservation project tracking tools to document all Action Plan implementation activities, research projects on SGCN and priority habitats, working group plans and activities that support conservation in Texas. | |
| Conservation Practice: Connection | |
| Each public lands site has an individual mission and purpose to servel local needs; however, these sites are increasingly important in a larger context. Encourage public land managers to evaluate the conservation condition and functional ecosystem contributions of their lands with others, based on the high priority habitats and issues identified in this handbook, to create site-specific "action plans" to hone management; collaborate with intention outside of boundaries with willing landowners, land trusts and other potential partners; and connect important habitats and resources across ownerships. | |
| Using the Texas Ecological Systems data, TXNDD data and input from regulators of natural resources in Texas, develop an "intact" index for mapped priority habitat types mentioned in this plan, a corridors analysis for wildife movements (similar to the one conducted for New Mexico (see http://pathwayswc.wordpress.com/maps-of-potential-and-existing-wildlife-corridors/) and a "best mitigation sites" website for planners and developers to use when addressing regulated and unregulated resources, including priority habitats in this | |

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| plan. While this may seem like three separate projects, they would be very related for grasslands, riparian, migratory, and aquatic habitats (with exception of isolated wetlands). | |
| Conduct joint capacity building with partners from Mexico and other Latin American countries seeking partnership with TPWD, focused specifically on priority habitats mentioned in this plan | |
| Conservation Practice: Delivery | |
| Provide technical guidance to conservation service providers about the differences among and regional applicability of all of the available conservation tools: Safe Harbor Agreements, Candidate Conservation Agreements, Candidate Conservation Agreements with Assurances, Habitat Conservation Plans, conservation easements, trusts, ETC. Evaluate the training based on reported use of these tools through a conservation delivery trackign website, and the conservation of priority habitats using these tools. | |
| Form a Statewide Conservation Delivery working group that includes entities who fund and who receive conservation grants to review existing web-based conservation data collection and practice sharing websites and implement "state of the practice" effectiveness reporting in Texas, using the measures method in the AFWA TWW 2011 Measuring the Effectiveness of State Wildlife Grants. **Coordinate with the Natural Resources Data Working Group (or all natural resources database managers, see above)**. Provide training for input into the TRACS or other conservation practice and spatial data tracking database (AFWA TWW 2011). These measures will be applied to the new USFWS TRACS database for all Sport Fish and Wildlife Restoration grants. While that device will be specific to those funds, other databases are currently working to be able to sync with that system. Having contributions from all Texas conservation action implementation in one view would be incredibly helpful to measure our successes, share our lessons learned, and improve conservation prioritization and delivery. | |
| Form a statewide working group to identify State Scientific Areas for priority habitat data collection and Best Management Practices development. Work with conservation grants to find money for incentives and regulatory assurances for data collection on private lands in these areas. | |
| Locate high quality large blocks of the Priority Habitats in this handbook (including those in emerging developing areas or adjacent to them, if they can be connected to intact, healthy wildlands); focus individual technical guidance on larger landowners and group workshops for clusters of small to mid acreage landowners. Encourage the group to form wildlife management cooperatives and participate in larger landscape scale connectivity efforts, restoration and management activities. | |
| Conduct a feasiblity study to determine the best methods and incentives for voluntary conservation easement participation in each ecoregion; these are beneficial instruments to both conservation practice and landowners, but are not well-leveraged across the state. | |
| Public properties for which natural resources management is a component of their mission need to be the best demonstration sites for natural resources management, conservation and recovery practices, and interpretation, based on the best science available (not local culture, whatever that may be – urban or rural) *especially* for the priority habitats in this plan. Every site should not be a demonstration of every land practice or every use. | |
| Encourage all conservation delivery providers to assess and include the potential for protection, restoration and interpretation of priority habitats in this plan in site visits, management plans, technical outreach (rx fire workshops), and other opportunities, even when the stated landowner purpose and objectives are not primarliy for conservation. | |
| Evaluate representative past and current species reintroduction mechanisms in North America – why successful or not successful, are cooperative ventures useful, what are the best (and worst steps) in the process, what are the barriers to private and public participation, funding required and sources, recovery demontrated – either incrementally and/or overall success, other lessons learned. Provide recommendations to overcome barriers and apply lessons learned to specific reintroduction efforts in ecoregions. | |
| Conservation Practice: Funding | |
| Evaluate the status of the Teaming With Wildlife state coalition, identify gaps in participation, and re-engage the coalition with guidance from the national steering committee efforts to develop strategic and REGULAR engagement toward a consistent source of non-game and habitat-based conservation funding. | |
| Conservation Practice: Policies, Guidelines, Rules, Regulation, Enforcement | |
| Conservation easements and other protection instruments which benefit landowners and interval or longterm protection vary widely, and much has been learned about necessary conditions in each ecoregion in the last 20 years. Conduct a broad study of various conservation easement types, from various entities and periods, to determine conservation effectiveness using the Measures document (AFWA TWW 2011). From this information, identify lessons learned and propose improvements to these instruments to enhance landowner understanding and desire to participate AS WELL AS longterm conservation effectiveness. | |
| Most regulations are species-specific and, in Texas, there are no habitat level protections for disappearing or imperiled communities or habitat types that are important to a wide variety of SGCN. Rules and regulations are not likely for these broad categories; however, there are opportunities for protection to fill gaps in federal and state regulations. Based on information in this plan and ongoing conservation work across the state, isolated wetlands, native riparian habitats, prairies, all habitats supporting state-listed species would be good starting points. Through MOUs and other coordination with development industries (wind, solar, transportation, mining, oil and gas), the conservation community couldevalaute existing BMPs, revise or add if needed, and include mitigation recommendations for these resources. | |
| *(See also Information section above)*<br>Adequate data, specific guidance, and timely response to requests for information and environmental review is likely to increase the odds that projects will accept TPWD's Habitat Assessemnt (Environmental Review) recommendations, when they are consulted. Development of an automated web based system to answer requests for information (TXNDD) and to process Environmental Review (Habitat Assessment) should be developed. By allowing 24 hour access to subscribed constituency it is possible to make TXNDD data more relevant in the project planning process. | |

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| Provide a one stop shop for all information necessary for developers and action agencies doing development/construction. Information would include links and info on to Project Development, TXNDD, Endangered Species Lists by County, Guidance on Resource Protection, Best Management Practices, Mitigation, Compliance Requirements, Applicable Rules and Regulations, and links to other resource agencies and NGOs involved in land/habitat conservation.<br>An automated "first cut" environmental review tool that provides an automated response to projects that are not likely to have a significant environmental impact would allow the Habitat Assessment staff to concentrate on those projects that will have an adverse impact. Lastly, there should be some way to develop a metric to determine the overall effect of sharing information and environmental review on the TX landscape. The definition of success for both programs should not be "we shared information" or "we provided comments". If we are being ignored then we should know that so we can find a better way to engage developers.See the AFWA TWW 2011 Environmental Review measures of success. | |
| Provide information and mechanisms to fully implement a revised TPWD – Texas Department of Transportation MOU to use the Texas Ecological Systems Mappign Project Data, TXNDD and Environmental Review processes and emerging information from the TCAP projects to protect state-threatened species, SGCN, and important habitats during the planning and project implementation processes. Promote the use of conservation BMPs through recommendations. Host and participate in transportation infrastructure design conferences (bridges, culvert, riprap) to target outreach and protection of priority habitats identified in this plan. Explore constraints, including costs of materials, alternative materials, engineering requirements behind the standards, SGCN requirements, buffer size for SGCN and rare habitat; start with simple area (rural vs urban?), build to include more complex sites and watersheds. Promote state of the practice conservation developments from the International Conservation on Ecology and Transportation.<br>For evaluation, select and focus on one small watershed (within one TxDOT District or a couple of counties) (with the potential for presence of SGCN) impacted by bridge, culvert, and/or riprap barriers for a fish and wildlife passage experiment. Develop an initial assessment of the sites (terrestrial and aquatic), including completeness of barrier, aquatic and terrestrial fauna, road kill statistics, habitat quality. After modifications, reassess site to document changes and at frequent enough intervals to demonstrate improvement in aquatic and riparian habitat; increased diversity in aquatic ecosystem and reduction of local roadkill/effectiveness of riparian corridor. Improve stability of SGCN population aquatic ecosystem occurring in area | |
| Evaluate current and new proposed regulations for conservation effectiveness and asses cost benefit ratio.Use Technical Committees that represent ecoregions and Programs. Develop standard process for presenting science-based recommendations to executive management and Commission.Develop specific research priorities through technical committees, prioritize opportunities and maximize resources.Ensure review of management recommendations by local biologists | |
| More enforcement is needed to curb the sale and the introduction of prohibited species | |
| Land & Water Management: Farm & Ranch | |
| Support the efforts of local land trusts, American Farmland Trust, and conservation NGOs to identify and conserve larger contiguous acreages willing to work toward SGCN and priority habitat conservation through the recommendations of the 2009 Land Trends Study (Texas A&M Institute of Renewable Natural Resources and the American Farmland Trust). | |
| Power Generation | |
| Coordinate with the TPWD Habitat Assessment Program and local conservation delivery professionals to nduct a workshop for current and future windpower providers focused on the amount and type of avoidance, minimization and mitigation information that is available for free from the TPWD Habitat Assessment service group, to encourage voluntary consultation. Additionally, roll out the Wind Guidelines and practical examples for implementation to producers within and outside of the state through interstate working groups (natural resources management agencies most affected by the industry's activities). | |
| Power Transmission | |
| Regional biologists and environmental review staff need to come up with ecoregionally specific ROW maintenance recommendations. Provide recommendations through field workshops to maintenance technicians in power delivery authorities. | |
| Oil and Natural Gas Production and Delivery | |
| Review and revise Best Management Practices for pad and road development, runoff and spill containment, and ecoregionally appropriate remediation guidelines, with recommended seed mixes and sources, including estimated costs for a full remediation. Distribute directly to oil and natural gas production companies | |
| Climate Change | |
| Develop models to predict climate change effects at a local scale, such as sea level rise, shoreline erosion, saltwater incursion, loss of cold water habitat, increase in and more frequent stand-replacing fires, etc. Identify habitats (and associated SGCN) that will be most affected by climate change. Develop strategies to conserve those habitats that can be conserved, and to increase resiliency of habitats in the face of climate change. Work with local communities to develop climate change adaptation plans, ensuring that conservation and resiliency of natural resources are addressed in the plan. For example, establishment of no-new-development zones or coastal land buy-back programs are preferable to hardened shorelines. Develop public programs that encourage or incentivize practices to facilitate climate change adaptation, such as removal of structures within predicted inundation zones as well as marsh restoration in these newly-relinquished areas. See Maryland's Climate Action Plan (http://www.mde.state.md.us/programs/Air/ClimateChange/Pages/Air/climatechange/legislation/index.aspx) for additional examples. | |
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| Research<br>▪ encourage participation in coordinated monitoring efforts such as the National Phenology Network (engages volunteers to monitor changes in plant and animal phenology across Texas<br>▪ monitor indicators of range shifts, particularly at the edge of ranges and on Sky Islands<br>▪ monitor the effects of rising sea levels on coastal habitats such as dunes, salt marshes, and lower tidal watersheds, as well as on their associated species<br>▪ identify vulnerable habitats and highly vulnerable species while recognizing that vulnerable species may be species flourishing today and not necessarily rare species. NatureServe, for example, has developed a vulnerability index that can easily be employed to qualitatively assess vulnerability on a species-by-species basis. Factors that will influence species' vulnerability include things like a species' thermal tolerance (will it be exceeded as environmental conditions change?), disruptive phenological shifts (e.g., a prey species unavailable at a key life-cycle stage of a predator), or shifts in the competitive balance (evidence that a different species will move into habitat). | |
| Adaptation : strategies that could help reduce or ameliorate anticipated negative effects of climate change; human activities intended to minimize the harmful effects of climate change on sensitive aspects of the environment. Generally recognized approaches to natural resource adaptation include increasing ecosystem resilience by reducing other stressors and facilitating transitions through building corridors. A more controversial approach is assisted migration in which species are moved ahead of an imminent threat on the basis of anticipated impacts.<br>Adaptation planning calls for: 1) identifying conservation targets (i.e., species, habitats, ecosystems), 2) assessing vulnerability to climate change by assessing sensitivity, exposure, and adaptive capacity, 3) identifying management options that would reduce sensitivity and exposure or increase adaptive capacity, and 4) implementing management options either through changes in policy, programs or institutions (NWF 2011).<br>Guiding Principles and Actions Related to Climate Change Adaptation:<br>▪ Conserve existing biodiversity by 1) conserving protected areas and other high quality habitats, 2) conserving the range and ecological variability of habitats and species, and 3) building replication within protected-area networks.<br>o Safeguard/buffer existing protected areas<br>o identify and protect other high-quality habitats<br>o create buffers around protected areas and high quality habitat<br>o ensure that conservation actions collectively protect as great a range of each type of habitat or species locality as possible, including atypical sites, and 5) protect movement corridors, stepping stones (e.g., stopover areas for migratory waterfowl) or refugia where climate impacts may be less severe.<br>▪ Reduce non-climate sources of harm.<br>o Review habitat management plans, species management plans, and other conservation management plans and projects to ensure that non-climate stressors are identified<br>o that mechanisms exist to assess these factors in the future<br>o that these are being addressed explicitly wherever possible, and<br>o encourage the formation of regional cooperatives to tackle these issues on a landscape scale.<br>▪ Develop ecologically resilient and varied landscapes by 1) conserving and enhancing local variation within sites and habitats, 2) making space for the natural development of rivers and coasts, 3) improving management and restoration of existing protected areas to enhance resilience.<br>o Identify opportunities to enhance habitat quality and quantity through habitat creation and restoration<br>o establish buffers through a variety of conservation activities along rivers and coasts to facilitate natural migration of watercourses.<br>▪ Establish ecological corridors through habitat protection, restoration, and creation.<br>o Identify and protect relatively intact landscapes that will serve as core conservation actions<br>o identify degraded habitats that can be enhanced through restoration and linked to high-quality habitats in order to build corridors<br>o establish partnerships among private landowners, non-profit conservation organizations, and state and federal agencies through which coordination and financial support of high-priority conservation activities can occur.<br>▪ Implement an adaptive management framework that will respond to changing conservation priorities as new information is collected and analyzed.<br>o Develop a climate change adaptation framework for conserving the biodiversity of Texas<br>o establish long-term monitoring objectives that will serve as the basis of adaptive management. | |
| Use the Texas Ecological Systems Mapping Project data to develop a habitat and a vegetation community based Climate Change Vulnerability Index. Develop a current and future climate envelope for major groups of ecological systems. Large differences may reflect increased climate change vulnerability. Also, simply score ecological systems based on expert opinion (coastal wetlands and mountain top types are more vulnerable for example). Areas of high vulnerability may deserve increased attention from TPWD and other agencies. | |
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| ALL Priority Habitats in this Plan | |
| Post Conservation-based, Scientifically-supported Best Management Practices for PRIORITY HABITATS identified in this plan on TPWD Portal that is connected to Technical Guidance, Landowner Outreach, Specific Resources webpages, and Environmental Review. Identify currently used BMPs for SGCN and rare communities, identify critical components related to their success (necessary ecoregion-specific modifications), develop BMPs in generic written format appropriate for Web posting, develop internal and external web sites (internal for BMPs under development and review, external for stakeholder application), both internal and external websites should have ability to send/receive feedback for each BMP. Develop multi-divisional and program working groups, involve outside stakeholders as needed. Analyze affects of BMPs on applicable SGCN and rare community, assess their usefulness (if implemented ideally, do they work-test them in Texas and document the assessment and post it to the web). Where BMPs are found to need species- or community-specific modifications, amend BMP. Provide revision dates on BMPs. Link BMPs to species information pages.<br>Identify issues and impact types that have no BMPs (example: wintertime reptile BMPs.) Prioritization of the threats identified per species and accessibility to the species threat analysis will help to identify BMP gaps. Convene small working groups to prioritize and address BMP gaps. Research and develop BMPs. Assess interaction of BMPs to provide context-specific variations. Periodically test BMPs for effectiveness and appropriateness. BMPs should include any necessary contextual caveats (specific to a species, industry, etc.). Species and rare community BMPs should include avoidance, minimization, and compensation measures with appropriate contacts or links for additional information<br>Note: TPWD Inland Fisheries already has a project in the works for water resources. TPWD Wildlife Habitat Assessment is also investigating Web options. Numerous programs have developed their own BMPs that they regularly use. BMPs need to be evaluated in larger context beyond Department use and recommendations, including cross-pollinated conservation delivery provider workgroups. Conservation goal is to have an accessible set of BMPs that staff and stakeholders can draw from when planning to address environmental impacts and/or benefits (e.g. invasive species control, restoration activities, etc.) during project development, appropriate for Texas ecoregions, SGCN, and rare communities. | |
| Riparian and Floodplains | |
| Texas Ecological Mapping System Data Riparian Quality Index Analysis: Develop Riparian Quality Index at the 12-digit Hydrologic Units level based on Texas Ecological Mapping Systems Data in conjunction with data developed by the National Fish Habitat Action Plan, Ecologically Significant Stream Segments, FEMA Floodplain maps, TXNDD, and local knowledge Identify highest priority areas for connectivity and community protection or restoration conservation actions. | |
| Identify watershed-specific and ecoregionally approriate seed and plant material sources for restoration projects. Distribute this information to native plant nurseries, conservation service providers, urban planning organizations and TXDOT Districts. | |
| Management approaches to conserving riparian zones must address both the loss and degradation of these habitats and the effects of human disturbance. The USDA Forest Service (Welsch 1991) provides specific guidelines for the conservation and maintenance of riparian zones, including recommendations for the size of forest buffer widths. In general, riparian buffer widths should be at least 300 feet to support wildlife habitat. However, conservation buffers of this size are not always possible. Buffers of at least 50 feet protect some streamside functions, although long-term effectiveness should be examined related to SGCN needs. Riparian buffer recommendations should be incorporated into all Best Management Practices and communicated to interested landowners, urban planners, and developers. See Wenger 1999, R.W. Tiner 2003, and Restoring Wetland and Streamside /Riparian Buffers: An Introduction. USFWS, Ecological Services, Hadley, MA | |
| Focus attention on non-floodplain landowners along lower-order streams who tend to farm to stream banks; 2) that programs such as the Conservation Reserve Program, Environmental Quality Incentives Program, and the Wildlife Habitat Incentives Program consider explicitly incorporating flood risk in determining agricultural land values for rental payments; and 3) that large scale riparian restoration projects consider flood risk as a potentially significant component of the opportunity cost of taking riparian land out of agricultural production. Z. Qiu, C. Hall, and K. Hale. Evaluation of cost-effectiveness of conservation buffer placement strategies in a river basinJournal of Soil and Water Conservation 2009 64(5):293-302 | |
| Native Grasslands | |
| Texas Ecological Mapping Systems Prairie Quality Index. Evaluate the quality of all areas on prairie soils with respect to intactness of native flora, patch size and invasion by native and exotic woody flora. Collaboration with the Native Prairies Association and other interested partners and the use of data and expertise developed by these groups on native prairies distribution and ecological services are important to successful completion of these projects. Refinement of all existing prairie inventories and development of new methods to evaluate status of existing grasslands will be based on existing inventories, new field investigation, analysis of Texas Ecological Mapping Systems Data and modeling data, including soils database, and Field Reference Database. | |
| Using the most recent information from Texas Ecological Mapping Systems project, Native Prairies Association, Texas Natural History Database, Texas Natural Diversity Database, and TPWD Rare Communities ecologist, grassland and prairie land trusts, public land managers, and other NGOs, identify the best locations for functional grassland conservation/restoration in contiguous blocks in west, north, and central Texas. Promote these areas for Farm Bill Conservation Programs, conservation easements, and land trust coordination. | |
| Identify grassland specific and ecoregionally approriate seed and plant material sources for restoration projects. Distribute this information to native plant nurseries, conservation service providers, urban planning organizations and TXDOT Districts. | |
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| Texas Ecological Mapping System Data Habitat Assessment for Vertical Structure. Use LiDAR or other high quality, high precision elevation data to evaluate vertical habitat appropriateness for species sensitive to vertical stratification of their habitat. Examples include grassland birds such as bob white quail and lesser prairie chickens. | |
| Seasonal and Daily Movement Corridors and Stopovers | |
| Using the Texas Ecological Mapping Systems project data, identify key stopover patch areas, connectivity corridors for migratory birds, wide-ranging animals, and transborder popultaions; map potential sites for landowner outreach and incentives to promote voluntary conservation of these areas, especially where adjacent to publicly managed land | |
| Using the Partners In Flight TriNational Plan, identify key areas for land and water based conservation on maps that can be used by all conservation partners. Identify other SGCN which would directly benefit from these sites. Document conservation and restoration actions of these areas on one of the web-based conservation effectiveness data sharing sites. | |
| Identify ecoregionally approriate seed and plant material sources for corridor improvement and restoration projects. Distribute this information to native plant nurseries, conservation service providers, urban planning organizations and TXDOT Districts. | |
| NABCI partners in the three countries worked together to develop Continentally Important Proposals for shared priority species on the continent. The proposals aim to conserve over one million acres of key habitats -- habitats that span the range of priority species and are critical to mitigate the impacts of threats such as illegal harvesting, pollution, and climate change on birds and other migratory wildlife. http://www.nabci-us.org/aboutnabci/CIP-intro.pdf . Several federal, state and non-governmental organizations have international conservation programs and initiatives with habitat priorities which contribute to or overlap with Texas conservation needs and priorities (TNC 2011):<br>Neotropical songbird overwintering areas (e.g. highland pine – oak forests in Chiapas which benefit the golden-cheeked warbler, <u>all</u> populations of which next in central Texas),<br>Bird migration pathways and stopovers and movement corridors for far-ranging mammals like black bear and mountain lion (e.g. riparian corridors on the Rio Bravo/Rio Grande);<br>Desert fishes habitats (e.g. groundwater resources expressed in regional cienegas (desert springs), small streams, and ephemeral and perennial tributaries and mainstem of the Rio Bravo/Rio Grande)<br>Chihuahuan desert grasslands and shrublands which benefit black-tailed prairie dogs, kit fox, mule deer, cactus species; | |
| Colonial Habitats | |
| Work with TXNDD, Colonial Waterbrid Survey, Texas Audubon, Bat Conservation Intenational, and others to idenfity data collection standards and timelines to map various kinds of colonial habitats and produce a mechanism (Texas Master Naturalists?) to update (revisit existing and add new) information every two years. Once the conservation measures or TXNDD web interface is available, work with willing landowners to allow this information to be viewed during planning and development project phases to prevent loss of these important systems. | |
| Some rookery sites do not have return use and other sites must be available to fill this need. Identify why sites are not repeatedly used (is the problem one with a remedy) and where alternative sites are located to ensure redundancy in those systems. | |
| Caves and Karst | |
| Map karst landscapes with their vegetation community contexts, create an index of vulnerability and rarity based on SGCN presence and knowledge to date, evaluate surface habitat needs to protect the feature(s) functions (see also Krejca et al. 2001.How Much Surface Habitat is Enough? Preserve Design and Application for Cave-Limited Species http://www.nckms.org/pdf/KREJCA.pdf ) and prioriize areas for landowner incentives and stewardship with grassland, forest, woodland, riparian and other conservation programs. | |
| Estuaries and the Gulf of Mexico | |
| Texas Ecological Mapping Systems Tidal Marsh Project. Map extent of tidal marsh and swamp system based on salinity regime based on analysis of existing data from TPWD and other partners, including potentially NOAA, USFWS and USGS, field investigation and Texas Ecological Mapping Systems Data, including Field Reference Database. | |
| Gulf of Mexico research initiatives, conservation plans, restoration plans and other action plans are many. A working group needs to identify how these plans can work together for the SGCN in this plan, with goals and recommendations for priority projects in the next 5, 10, 30 years. A recommended working group would include many of the NGOs in the coastal conservation community (GCBO, CBBEP, TNC, Audubon, etc.), Harte Institute, Texas Parks and Wildlfie Department Coastal Ecosystem Leads and the Science and Policy group, Artificial Reefs Program, USFWS Coastal Conservation Program, NOAA, USACE, GLO … This should be a priority to identify areas for protection, incentives, conservaton easements, scientific areas, restoration and resiliency in the face of climate change, rising sea level, potential oil spills, marsh loss and coastal development. | |
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## MEASURING PROGRESS AND EFFECTIVENESS

*"Like the resource it seeks to protect, wildlife conservation must be dynamic, changing as conditions change, seeking always to become more effective." – Rachel Carson*

It has become increasingly important to determine if the work we do on a *daily* basis is actually leading to the overall conservation outcomes we desire – **restoration, recovery, sustainability, resiliency**. As conservation practitioners, we can use milestones (or intermediate results) and reporting to communicate our progress and leverage future conservation action, partnerships, policy changes, and funding.

With this revision, the TCAP becomes more involved in a national movement to track conservation actions and progress across local, state, regional and national levels. As with the 2005 Plan, actions presented in this edition vary in detail, scale, and duration; however, in this edition, measures of success are identified where possible and specifically encouraged in future project development. To that end, the toolkit in Measuring the Effectiveness of State Wildlife Grants (AFWA TWW, 2011) is strongly recommended to define projects, target audiences and partners, identify desired step-wise intermediate results, and collect the "right" data to report our conservation acheivements.

Full-cycle management from the Open Standards of Conservation Practice (2007) needs to be applied to all actions. Well-crafted monitoring and evaluation (cost effective, answers key questions) informs management and allows conservation practitioners to "course-correct" as necessary for effective conservation (Salzer and Salafsky 2006). This kind of reflection is necessary, albeit not currently widely written into project plans. It is critical to document measures, progress and success, to learn from our work, share lessons learned, and educate future conservation practitioners.

With the need for Action Plans to take advantage of several "pots of conservation money," the people we serve and those who govern private and public conservation funds demand reporting, transparency, and *demonstration* that projects are positively impacting the conservation of species and habitats. To get beyond reporting that money was spent and projects were done, AFWA TWW convened a committee in 2009 to craft "effectiveness measures" for the conservation actions across all Plans. A toolkit for classifying and measuring conservation action effectiveness was produced in 2011, approved by AFWA TWW Executive Committee comprised of state fish and wildlife agency directors and others. These measures will be an important part of moving the plans and conservation forward.

## CONSERVATION RESOURCES

This section is in progress and will complement the Natural Resources Conservation Programs and Services for Texas Landowners (http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_w7000_1198.pdf) created in 2007.

## RESOURCES AND REFERENCES

This section is incomplete for the JUNE DRAFT will be updated with all resource information fromthis handbook after the handbook has been completed


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