

**A PLAN FOR ACTION TO CONSERVE RARE
RESOURCES IN TEXAS**

**Second Review Draft
October 16, 1995**

**Texas Parks and Wildlife Department
Endangered Resources Branch**

**Edited by:
Lee Ann Johnson Linam**

**Contributions from:
David E. Bowles
Mary Candee
William R. Carr
Noreen Damude
David D. Diamond
Lee F. Elliott
Gary L. Graham
Margaret A. Horner
Dean P. Keddy-Hector
Gena C. Janssen
Patricia Morton
Melissa M. Parker
Jackie M. Poole
Andrew H. Price
Gareth Rowell**

**Editorial Assistance from:
Cidney Sunvison
Jeannette Martinez
Carmen Gilbert**

A PLAN FOR ACTION TO CONSERVE RARE RESOURCES IN TEXAS

INTRODUCTION	1
VISION FOR THE FUTURE	3
RARE SPECIES ACTION PLANS - AN OVERVIEW	11
VERTEBRATE SPECIES ACTION PLAN HIGHLIGHTS	
High and Medium-High Priority Amphibians	16
Medium Priority Amphibians	19
High and Medium-High Priority Birds	21
Medium Priority Birds	28
High and Medium-High Priority Fish	31
Medium Priority Fish	35
High and Medium-High Priority Mammals	36
Medium Priority Mammals	39
High and Medium-High Priority Reptiles	44
Medium Priority Reptiles	48
SUMMARY OF PRIORITY PLANT CONSERVATION NEEDS	50
OVERVIEW OF INVERTEBRATE ACTION PLAN	60
Table 1 Endangered and candidate invertebrates	62
Table 2 Endangered and candidate aquatic invertebrates	63
Table 3 Comparison of primary habitat types for aquatic invertebrates	64
Table 4 Distribution of candidate invertebrates by primary ecosystems	65

TABLE A Explanation of Terms and Symbols

APPENDICES (Available upon request)

APPENDIX I. Invertebrate Species Action Plans

APPENDIX II. Plant Species Action Plans

APPENDIX III. Amphibian Species Action Plans

APPENDIX IV. Bird Species Action Plans

APPENDIX V. Fish Species Action Plans

APPENDIX VI. Mammal Species Action Plans

APPENDIX VII. Reptile Species Action Plans

A PLAN FOR ACTION TO CONSERVE RARE RESOURCES IN TEXAS

INTRODUCTION

Texas is an amazing place to live. This is especially true with respect to our biological and cultural diversity. We have more species, plant community-types, and landscape diversity than just about any place in this hemisphere north of the Mexican border. As an example, over 590 species of birds have been recorded in the 11 ecological or landscape regions of Texas. A surprisingly large proportion of the plants and animals that live here are endemic to this state. For instance, of the 5,500 plant species, 425 occur nowhere but Texas.

Why is Texas so unique? The reasons include where it is located, its size, and its varied terrain. Ecological zones representing eastern woodlands, central plains, western mountains and desert systems, and southern subtropical ecosystems converge in Texas. Texas is big! Covering 266,807 square miles, 15 of the other 49 states could fit within its borders. It has a great deal of variation in climate and landscapes, factors influencing habitat diversity. The state has 91 mountains that are a mile or more high and we also have a greater volume of inland water than any state except Alaska.

As unique as this natural richness is, it is rapidly disappearing. At least 17 animal species, including Bison, Mexican Gray Wolf, and Ivory-billed Woodpecker, that once occurred in Texas have vanished from here during the last 150 years. Attwater's prairie chicken, a truly Texan bird that once numbered over a million, has drastically decreased from 450 in 1993 to 68 in 1995 and may be the next to be added on the growing list of extinct species. Many others, such as the Whooping Crane, hang on in precariously low numbers. Over 10% of Texas vertebrates are listed by the state as threatened or endangered. Even entire plant community-types are seriously threatened. For example, beech-magnolia forests have been reduced to a few mature stands. In fact, of the 90 plant communities in Texas, 29 are considered rare.

Texas is a private lands state with an urban public. Ninety three percent of Texas citizens support the conservation of rare species. About eighty percent of the citizens live in largest urban centers, whereas well-over 90% of the state is privately owned. Consequently, over 50% of all federally listed species in Texas are found *exclusively* on private lands, demonstrating a historical and ongoing commitment to conservation on these lands. These are very important facts that must be included in virtually all state conservation efforts.

Finally, although sound information is essential for making wise conservation decisions, recovery of imperiled species in Texas is not simply a scientific process. Instead, the Endangered Resources Branch recognizes that for conservation to be successful it will have to be pursued as a partnership with many participating parties. In some cases, partners will include other agencies with similar responsibilities and interests; however, most often in Texas the essential partner will be private landowners. It is the goal of the Endangered Resources Branch to work cooperatively with landowners to identify conservation strategies that address both the needs of the species and the concerns of the private landowner for long-term success. In addition, both state law and

TPWD policy require TPWD employees to respect landowner property rights. Employees will gather and disseminate data from private property only with the written consent of the landowner.

Texas Parks and Wildlife Department's Endangered Resources Branch

While responsibilities concerning endangered resources in Texas involve many different divisions within Texas Parks and Wildlife Department (TPWD), primary responsibility for endangered resources planning, administration, and review has resided with the Endangered Resources Branch (ERB) of the Resource Protection Division since 1989. As the Division charged with the primary responsibility for environmental review and with a scope encompassing plants, animals, and natural communities, the Resource Protection Division seeks to give a statewide, resource-wide perspective to endangered resources conservation.

The Endangered Resources Branch of the Division is responsible for inventorying, cataloging, and monitoring rare species and communities of concern within the state; for research, listing, and outreach activities designed to implement species recovery; and for providing information to the Texas public on these elements of natural diversity. In addition, many of the endangered resources responsibilities and activities are carried out through cooperation with the other TPWD divisions, with the Wildlife, Inland Fisheries, Law Enforcement, and Coastal Fisheries Divisions all playing significant roles.

The Action Plan

In 1991, the ERB published the "Endangered Resources Annual Status Report" as a first effort to share information about endangered resources conservation priorities and progress with the interested public. Significant progress has been made toward many of the goals identified in that document. One of those goals included the preparation of a long-range plan that would identify and prioritize protection, information, and management needs for rare resources in the state. This Action Plan represents one step toward completion of that goal.

The Action Plan is organized into two main sections. The first section, titled "A Vision for the Future" identifies some programmatic goals for the Endangered Resources Branch during the next five years, along with objectives and strategies to reach those goals. It is expected that strategies will be updated on an annual basis. The second part of the Action Plan consists of Species Action Plans. An introduction to this section is provided, along with highlights from some of the Species Action Plans. The actual Species Action Plans themselves are found in Appendices I-VII.

The original draft of this Action Plan was provided for public review during a one-year period. Comments were specifically solicited from TPWD's list of Endangered Resources Technical Advisers and TPWD's Endangered Resources Policy Advisory Committee. In addition the draft Action Plan was made available to any other interested parties requesting it. The comments of these reviewers are appreciated and have helped to improve the content and approach of this document.

VISION FOR THE FUTURE
(Goals, Strategies, Tasks)

1. Promote local community involvement in the conservation of rare resources.

Local community involvement is now recognized worldwide as essential to success in conservation. This is particularly important in Texas. In order to deliver the responsible management of our biological diversity expected by our customers, who are largely urban, we must develop better methods of working with rural private landowners. We want to encourage rural landowners to actively participate in the conservation of rare resources through a process that is initiated and directed by the landowners and their neighbors, customized to fit the local community, ecosystem based, and subject to revision as we learn more.

1.1 Provide easy public access to important technical information for use in land management and conservation of natural resources.

1.1.1 From community/rare species analysis, develop county by county data bases of habitats (natural communities) and the significant natural features found there. Complete a prototype for data delivery for one county in 1995-96.

1.1.2 Develop management recommendations to conserve the health and biological diversity of each different habitat.

1.1.3 Prepare materials, including management guideline leaflets and management videos.

1.1.4 Conduct endangered species management workshops and give presentations at meetings of landowners and extension specialists.

1.1.5 Explore the possibility of making data available via the Internet.

1.2 Assist landowners, landmanagers, and local communities with the development of innovative conservation tools to chose from (Habitat Conservation Plans (HCPs) and related approaches such as Transferable Endangered Species Certificates, Cooperative Conservation Plans, conservation easements, conservation leases, conservation agreements, wildlife management plans, etc.).

1.2.1 Develop capacity for new conservation tools:

1.2.2 Locate existing sources of information on conservation options.

1.2.3 Conduct staff training on HCPs, conservation easements, and other management options.

1.2.4 Determine which options may be of interest to landowners through meetings with them, queries in newsletters, etc.

1.2.5 Explore sources of funding for incentive programs and to support planning efforts such as HCPs.

- 1.3 Develop a landowner/cooperator appreciation award program.
 - 1.3.1 Actively participate in TPWD landowner recognition program.
 - 1.3.2 Create a landowner appreciation process for the Branch that complements the recognition program (and have process approved by the executive office).
 - 1.3.3 Use TPWD media and outreach avenues to highlight those landowners who are doing a good job of species conservation and habitat management.
- 1.4 Work to develop and implement management plans and agreements.
 - 1.4.1 Respond to requests for assistance as received. Provide management recommendations as requested.
 - 1.4.2 Proactively seek conservation agreements potentially leading to species recovery.
 - 1.4.3 Take the lead in an effort to encourage and empower landowners at the county level to address conservation planning for biodiversity and endangered species management. Provide technical assistance to landowners and agency personnel to accomplish these objectives.
 - 1.4.4 Prepare a magazine article describing some of the success stories with landowners.

2. Determine distribution, status, and trends of significant natural features from species to communities to landscapes.

Accurate and defensible data are essential to more rigorously determining the status of our resources. Such determinations are very important with respect to establishing conservation priorities, developing management plans, and securing public support.

- 2.1 Identify and prioritize inventory and research needs for specific vertebrate and plant taxa based on review of the best information available.
- 2.2 Focus inventory efforts on (1) public lands, (2) rare ecosystems or ecosystems with many rare species, and (3) private lands upon land owner request.
 - 2.2.1 Complete Department Lands Inventory including rare plant and animal searches, vegetation cover type descriptions, potential vegetation descriptions, and suggest management options for significant natural features.
 - 2.2.2 Conduct site inventories on National Guard lands.
 - 2.2.3 Inventory rare plants of the Lower Rio Grande National Wildlife Refuge (NWR) and state holdings.
- 2.3 Prioritize invertebrate inventory needs by priority habitats
 - 2.3.1 Complete review of known distribution and status of federal candidate invertebrates, cross-referencing by locality and habitat-type.

- 2.3.2 Initiate qualitative sampling of priority habitats for component candidate species and associated aquatic invertebrates to develop community similarity indices.
 - 2.3.3 Coordinate general invertebrate inventory work with universities, other government agencies, and independent consultants, when possible, to avoid duplication of effort and to expedite the inventory process.
 - 2.3.4 Identify and pursue external sources of funding for supporting invertebrate inventory work and conservation-oriented research.
- 2.4 Implement monitoring plans for rare resources in Texas, focusing first on high priority federal candidate and state listed species.
- 2.4.1 Prioritize species in need of monitoring.
 - 2.4.2 Identify resource professionals at TPWD and in other natural resource agencies and organizations who can assist with monitoring efforts.
 - 2.4.3 Prepare monitoring manuals and data sheets.
 - 2.4.4 Analyze results for implications regarding protection or management needs.
 - 2.4.5 Recruit, train and utilize monitors including local volunteers.
 - 2.4.6 Develop a volunteer manual that includes guidelines for ethics, collecting issues, participation by minors, etc.
 - 2.4.7 Develop a recognition program for volunteers and their efforts.
 - 2.4.8 Provide career information and opportunities for developing volunteer involvement.
 - 2.4.9 Develop a newsletter or form of communication to keep involved cooperators informed of monitoring efforts.
 - 2.4.10 Create monitoring partnerships with cooperative landowners, businesses, schools and other groups.
- 2.5 Use modern techniques, including Geographic Information Systems (GIS) and Image Processing, to help identify the most important conservation locations at several scales with a focus on public lands.
- 2.5.1 Complete analysis of the importance of plant communities based on rare species.
 - 2.5.2 Complete GIS for delivery to National Guard.
 - 2.5.3 Analyze the utility of ecosystem management for species and community conservation by overlaying rare species locations with vegetation cover type mapping; couple with ecological management considerations.
 - 2.5.4 Develop a defensible priority list of rare ecosystems for inventory.

3. Conduct research and implement recovery actions for rare species and natural communities.

Funds to conserve rare resources are limited and must be used efficiently. Research priorities need to be based on objective criteria, be cost effective, and be supported by most of the biologists and conservationists associated with the issues. In addition, TPWD priorities should focus on research essential to management issues, species for which the state can play a significant role in recovery (such as candidate species and endemics), and research that integrates species and natural communities. Research projects need to be carefully designed and reviewed by experts representing diverse perspectives.

- 3.1** Routinely update and review Action plan in order to prioritize research and recovery needs for species and communities.
 - 3.1.1** Develop and strengthen communities section and linkages between species and communities.
- 3.2** Increase efficiency and effectiveness of research through systematic peer review of project proposals and reports.
 - 3.2.1** Develop a selection and review policy for Section 6 proposals.
 - 3.2.2** Develop a review policy for project reports.
- 3.3** Conduct priority research and recovery based on priorities identified in Action Plan.
- 3.4** Increase interaction and cooperation regarding research projects.
 - 3.4.1** Develop professional relationships and joint projects with Mexican border states.
 - 3.4.2** Communicate regularly with TPWD staff and other researchers to maximize efforts to develop and implement plans for rare resources.
 - 3.4.3** Make contact with local community interests when conducting research projects.
 - 3.4.4** Develop an annual project report summarizing the activities of the Branch. Eventually move to Internet.
 - 3.4.5** Publicize success stories.
- 3.5** Seek alternative funding sources to support work on non-federally listed species.

- 4. Maintain systems for compiling, analyzing, and disseminating resource information.**
Efficient management of accurate and defensible information is crucial to our rapid response to more than 500 requests we receive each month. The information we provide conserves hundreds of populations of rare species and saves a great deal of money through proactive environmental planning by more than 300 companies and individual users each year.
- 4.1** Manage the Biological and Conservation Data (BCD) system currently used to answer information requests, conduct environmental reviews, help set conservation priorities, and assist with setting priorities for research and inventory.
 - 4.1.1** Maintain quality control steps for information flow into the BCD, and generalize quality control steps for information flow to be applied to data layers of the Terrestrial Wildlife Database.
 - 4.1.2** Maintain manual, map, and computer files in an integrated way to facilitate rapid retrieval of information via various search procedures (e.g. starting with a site, a species, or a community in computer, map, or manual files).
 - 4.1.3** Continue migration of appropriate BCD data onto GIS for inclusion as a layer within the Terrestrial Wildlife Database; train staff on how to access that information.
 - 4.1.4** Explore the possibility of including other natural resource data together with BCD data for easy access and use both externally and internally.
 - 4.2** Provide technical information for dissemination.
 - 4.2.1** Continue to answer more than 500 information requests per month from a variety of data users.
 - 4.2.2** Develop a method to determine the impact of project review based on acres or populations conserved. Disseminate results to public.
 - 4.2.3** Develop a BCD technical information request form for the TPWD home page on internet.
 - 4.3** Compile and analyze data on significant natural features for entry into the BCD; focus on public lands.
 - 4.3.1** Annually update the rankings of rare species and communities based on review of numbers, distribution, and threats.
 - 4.3.2** Draft an article for the *Texas Parks and Wildlife Magazine* on the utility of information management systems for project review and pro-active conservation.
 - 4.3.3** Enhance network and exchange of information among knowledgeable landowners, researchers, managers, and other interest parties.
 - 4.3.4** Capture information by transcribing data records, mapping information, and ensuring quality control and compatibility with Department GIS efforts and the Terrestrial Wildlife Database.

- 4.4 Use Geographical Information System and Image Processing to enhance research, data delivery, and information management capabilities.
 - 4.4.1 Develop personal computer GIS applications and capabilities in Austin and field offices.
 - 4.4.2 Explore options for incorporation of GIS technology into the information management system, including the production of summary maps for staff and for public use and routine answering of information requests.
- 4.5 Demonstrate and promote the utility of the BCD for natural resource information.
 - 4.5.1 Compile a list of requestors and the types of requests answered. Focus on one or two large or interesting projects.
 - 4.5.2 Produce a pamphlet on BCD that explains the function and utility to various user groups.
- 5. **Ensure that Texas species are provided appropriate legal protection.**

The biological basis for legal protection needs to be as rigorous and current as possible in order for the public to support protection efforts and be made aware of the resources most at risk.

 - 5.1 Revise state lists.
 - 5.1.1 Finalize listing/delisting criteria for plants and vertebrates, assessing the value of new listing categories, such as Sensitive Species or Landowner-Protected species.
 - 5.1.2 Review and assess listing needs for invertebrates.
 - 5.1.3 Review state Threatened and Endangered (T&E) list every three years.
 - 5.1.4 Update state T&E lists and proclamations as federal list changes.
 - 5.2 Revise state T&E statutes, policies, and regulations for additional clarity and protection needs.
 - 5.2.1 Clarify regulations.
 - 5.2.2 Provide input to legislative changes, especially for clarity and consistency.
 - 5.2.3 Develop reintroduction policy for animals and plants.
 - 5.2.4 Investigate permit options for collecting invertebrates, including requirements for annual reporting.
 - 5.2.5 Coordinate regulatory efforts with Nongame Program.
 - 5.3 Develop interpretive materials to help the public understand state lists.

6. Provide information and learning opportunities about rare resources.

An active, well-informed and involved citizenship is essential to the conservation of rare resources. The Branch directs education and outreach efforts to diverse groups including the general public, landowners, educators, private business, politicians and to state, federal and non-governmental natural resource agencies and organizations.

6.1 Prepare Branch staff to respond to requests for information and presentations.

6.1.1 Provide training opportunities to improve education and outreach skills.

6.2 Maintain comprehensive slide collection of rare plants and animals

6.2.1 Identify slide needs and fill gaps.

6.3 Prepare new outreach materials and teaching tools such as:

(# indicates projects planned for 1995-96)

***ecoregion curricula, slide & video sets, scripts and activities#**

***brochure about Texas endangered species and ecoregions#**

***brochure about Branch#**

***biodiversity video#**

***rare plants of Texas book (update and add management guidelines)#**

***handbook on thornscrub restoration**

***habitat management videos with accompanying brochures#**

***endangered species posters#**

***bumper sticker about biodiversity**

***more activities for schools, especially high schools#**

***more activities for very young children (picture & coloring books)**

***study skin collection**

6.3.1 Create outreach materials for all taxonomic groups (i.e., invertebrates).

6.3.2 Determine market segments for conservation messages.

6.4 Investigate new outreach opportunities using Internet and CD ROM.

6.5 Organize and participate in teacher training workshops and other activities that involve schools and giving hands-on opportunities to students.

6.5.1 Create a South Texas (Harlingen) wetland monitoring project for schools to monitor wetlands for water quality, vegetation and rare species.

6.6 Increase Branch participation in mentor and intern programs.

6.7 Recruit local volunteers to assist with projects.

6.7.1 Train volunteers to provide assistance with research and monitoring activities.

6.7.2 Train and equip volunteers to give programs to community groups.

- 6.8** Collaborate within and across divisional lines to take advantage of the excellent education and outreach resources that exist throughout TPWD especially in Wildlife (Nongame & Urban) and Public Lands.
 - 6.8.1** Offer or participate in training workshops for regional resource specialists and park naturalists/interpreters.
- 6.9** Organize and participate in workshops and other activities that train and inform colleagues from other natural resource agencies and organizations.
- 6.10** Develop strategies to communicate with and inform audiences such as the legislature and commission.
- 6.11** Utilize Conservation Communications to raise awareness about rare resource issues and promote key projects and activities.
 - 6.11.1** Provide local news media with regular updates on rare species status.
- 6.12** Develop funding sources (i.e., product sales) to add to the Nongame and Endangered Species Conservation Fund.
- 6.13** Collaborate with TPWD personnel, private businesses and communities in establishing ecotourism activities that relate to rare resources.

RARE SPECIES ACTION PLANS - AN OVERVIEW

Introduction

The task of identifying and prioritizing conservation needs for rare species in Texas is admittedly an awesome challenge, and this effort by the Endangered Resources Branch of the Texas Parks and Wildlife Department should only be viewed as a first step in a process that will include review and refinement both now and in years to come. We felt the task was worth undertaking, however, for several reasons. First, no ready synthesis of status and conservation information is available for the list of approximately 600 species of special concern tracked by the Endangered Resources Branch. Second, conservation efforts are destined to always face hard decisions about prioritizing expenditure of time and money, and, although the Recovery Planning process of the U.S. Fish and Wildlife Service attempts to set priorities for listed species, a need exists to attempt conservation of rare species before they reach endangered status. Finally, through a rather intensive examination of the conservation needs of individual species, commonalities become apparent that may guide us to a more effective approach toward conservation of suites of species or shared ecosystems with their entire complex of biodiversity.

Approach

The species included in this Action Plan are among those vertebrates, invertebrates, and plants tracked by the Endangered Resources Branch (ERB). The Branch assigns a rank to species based on their rarity and threats on a global (G-rank) and state (S-rank) basis (Table A). The Branch then tracks occurrences of species that are rare within the state (S1-S3 species). All "tracked" vertebrates are included in this Action Plan. Only a subset of plants that are considered to be of highest biological conservation concern are included. Nearly all rare plants tracked by the Branch (approximately 300 species) have some unknown aspects of their natural history that are considered a conservation priority; however, efforts were made to focus this overwhelming task on truly high priority species and to omit those that, for example, are known only from a herbarium specimen. The plant species included in the Action Plan have two or more high priority tasks (tasks being categorized as survey, monitoring, research and management). For invertebrates, this Action Plan addresses only those species that are candidates for listing by the U.S. Fish and Wildlife Service. Since the state of knowledge concerning the status of invertebrates in the state as a whole is very rudimentary and the task of complete status assessment is overwhelming, we attempted to use this subset of species to predict ecosystems that appear to harbor large numbers of unique taxa.

Information in the Action Plans is presented in a form that includes legal and biological status, distribution, habitat type, reasons for concern, and status, monitoring, research, and management needs. In addition, each species is assigned a TPWD priority of high, medium-high, medium, medium-low, or low. These priorities were derived from a qualitative scale that considered factors such as rarity, threat, capability of TPWD to contribute to species recovery, population trends, lack of conservation attention, significance of Texas population, co-occurrence with other species of concern, and timeliness of action needs. Each conservation need for each species is

assigned a priority of high, medium, or low, based upon an assumption of its importance to the conservation of the species. U.S. Fish and Wildlife Service Recovery Plans (when available) were used as a reference for conservation needs. The conservation needs (i.e. status, monitoring, research and management) listed are intended to reflect actions that TPWD should consider undertaking and thus do not reflect all actions that might be appropriate for the species. Rather, they are intended to facilitate planning and prioritization of expenditures for TPWD and especially the Endangered Resources Branch.

The individual species action plans are available as appendices; however, several summaries are presented in this document. A beginning attempt is made to identify shared conservation needs in order to draw attention both to ecosystem-level concerns and to potential efficiencies in addressing conservation needs for multiple species. This attempt helps add to the current community classification and ranking maintained by the Branch. In addition, a draft matrix of rare species and community types developed by the Endangered Resources Branch and the University of Houston that underscores these relationships is presented. Following the section on shared conservation needs, highlights of the vertebrate and plant species action plans are presented, along with an overview of the invertebrate action plans.

Ecosystem Conservation Needs

Not surprisingly, many species share research and management needs that are ecosystem-related. A cursory analysis of some of these similarities is offered below. Projects that address these shared conservation needs will be considered highest priority by the Endangered Resources Branch.

East Texas Pineywoods - Several species are associated with a landscape mosaic including longleaf pine uplands, hillside seepage bogs, broadleaf evergreen woodlands, and mixed pine-hardwood (oak-beech-loblolly pine) slopes and creek-sides. Fire was the predominant natural process that controlled community dynamics in this mosaic. Associated species dependent upon this landscape mosaic include bog coneflower and yellow-eyed grass in seeps; Red-cockaded Woodpecker, Texas trailing phlox, Bachman's Sparrow, Henslow's Sparrow, and Louisiana Pine Snake in longleaf pine uplands; and Southern lady's slipper and Southeastern Myotis in mesic woodlands. In addition, white bladderpod is found in fire-maintained glades within pine forests. For some species, these habitat relationships are fairly well understood, while for others, such as the Henslow's Sparrow and Louisiana Pine Snake, more information may be needed regarding effects of different fire management and timber management regimes.

Similarly, several species are (or were) primarily restricted to mature bottomland hardwood communities, including the Eastern Big-eared Bat, Louisiana Black Bear, Timber Rattlesnake, Bachman's Warbler, Cerulean Warbler, American Swallow-tailed Kite, Wood Stork, and Bald Eagle. While the loss of bottomland hardwoods has already elicited concern, these rare species provide more impetus for its conservation.

Finally, several aquatic species in East Texas share conservation concerns. Species associated with large water bodies, such as the Blue Sucker, Paddlefish, Alligator Snapping Turtle, and Bluehead Minnow, have been impacted by wetland loss and reservoir construction. Conservation of remaining wetlands, maintaining river flows, and managing isolated populations may be important for these species.

Central Prairies and Woodlands - Several rare species occur in the deep sandy soil systems of the Post Oak Savannah, including the Houston toad, Aransas Short-tailed shrew, large-fruited sand verbena, and Navasota ladies' tresses. Not only is habitat conservation needed for these species, especially avoidance of conversion to improved pasture, but more research is needed concerning the role of fire in maintaining these savannah communities and its effect on these rare species. Few Blackland Prairie species are yet considered rare; however, examples of native tallgrass prairie have themselves become extremely rare in the state and therefore worthy of conservation.

Coastal Prairies and Marshes - Within the coastal tallgrass prairie several species have critically declined, including Attwater's Prairie Chicken, Texas Henslow's Sparrow, and Texas prairie-dawn. Prescribed fire needs to be returned to many areas of coastal prairie degraded by brush invasion. In addition, the Henslow's Sparrow is dependent on areas of lightly-grazed or seasonally ungrazed grassland for nesting habitat. Coastal oak woodlands are also a rare community type, as well as being important stopover habitats for migrating songbirds.

Coastal wetland species share many conservation needs as well. Bays, marshes, tidal flats, and beaches provide habitat for many shore and wading birds and reptiles of concern. Threats from urban development, oil spills, contaminants, and coastal erosion need to be addressed to ensure the survival of these species. The most important habitats need to be identified and protected. In addition, a better understanding and conservation of freshwater inflows into estuaries is needed to maintain estuarine and bay health, as well as species that are very estuarine dependent, such as the Gulf Saltmarsh Water Snake and Texas Diamondback Terrapin. The Action Plans also include descriptions of common conservation needs for marine mammals.

South Texas Brush Country - Several habitats are of significant conservation concern in this natural region, and some are severely threatened. Subtropical forests of the lower Rio Grande valley provide habitat for a variety of songbirds, raptors, bats, reptiles, amphibians, and plants that are endemic or reach the northern end of their distribution in this area. Brush communities, both in the lower Rio Grande Valley and in other parts of South Texas, provide habitat for Ocelots, Jaguarundis, several bird species, such as Olive Sparrow and Audubon's Oriole, several reptile species, such as the Reticulate Collared Lizard, Texas Tortoise, Texas Indigo Snake, and Texas Horned Lizard, and many plant species, such as Johnston's frankenia and ashy dogweed. The live oak woodlands of the Coastal Sand Plain region also are a unique community, as well as providing significant habitat for the Ferruginous Pygmy Owl and the Northern Beardless Tyrannulet. While many conservation efforts, such as habitat restoration and/or acquisition are ongoing, inventories of many areas are still needed, as well as incentives and cooperative

agreements for private landowners. In addition, the effects of various brush, grazing, and fire management schemes on most of these species are not well-known.

South Texas grasslands are also significant for several rare species, including the Texas Botteri's Sparrow, White-tailed Hawk, and Aplomado Falcon. While significant tracts of habitat still remain for these species, it is important that good grazing and fire management be practiced. Similarly, South Texas wetlands are important to several rare species, including the Brownsville Common Yellowthroat, Black-spotted Newt, Rio Grande Lesser siren (although its taxonomy is in question), and anuran species perhaps dependent on these wetland breeding sites. These wetland habitats are under pressure from development and the threat of contaminants.

Edwards Plateau - In general, the Edwards Plateau region is of high conservation concern, both because of a high level of endemism and because of rapid human population growth. Several rare terrestrial species are associated with the woodlands of the Balcones Canyonlands subregion, including the Golden-cheeked Warbler, Zone-tailed Hawk, Texas snowbells, bracted twistflower, big red sage, canyon mock-orange, and Texabama croton. Conservation strategies in the face of urban sprawl need to be developed, and information needs to be gathered regarding restoration and compatible economic uses of the remaining woodlands.

Aquatic resources in the Edwards Plateau are equally significant and perhaps more threatened. The region's aquifer, springs, and streams provide habitat to 44 endemic species, including several *Eurycea* salamanders, at least ten rare fish, one endangered plant (Texas wild-rice) and a large number of endemic invertebrates. While recent research has helped to define the distribution of the spring-dwelling salamanders, and the fish distributions are fairly well known, significant information gaps exist for invertebrates. Water quality and flow issues related to the Edward's Aquifer are the most pressing conservation concerns in this region, both for rare species and the human population.

Rolling and High Plains - Loss and fragmentation of grassland ecosystems have most impacted rare species of this region. Concern has been expressed nationwide for several species inhabiting shortgrass habitats, including the Black-footed Ferret, Swift Fox, Mountain Plover, Ferruginous Hawk, Burrowing Owl, and Baird's Sparrow. A need exists to determine what grassland habitats are remaining, both in the high plains and in the rolling plains, where the Texas Kangaroo Rat is a species of concern. Other more localized geologic formations support species of concern, including Lesser Prairie Chickens in the Wheeler sandhills, Texas poppy mallow in outcrops of sandy soils, and the Palo Duro Mouse in the woodlands of the caprock escarpment.

Plains rivers have also emerged as a concern. Understanding stream flow may be especially important in maintaining habitats for the Interior Least Tern, Snowy Plover, Arkansas River Shiner, Smalleye Shiner, Sharpnose Shiner, and Harter's Water Snake.

Trans-Pecos - Like the Edwards Plateau, the Trans-Pecos region is an area of many endemic species and significant natural communities. Threats have tended to be much lower in the past in this region due to low human population and large land ownerships, although recent

subdivision of some areas for vacation homes has increased concern for many of the plant and mammal species with extremely limited distributions. In addition, an increased understanding of the fire and grazing dynamics of grassland ecosystems that support species such as the Davis Mountains cottontail, yellow-nosed cottonrat, and several pocket gophers would be desirable...

Most critical conservation concerns in the Trans-Pecos region center around aquatic systems. Springs, and their issuing streams in the Trans-Pecos region are extremely important habitats for a large number of threatened and endemic species, including at least six fish, one plant, and a number of invertebrates. Given the number of springs that have ceased flowing in the Trans-Pecos region, more information is needed concerning the hydrology and use of many of these systems if effective locally-based conservation action is to be achieved. Future efforts should follow the example of several recent efforts to create or restore aquatic habitats in the Trans-Pecos region; these efforts included much local involvement and support.

Species that inhabit riparian woodlands throughout west Texas and the southwest, such as the Northern Gray Hawk, Zone-tailed Hawk, and Common Black Hawk, and Southwest Willow Flycatcher have come under concern because of habitat degradation and invasion of habitat by salt cedar. Research on restoration of these cottonwood-willow woodlands has been initiated in other states, but efforts have not yet begun in earnest in Texas.

Finally, American Rivers, a non-profit organization, in 1993 recognized the Rio Grande as the most endangered river in the United States due to pollution effects and depletion of flow. The Rio Grande and its tributaries harbor at least 12 rare fish species. An extensive inventory effort is currently underway, but improvement of aquatic habitats for these species will require a coordinated effort between Texas and Mexico.

VERTEBRATE SPECIES ACTION PLAN HIGHLIGHTS

This section summarizes high and medium priority conservation needs for high and medium-high priority species and high priority conservation needs for medium priority species.

HIGH AND MEDIUM-HIGH PRIORITY AMPHIBIANS

1. Scientific Name: *Bufo houstonensis*
Common Name: Houston Toad

Determine status throughout potential habitat in Lee, Waller, Montgomery, and San Jacinto counties. (M)

Locate cooperative landowners for access to land for annual surveys and to participate in HCP. (H)

Annually document presence of Houston Toads at known sites and determine population sizes and extent of distribution using demonstrated techniques. (H)

Determine rate of conversion of habitat to unsuitable conditions utilizing available techniques. (M)

Determine life table, home range, and activities outside of breeding season. (H)

Continue long-term demographic research in Bastrop State Park, including effects of prescribed burning, and institute same in at least one additional population. (H)

Implement conservation plan in Bastrop County. (H)

Develop and implement conservation plans in other areas as opportunities occur. (H)

2. Scientific Name: *Eurycea neotenes*
Common Name: Texas Salamander

Resolve taxonomic relationships among populations within the complex. (H)

Determine extent of distribution. (M)

Expand and refine knowledge of the physical characteristics of the drainage and recharge systems. (H)

Locate cooperative landowners for access to land for annual surveys. (M)

Determine sensitivity to aquatic pollutants and changes in water quality parameters. (H)

Determine demographic characteristics. (M)

Support efforts to determine and assure adequate springflows. (H)

Integrate management needs of the species into state or regional conservation plans for the aquifer. (H)

Establish and maintain captive stocks and a contingency plan. (M)

3. Scientific Name: *Eurycea sosorum*
Common Name: Barton Springs Salamander

Determine whether the species occurs elsewhere in the aquifer. (M)

Expand and refine knowledge of the physical characteristics of the drainage and recharge systems. (H)

Monthly document presence of the Barton Springs Salamander in Barton Springs. (M)

Continually monitor spring flow. (M)

Determine sensitivity to aquatic pollutants and changes in water quality parameters. (H)

Determine demographic characteristics. (M)
Continue to work with the City of Austin's salamander team on the management needs of the system. (H)
Determine predatory effects of exotic fishes and other organisms in the system. (M)
Support efforts to determine and assure adequate springflows. (H)
Integrate management needs of the species into state or regional conservation plans for the aquifer. (H)
Establish and maintain captive stocks and a contingency plan. (M)

4. Scientific Name: *Eurycea* sp. 1
Common Name: Jollyville Plateau Salamander

Complete formal taxonomic work on the species. (H)
Determine the extent of the distribution of the species. (M)
Expand and refine knowledge of the physical characteristics of the drainage and recharge system. (H)
Institute long-term monitoring program in each of the 3 drainages. (H)
Locate cooperative landowners for access to land for annual surveys. (M)
Quarterly document presence of Jollyville Plateau Salamanders at known sites. (M)
Determine sensitivity to aquatic pollutants and changes in water quality parameters. (H)
Determine demographic characteristics. (M)
Integrate management needs into the BCCP framework. (M)
Support efforts to determine and assure adequate springflows. (H)
Integrate management needs of the species into state or regional conservation plans for the aquifer. (H)
Establish and maintain captive stocks and a contingency plan. (M)

5. Scientific Name: *Eurycea* sp.5
Common Name: Georgetown Salamander

Complete formal taxonomic work on the species. (H)
Determine the extent of the distribution of the species. (M)
Institute long-term monitoring program. (H)
Locate cooperative landowners for access to land for annual surveys. (M)
Quarterly document presence of Georgetown Salamanders at known sites. (M)
Determine sensitivity to aquatic pollutants and changes in water quality parameters. (H)
Determine demographic characteristics. (M)
Support efforts to determine and assure adequate springflows. (H)
Integrate management needs of the species into state or regional conservation plans for the aquifer. (H)
Establish and maintain captive stocks and a contingency plan. (M)

6. Scientific Name: *Siren*
Common Name: South Texas Large Form

Formalize the taxonomic status of this form. (H)
Determine the geographic range of this taxon. (H)
Delimit sites where monitoring of populations is likely to provide substantial data and begin trapping.

Suggested Method: Use minnow-traps and PIT tags to determine demographic parameters. Suggested

Sites: Olmito Abandoned Hatchery (TPWD), Santa Anna NWR, LRGVNWR Villa Nueva Tract. (M)

Taxonomic research deserves the highest priority for this species. (H)

Provide protection by thoroughly evaluating projects calling for destruction of appropriate wetlands. (H)

In project review, provide information to resource agencies concerning importance of substrate adequate for aestivation and emergent vegetation for cover from predatory species. (H)

Limit application of pesticides in areas known to be occupied by this species and/or the black-spotted newt. (M)

Provide habitat where species would be protected from the hazards of inadequate water quality and supply. (M)

Provide education materials concerning the maintenance of functioning wetland ecosystems in the valley. (M)

Encourage conservation of south Texas wetlands on public lands with cooperative private landowners. (H)

MEDIUM PRIORITY AMPHIBIANS

1. Scientific Name: *Eurycea nana*
Common Name: San Marcos Salamander

Determine sensitivity to aquatic pollutants and changes in water quality parameters. (H)
Work with the City of San Marcos and with Southwest Texas State University on the management needs of the system. (H)
Support efforts to determine and assure adequate springflows. (H)
Integrate management needs of the species into state or regional conservation plans for the aquifer. (H)

2. Scientific Name: *Eurycea* sp. 2
Common Name: Salado Springs Salamander

Complete formal taxonomic work on the species. (H)
Determine the physical characteristics of the Salado Creek drainage and recharge system. (H)
Determine sensitivity to aquatic pollutants and changes in water quality parameters. (H)
Support efforts to determine and assure adequate springflows. (H)
Integrate management needs of the species into state or regional conservation plans for the aquifer. (H)

3. Scientific Name: *Eurycea tridentifera*
Common Name: Comal Blind Salamander

Determine sensitivity to aquatic pollutants and changes in water quality parameters. (H)

4. Scientific Name: *Hypopachus variolosus*
Common Name: Sheep Frog

Update and increase information on distribution and population status. (H)
Identify cooperative landowners with existing breeding sites to allow annual census. (H)

5. Scientific Name: *Notophthalmus meridionalis*
Common Name: Black-spotted Newt

Follow up on sites identified by Rappole and Klicka is needed. Additional sites should be investigated. (H)
Determine threats to habitat (pesticides, clearing for agriculture, water development, overgrazing). (H)
Study life history, including demographics and diet. (H)
Protect ponds under public ownership (Laguna Atascosa NWR) containing significant populations by allowing development of some emergent vegetation and occasional drawdown to prevent development of significant populations of predators. (H)
Encourage conservation of aquatic habitats on private lands. (H)
Identify conservation areas necessary for survival of this group of south coastal plain wetland species, and consider the possibility of re-introduction. (H)

6. Scientific Name: *Rana grylio*
Common Name: Pig Frog

Determine extent of distribution. (H)

Determine sensitivity to aquatic pollutants and changes in water quality parameters. (H)

Encourage conservation of freshwater wetlands. (H)

7. Scientific Name: *Typhlomolge rathbuni*
Common Name: Texas Blind Salamander

Acquire Rattlesnake Cave and establish permanent audiovisual monitoring and interactive educational display. (H)

Determine sensitivity to aquatic pollutants and changes in water quality parameters. (H)

Integrate management needs of the species into state or regional conservation plans for the aquifer. (H)

HIGH AND MEDIUM-HIGH PRIORITY BIRDS

1. Scientific Name: *Aimophila aestivalis*
Common Name: Bachman's Sparrow

Derive a more accurate population estimate for Texas. (M)

More accurate censusing, especially in red-cockaded woodpecker (RCW) stands. Relative abundance should be determined by playback as some sites are frequently visited by birders. (M)

Habitat quality and incidence of nesting should be checked. (M)

Birds should also be monitored in winter to learn something about the winter ecology of the species. (M)

Hunter (1990) recommends a detailed study on the population dynamics of the species, etc., under various forest management regimes wherever it nests. (M)

Manage breeding habitat by promoting fire climax, pine savannah with lush herbaceous vegetation. (H)

Educate landowners and the general public about the natural history and management needs of this species. Develop Memorandums of Understanding (MOU's) between landowners, their neighbors and TPWD. (H)

2. Scientific Name: *Buteo nitidus maximus*
Common Name: Northern Grey Hawk

Inventory surviving acreages of cottonwood-willow bottomlands in the Trans-Pecos. (H)

Inventory total acreage of Rio Grande riparian woodlands. (H)

Monitor status and distribution. (M)

Monitor pesticide contamination in potential prey and eggshells. (M)

Determine effect of grazing intensity on prey availability. (M)

Where possible eradicate tamarisk and reestablish cottonwood-willow woodlands. (H)

Prepare and disseminate educational materials designed to improve understanding of the natural history of this species. (H)

Reduce risk of shooting mortality through hunter education programs. (M)

Reduce risks of electrocution and collision with powerlines through better design of utility poles. (M)

On managed areas protect cottonwood, willow woodlands, and mesquite bosques from clearing and effects of overgrazing and overbrowsing. (H)

Limit recreational access to known nesting locations. (M)

3. Scientific Name: *Charadrius alexandrinus nivosus*
Common Name: Western Snowy Plover

Identify nesting areas, both inland and on the coast. (H)

Determine historical nesting range and compare to present range. (M)

Define wintering habitat and distribution. (H)

Once nesting distribution is determined, monitor sites to insure no loss of nesting habitat. (H)

Monitor wintering population in conjunction with other shorebird monitoring efforts. (M)

Determine parameters defining breeding and wintering habitat needs and map available habitat (this can

probably be done in conjunction with piping plover habitat mapping). (M)
Determine extent and nature of habitat loss. (M)
Evaluate effects of declining water quality on foraging habitat of the species. (M)
Determine the importance of disturbance on nesting as well as migrating and wintering birds. (H)
Protect habitat, both breeding and wintering. For inland breeding populations this may require increasing the awareness of water managers that maintain and monitor flood control structures. For coastal breeding populations this may require restricted access to some beach habitats, control of pet access to beaches, and/or protective fencing of nesting areas. Wintering habitat will entail careful scrutiny of coastal development and wise planning to minimize or eliminate loss of wetlands. (H)
Listing of this species, if status assessment indicates appropriate, along with the current status of the piping plover, and the precarious status of other species such as the reddish egret, may provide sufficient justification needed for the general protection of our estuarine habitats. (M)
Locate, define, and establish protected areas for this and other shorebird species using the Texas coast. This may be accomplished through the Western Hemisphere Shorebird Reserve Network, or some more substantial protective procedure. (H)

4. Scientific Name: *Charadrius melodus*
Common Name: Piping Plover

Continue to clarify the distribution of the species on its wintering grounds. (H)
Continue to gather information on the distribution and abundance of wintering birds and attempt to differentiate the importance of various habitats for the species. (M)
Support, and provide assistance to, any efforts to initiate a coast wide census of the wintering population. (M)
Provide data to address the importance of human disturbance to the species. (M)
Continue to support the efforts directed towards determining habitat parameters important to the species. Attempt to develop coast wide habitat model to be used to identify and prioritize habitats for protection and management concerns. Considerable attention has been focused on areas where plovers do occur, some research should address similar habitats where plovers are not found. (H)
Quantify habitat and its loss, particularly in the lower Laguna Madre. (H)
Prioritize other areas for habitat loss studies. (H)
Determine criteria required to identify essential habitat. (M)
Clarify movement patterns of the species. Determine roosting requirements and if roosting sites and feeding sites need certain juxtaposition. (M)
Investigate effects of environmental contamination, including increased sediment load (from dredging and/or mariculture activities) on winter survival. (M)
Assess winter mortality. (M)
Assist listing process for other species that share this ecosystem when appropriate so that protection measures can proceed in a more cohesive fashion (H)
Support efforts to develop WHSRN sites, evaluate and prioritize areas throughout the coast that may deserve special protection (M)
Provide data to resource agencies to protect habitat through wetland permitting procedures. (M)
Develop educational materials to publicize aspects of the biology of piping plovers, including recovery options. Provide controlled viewing opportunities. (M)

5. Scientific Name: *Charadrius montanus*
Common Name: Mountain Plover

Stet Mountain Plovers are routinely sighted, including breeding, winter, and migratory sites. (H)
Survey prairie dog town area in Mexico (Chihuahua) south of El Paso for wintering mountain plovers. (M)
Obtain population estimate of wintering sites. (M)
Locate cooperative landowners for access to land for annual surveys. (H)
Annually document presence of Mountain Plovers and obtain population estimates using local Audubon members. (H)
On known wintering sites, attempt to capture and band the flock to track long-term movements. (M)
Determine habitat types used in Texas. (H)
Determine short term, seasonal movement patterns. (M)
Determine effects of winter pesticides on wintering individuals. (M)
Advise landowners of presence of mountain plovers and discuss alternative options of pesticide usage; encourage continued landuse practice - maintain prairie dog towns, plowed fields or short grasses. (H)

6. Scientific Name: *Dendroica chrysoparia*
Common Name: Golden Cheeked Warbler

Refine estimates of habitat occupancy and densities. (H)
Monitor changes in the availability of suitable breeding and wintering habitat. (H)
Monitor productivity of selected GCW populations. (M)
Monitor rates of cowbird parasitism in selected agricultural and non-agricultural areas. (M)
Support of studies of warbler habitat selection and population biology so as to assist in efforts to design a system of GCW management areas. (H)
Support studies to predict the impacts of various landuse activities on warbler habitat quality and productivity. (H)
Actively promote studies of the species on its wintering grounds in Mesoamerica. (H)
Promote reforestation in designated GCW management areas selected to support long-term recovery of the species. (H)
Reduce browsing pressure in occupied and restored habitat. (H)
Prepare and disseminate educational materials designed to improve understanding of the natural history of this species. (H)
Encourage additional conservation strategies for the species, including cooperative management agreements with landowners. (H)
Work cooperatively with other natural resource management agencies to help private landowners adopt more ecologically appropriate land management practices. (H)

7. Scientific Name: *Egretta rufescens*
Common Name: Reddish Egret

Monitor population levels through continued support of colonial waterbird survey. (H)
Determine foraging ecology of the species to provide baseline information to address impacts on habitat. (H)
Identify important nesting sites and monitor nesting success. (H)
Monitor impacts of discharges, decreased freshwater inflows, erosion, oil spills, and pesticide contamination on populations and foraging areas. (M)
Define and gather data on demographic parameters important in detecting negative impacts to the species. (M)
Provide public education to deter impacts of human disturbance to nesting islands. (H)
Provide data to resource agencies to facilitate decisions concerning threats to the species on either foraging or nesting areas. (M)

8. Scientific Name: *Empidonax trailii extimus*
Common Name: Southwest Willow Flycatcher

The primary need at this time is for surveys of the abundance and distribution of this species. In particular we need to know the availability of riparian cotton-willow woodlands for this species. This is likely the most critically endangered plant community in Texas and the remainder of the southwestern United States. (H)
Monitor changes in the availability of appropriate habitat for this species. (H)
Monitor changes in the productivity of any extant breeding territories that are found. (M)
Determine the impact of landuse practices on extant populations of this species in Texas. (H)
Determine the extent to which this and other riparian nesters use tamarisk bottoms. (H)
Protect SW riparian woodlands through agreements and restore this community to areas where it formerly occurred. (H)
Manage grazing carefully to allow conservation of riparian vegetation. Initiate cowbird control efforts if evidence indicates that control efforts are necessary. (H)

9. Scientific Name: *Falco femoralis septentrionalis*
Common Name: Northern Aplomado Falcon

Inventory existing amounts of coastal tall-grass prairie and desert grassland. (H)
Support studies of the status and distribution in Mexico. (M)
Determine the extent of the species distribution in Mexico. (M)
Determine rates of productivity for a representative sample of nesting attempts in Mexico. (M)
Determine whether the species is indeed threatened by pesticide contamination. (M)
Determine extent of exposure to lead shot in prey species. (M)
Monitor effects and work to limit use of pesticides known to poison birds of prey and small birds. (H)
Prepare and disseminate educational materials designed to improve understanding of the natural history of this species. (H)
Reduce risks of electrocution and collision with powerlines through better design of utility poles. (M)

Reduce risk of shooting mortality through hunter education programs. (M)

10. Scientific Name: *Geothlypis trichas insperata*
Common Name: Brownsville Common Yellowthroat

Update and improve on status information provided in Rappole and Klicka, 1991. (M)

Site(s) to be monitored: *National Audubon Society, Sabal Palm Sanctuary, Cameron Co., and Anzalduas (Hidalgo) County Park, south of Mission, Texas. Laguna Atascosa NWR may also be a place to look for it. Methodology: Find population and estimate numbers of individuals present. Check for evidence of reproductive behavior. Do habitat analysis. Optimal time frame: Time of year is important. April through end of May. (H)*

Monitor impacts of cowbird parasitism. (M)

Evaluate taxonomic status of this subspecies and clarify distribution in Texas. (M)

Examine effects of pesticide use in occupied habitat. (M)

Protect wetlands in extreme south Texas. Protection of these wetland habitats will also provide protection for several other species of concern in the valley, particularly various amphibian species. (H)

Maintain heavy vegetation in wetland areas. (M)

Modify design of irrigation canal bank, to provide growth of lush vegetation. (M)

Seek conservation agreements for occupied habitat. (H)

11. Scientific Name: *Glaucidium brasilianum cactorum*
Common Name: Cactus Ferruginous Pygmy-owl

Determine status of this species in South Texas. (M)

Determine extent of present populations in Brooks County and within Falcon Woodlands. (M)

Support research directed towards monitoring populations occurring on the King Ranch (Norias Division). (M)

Emphasize importance of using population estimates based on passive monitoring. (H)

Evaluate habitat parameters of the species. (H)

Determine accuracy of using playbacks to estimate population numbers. (M)

Determine competitors for nesting cavities and evaluate nesting cavity requirements. (M)

Determine impacts of playbacks by recreational ornithologists. (M)

Radio track individuals to examine home range use. (M)

Evaluate success of artificial nesting provisions. (M)

Involve private landowners in recovery, and provide support and incentive for ongoing attempts to manage land in ways compatible with the continued existence of the owl. Potential for listing of this species should be accompanied by some sort of conservation plan to recognize the successful protection of the species through the efforts of private ranch owners. This may be accomplished through threatened listing with accompanying plans to provide incentive to landowners. (H)

Protect riparian and mesquite-ebony woodlands adjacent to the lower Rio Grande. (H)

12. Scientific Name: *Picoides borealis*
Common Name: Red-cockaded Woodpecker

Conduct a written survey submitted to landowners with more than 20 acres of pine habitat to determine population trends on private lands. (H)
Obtain information from private landowners concerning numbers of RCW's and colonies. (H)
Check the activity status of each cluster annually each spring. (M)
Further evaluate midstory tolerance of the species on private lands. (M)
Determine the relationship between the southern pine beetle and RCW cavity trees. (H)
Develop a technique to conduct augmentation with mature birds. (H)
Develop management strategy for small populations in Texas. (H)
Perfect artificial cavities and drill techniques for the species. (H)
Develop habitat corridors for the species. (H)
Establish Memorandums of Agreements with large and/or small landowners to provide habitat for RCW's on a sustainable basis. (H)
Disseminate management information to landowners. (H)
Develop a regional Habitat Conservation Plan to address concerns of private landowners and overall conservation strategy for RCW in East Texas. (H)

13. Scientific Name: *Tympanuchus cupido attwateri*
Common Name: Attwater's Prairie Chicken

Conduct annual counts on booming grounds (H--accomplished by Wildlife Branch).
Continue to develop propagation and release techniques, building on experience with Greater Prairie Chickens and Masked Bobwhites. (H)
Refine understanding of optimal habitat requirements (through comparisons with stable Greater populations?). (H)
Conduct disease and genetics research to support restoration efforts. (H)
Continue to encourage habitat recovery and restoration within known range, including incentives for private land. (H)
Improve stability of Colorado County population through land management agreements--seeking to restore large, contiguous prairie ecosystem. (H)
Utilize captive stock to supplement critically low populations (if disease concerns can be addressed) or to establish new populations if suitable habitat can be located. (H)
Disseminate information to encourage landowner support and to develop grass-roots support and funding from the private sector. (H)
Control imported fire ants. (H)
Locate additional sources of funds, including generation of public awareness, to support recovery efforts. (H)

14. Scientific Name: *Vermivora crissalis*
Common Name: Colima Warbler

For this species it is important to continue monitoring distribution and abundance within the Chisos Mountains, as well as the bulk of the species range in Mexico. (H)
Rates of cowbird parasitism in warbler nests should be studied in order to assess the need to reduce or remove livestock, including horses, from the Chisos Basin in Big Bend National Park. (H)
Reduce the tendency of cowbirds to frequent campgrounds in the park. (H)
Intensive cowbird trapping should be employed if research shows this to be a problem. (H)

15. Scientific Name: *Vireo atricapillus*
Common Name: Black-capped Vireo

Determine status of the species in Mexico. (H)
Determine status of the species on private lands in Texas. (H)
Continue monitoring the status of the species on public lands. (H)
Monitor annual variation in levels of vireo productivity and populations turn-over, and dispersal at scattered study sites, within designated recovery regions. (H)
Develop techniques for creating vireo habitat. (H)
Develop non-invasive techniques for minimizing rates of cowbird parasitism in vireo colonies. (M)
Determine the extent and nature of vireo wintering habitat. (H)
Develop a population viability model for the species. (M)
On private lands, work with landowners to promote voluntary protection of existing vireo habitat and implementation of management practices which serve to regenerate habitat on a long-term basis. (H)
On public lands, establish vireo management areas in which new habitat is cyclically generated. Control browsing pressure. (H)
On public lands, minimize use of cattle and other large ungulates in the vicinity of nesting vireos unless an intensively-managed cowbird trapping program is implemented. (M)
Implement cowbird management programs where data suggested there is a nest parasitism problem. (M)
Explore opportunities for a regional Habitat Conservation Plan to encourage private landowner involvement. (H)

MEDIUM PRIORITY BIRDS

1. Scientific Name: *Aimophila aestivalis*
Common Name: Baird's Sparrow

Determine winter distribution and abundance in Texas. (H)

Determine habitat structure, habitat plant species composition, and landuse history of sites regularly used by wintering Baird's Sparrow (H).

2. Scientific Name: *Aimophila botterii texana*
Common Name: Texas Botteri's Sparrow

We need to find more populations. The birds are very hard to see and not easily identified when seen. A cryptic species, the male song is the best clue to identification. Site(s) to be monitored: Laguna Atascosa NWR or King Ranch with permission. Methodology: Relative abundance (use playback), habitat quality analysis. Optimal time frame: Censusing best done when males are singing after spring rains (Whitney, 1991). Breeding populations in northernmost part of range migrate south for winter, leaving U.S. by end of September. Arrives in nesting area in TX late April-May. (H)

Recommended protection of the coastal grassland habitats important to the species. The habitats important to this species may also provide habitat for the Aplomado Falcon. (H)

Well-managed grazing to ensure that some areas are lightly grazed or ungrazed each nesting season. (H)

3. Scientific Name: *Ammodramus henslowii*
Common Name: Henslow's Sparrow

This species is reclusive. During the non-breeding season when the species is most likely to be found in Texas the species remains close to the ground and is reluctant to flush. The easily identified song is, of course, less frequently heard outside of the breeding season. Of secondary importance would be status and monitoring efforts which look at the distribution and abundance of this species in relation to land use activities. (H)

Prairie restoration (with non-breeding season burning regimes) coupled with careful management of any grazing and periodic burning to prevent woody invasion, would seem to be the best management strategy for Henslow's Sparrow. (H)

4. Scientific Name: *Buteo regalis*
Common Name: Ferruginous Hawk

Determine the status of the species as a permanent and winter resident: Does it breed in the Trans-Pecos?. Does it breed in other Panhandle areas outside of Dallam Co.? Approximately how many birds winter in various portions of Texas? (H)

Study winter and breeding season ecology (diet composition, nesting and winter habitat characteristics and landuse, spatial requirements, etc.). (H)

Discourage rodent poisoning on National Grasslands and other public lands. (H)

Encourage efforts to conserve pinyon and juniper in nesting areas of this species and appropriate management of firewood cutting. (H)

5. Scientific Name: *Buteogallus anthracinus*
Common Name: Common Black Hawk

Inventory surviving acreages of cotton wood-willow bottomlands in the Trans-Pecos. (H)

Inventory total acreage of Rio Grande riparian woodlands. (H)

Establish a banding program to aid in understanding dispersal, wintering ground locations, and population turn-over. (H)

Where possible eradicate tamarisk and reestablish cottonwood-willow woodlands. (H)

Reduce impacts of livestock grazing to riparian vegetation through exclusion of livestock or application of carefully managed grazing regimes. (H)

6. Scientific Name: *Falco peregrinus anatum*
Common Name: American Peregrine Falcon

Study trends in the production of young by west Texas peregrines. Determine the extent to which these birds have exposure to environment contaminants. (H)

Determine trends in the productivity of west Texas eyries. (H)

Within Texas, monitor and restrict applications of insecticides known to harm this species in and near falcon foraging areas. (H)

7. Scientific Name: *Grus americana*
Common Name: Whooping Crane

Need to track sightings during migration to determine migration areas and to respond to emergencies like injuries. (H)

Need to determine effects of freshwater inflows and commercial harvests on bay productivity and food supplies. (H)

Oil spill response plans are needed for wintering areas (already prepared for Wilder Flats). (H)

Shoreline erosion protection is needed along GIWW (H--being addressed by USFWS and COE).

Provide public awareness and education to prevent shooting incidents. (H)

8. Scientific Name: *Haliaeetus leucocephalus*
Common Name: Bald Eagle

Continue monitoring the status and distribution of wintering and breeding birds in Texas. (H)

Protect bottomland hardwood and riparian woodland habitats. (H)

9. Scientific Name: *Laterallus jamaicensis*
Common Name: Black Rail

Collect distributional data from sources along the coast where habitat is available (Murphree WMA, Anahuac NWR, Brazoria NWR, Galveston Island, San Bernard NWR, Sea Rim SP, Guadalupe Delta WMA, Aransas NWR) and all other existing data sources. Follow up on data gaps and refine distributional data. (H)

Protect tidal marshes, particularly along the upper coast. (H)

10. Scientific Name: *Pelecanus occidentalis*
Common Name: Brown Pelican

Continue monitoring nesting activity along the coast. Support colonial waterbird survey efforts. (H)
Begin accumulating information to perform population viability analysis. Analysis should include probability of hurricane (or other catastrophic event, such as oil/toxic spill) destruction of one or more colonies. Results may be important in determining parameters to be measured in monitoring recovery status. Obtain band return data from work done by D. Blankenship. (H)

Attempt to define parameters important to pelicans for choice of nesting localities. Some possibilities include nesting substrate, distance to passes, prey resources. (H)

Revise recovery plan. (H)

Improve public awareness and possibly implement wardening system to control human disturbance on nesting islands. (H)

11. Scientific Name: *Plegadis chihi*
Common Name: White-faced Ibis

Site(s) to be monitored: Eagle Lake (which is owned and operated by Lower Colorado River Authority), all other colonial waterbird colonies. Methodology: Relative abundance, habitat quality, nesting success. Support colonial waterbird survey. (H)

Determine foraging requirements for the species. (H)

Define demographic parameters needed to monitor status of population. (H)

Provide information to public concerning sensitivity of nesting sites. (H)

Protect freshwater wetlands preferred as foraging habitat. (H)

12. Scientific Name: *Sterna antillarum athalassos*
Common Name: Interior Least Tern

Develop and establish annual survey method for interior least terns (interior waterbirds no longer monitored on the colonial waterbird census). (H)

Determine breeding success rates for the largest population in each of the river systems. (H)

Identify nesting sites and potential nesting sites in each of the river systems. (H)

HIGH AND MEDIUM-HIGH PRIORITY FISH

1. Scientific Name: *Cyprinodon bovinus*
Common Name: Leon Springs Pupfish

Periodical monitoring of known populations should be accomplished for signs of decline. Habitat stability also should be monitored, including potential introduction of exotic species, and contamination by petroleum products. (H)

The biology of this species is well known, but specific habitat requirements should be further evaluated. Efforts should be made at determining spring-flow trends and the extent of threat of loss-of spring-flows. (H)

Diamond Y Springs, the primary habitat for this species is owned by and is being actively managed by The Nature Conservancy. Efforts should be made to protect spring-flows. (H)

2. Scientific Name: *Cyprinodon elegans*
Common Name: Comanche Springs Pupfish

Some wild populations appear to be in general decline, but the population located at Balmorhea State Park appears to be stable. A status survey should be completed that addresses the genetic diversity within the species. The status of stocks of exotic *C. variegatus* in Lake Balmorhea also should be reviewed. (H)

All populations should be monitored for further signs of decline, and for the possible introduction of exotic species and habitat degradation. (H)

The genetic make-up of both wild and captive stocks should be studied. Construction of additional refugia should be evaluated. A hydrological study of the groundwater and drainage basin delineation of the San Solomon spring-group is needed. (H)

Active management programs are underway for this species at San Solomon Springs and Phantom Spring refugia. Additional refugia should be constructed where possible. An attempt should be made to develop a management program for Giffin Spring in cooperation with the private landowner and the Reeves County Water Improvement District (H)

3. Scientific Name: *Cyprinodon pecosensis*
Common Name: Pecos Pupfish

All populations are declining due to intense hybridization with the introduced sheepshead minnow. A follow-up status survey is urgently needed to determine the extent and significance of the declines. (H)

Dependent largely on the results of the status survey. Monitoring should include checking the spread of the sheepshead minnow. (H)

The extent of hybridization with the sheepshead minnow, particularly the Salt Creek population, should be evaluated. A serious attempt must be made at isolating and protecting genetically pure wild populations of the Pecos pupfish. The hydrology of Salt Creek, including associated cienegas, should be investigated. (H)

Salt Creek lies entirely on private land, and, as such, the last genetically pure populations of the Pecos pupfish are not being actively managed. A serious effort must be made to work with private landowners toward developing a management program that will ensure protection of this species. (H)

4. Scientific Name: *Dionda diaboli*
Common Name: Devil's River Shiner

Additional status information currently is being collected through a section 6 project addressing the Chihuahuan desert fishes. (H)

This species should be closely monitored to determine if populations are further declining. (H) Specific habitat requirements, and effects of predation due to introductions of exotic species should be studied. (H)

An effective management program must address these issues. (M)

5. Scientific Name: *Etheostoma fonticola*
Common Name: Fountain Darter

Both populations of fountain darters should be periodically monitored for signs of decline, particularly in light of diminishing groundwater levels. (M)

Projects currently are underway to evaluate specific habitat requirements and feeding habits of this species. Generally, the biology of this species is well understood. (H)

Mitigation efforts should focus primarily on identified threats. The cities of San Marcos and New Braunfels should be included in any management plans involving this species. (M)

6. Scientific Name: *Gambusia gagei*
Common Name: Big Bend Gambusia

The population at the Big Bend refugium apparently is stable. A status survey should be completed. (M)

There is significant potential for decline or extirpation of the Big Bend population due to possible introductions of exotic species, and habitat loss and modification. Accordingly, this species should be monitored closely. (H)

The genetic structure of this species should be examined in light of a potential genetic "bottleneck" stemming from the present Big Bend population being derived from only three descendants. Specific habitat requirements should be determined. (H)

The Big Bend population is being actively managed by the National Park Service and the U.S. Fish & Wildlife Service. (M)

7. Scientific Name: *Gambusia heterochir*
Common Name: Clear Creek Gambusia

A status survey is needed for this species, but the population is presumed to be stable. Threats associated with diminishing springflow should be studied. (M)

The population at Clear Creek should be periodically monitored to see if further hybridization with *Gambusia affinis* is occurring. (H)

Determine the extent of hybridization occurring in the population. (H)

Management for the Clear Creek gambusia primarily involves maintaining the dam that separates this species from the downstream population of mosquitofish. Other management practices could involve the physical thinning of the *G. affinis* population and their hybrids. (M)

8. Scientific Name: *Gambusia nobilis*
Common Name: Pecos Gambusia

Most populations probably have been identified and appear to be stable. (M)

Populations, particularly at Diamond-Y Spring, and Phantom Lake Cave refugia, should be periodically monitored to check for signs of decline or introductions of exotic species that may impact these populations. (H)

The effects of competition and possible hybridization with a related species, *G. geiseri*, that shares some habitats with the Pecos gambusia should be studied. (M)

Periodical thinning of co-existing *G. geiseri* populations should be included in any management plan. (H)

9. Scientific Name: *Notropis buccula*
Common Name: Smalleye Shiner

Populations of the smalleye shiner should be monitored periodically to see if populations are declining further. (H)

Specific habitat requirements should be determined, and the effects of agriculture and impoundments on water quality in relation to shiner habitat should be studied. (M)

Due to the potential large-scale impacts affecting this species, management of smalleye shiner populations may be difficult. A recovery plan should be developed for this species. (H)

10. Scientific Name: *Notropis girardi*
Common Name: Arkansas River Shiner

A monitoring plan should be developed to address known populations in the Canadian River. (H)

Specific habitat requirements should be determined, and the effects of impoundments on this species should be studied. Instream flows should be evaluated, particularly with respect to the Canadian River Compact. (H)

The Arkansas River shiner soon may be listed as endangered by the U.S. Fish and Wildlife Service. (M)

11. Scientific Name: *Notropis oxyrhynchus*
Common Name: Sharpnose Shiner

Populations of this species have declined by as much as two-thirds in recent years. Existing populations should be monitored for further signs of decline. (H)

The specific habitat requirements for this species should be determined, and the extent of water quality degradation in the Brazos River drainage due to agricultural practices and impoundments should be studied. (M)

Implement programs to avoid further sedimentation of bottomland streams. The primary threats to this species appear to be related to habitat degradation including siltation, effects of impoundments, and agricultural practices. Plans for mitigation should address these impacts. A recovery plan for this species should be developed. (M)

MEDIUM PRIORITY FISH

1. Scientific Name: *Cyprinodon eximus*
Common Name: Conchos Pupfish

The status of this species is unknown, but populations are threatened due to potential alterations of its limited habitats. A status survey should be accomplished. The taxonomic status of the Dolan Creek/Devils River populations should be examined. Preliminary data suggest these populations are species distinct from those of the Conchos River/Alamito Creek. Threats to its habitat also should be assessed. (H)

2. Scientific Name: *Gila pandora*
Common Name: Rio Grande Chub

A status survey should be completed. (H)

The population at Little Aguja Creek should be monitored periodically to see if any decline in abundance is occurring. (H)

3. Scientific Name: *Ictalurus lupus*
Common Name: Headwater Catfish

The current status of this species is unknown but most populations are considered to be in decline. A status survey is needed to determine the extent of the decline. (H)

4. Scientific Name: *Satan eurystomus*
Common Name: Widemouth Blindcat

A status survey would be desired, but due to the difficulties of sampling the habitat of this species such a survey may not be practical. Populations are presumed to be stable as long as the quality and quantity of the Edwards Aquifer are not compromised. (H)

This species potentially could be monitored as number of individuals per volume of water pumped from wells in cooperation with well owners. (H)

Specific habitat requirements and other aspects of the biology of this species should be studied. (H)

5. Scientific Name: *Trogloglanis pattersoni*
Common Name: Toothless Blindcat

A status survey would be desired, but due to the difficulties of sampling the habitat of this species such a survey may not be practical. Populations are presumed to be stable as long as the quality and quantity of the Edwards Aquifer are not compromised. (H)

This species potentially could be monitored as number of individuals per volume of water pumped from wells in cooperation with well owners. (H)

Specific habitat requirements & other aspects of the biology of this species should be studied.(H)

HIGH AND MEDIUM-HIGH PRIORITY MAMMALS

1. Scientific Name: *Dipodomys elator*
Common Name: Texas Kangaroo Rat

Using the Shaw 1990 GIS report, map the preferred habitat (areas with mesquite/grasslands, Permian-Blaine geologic formation, Tillman-Vernon-Weymouth soil association) with a layer of current landuse practices throughout the historic range of kangaroo rats (Oklahoma included) and ground truth potential areas to search for new kangaroo rat locations. (H)

Determine a population estimate within the known current distribution. (M)

Update the map of current locations of kangaroo rats (Best and Wahl, 1985; Jones et. al. 1988, Stangl and Schafer 1990, Shaw 1990. (M)

Identify a subset of the kangaroo rat population (largest, smallest, easterly, westerly) to establish annual population trends using consistent methodologies. (H)

Investigate a technique that would relate population size with number of burrows/other variable. (H)

Visit each of the known populations periodically to detect presence/absence. (M)

Determine minimum viable population. (M)

Determine the effects of different grazing regimes on Kangaroo rat populations. (M)

Work to establish conservation areas to ensure Texas Kangaroo Rat existence based on minimum viable population. (M)

Encourage some grazing and prescribed burning on occupied habitat dependent on research findings. (M)

Develop corridor system between occupied habitats for dispersing individuals. (M)

2. Scientific Name: *Felis pardalis*
Common Name: Ocelot

Provide support for continued research to determine extent of present populations, particularly outside of Cameron County. (H)

Expand efforts to evaluate population status and current threats in Mexico. Priority of recovery efforts may hinge on current information available in adjacent Mexico. (M)

Refine system for tracking sightings. Currently several individuals acquire data and only part of the sightings are known to individuals that need to know. (M)

Maintain data on population currently tracked by the U.S. Fish and Wildlife Service personnel in the vicinity of the Laguna Atascosa National Wildlife Refuge. (H)

Examine trends in land-use within the species' range. (M)

Conduct metapopulation analyses since many of the cats occupying habitat in south Texas are separated from other sub-populations by highways or agricultural lands. These analyses will address many of the parameters typically considered in population viability analyses. (M)

Develop and implement GIS for ocelot information to allow informed management decisions. Include in this information set areas in public ownership and private lands in active management for ocelot habitat. (H)

Evaluate and support captive population experimentation to determine the feasibility of captive breeding and release, as well as providing insight into aspects of the biology that are difficult to monitor in the field. (M)

Improve private landowner participation in recovery. This will entail coordination with USFWS because of Section 9 concerns. The Services's biggest concern is that habitat will be produced, become occupied and then the landowner will decide that he wants to do something else with the land and be in violation of the ESA. Determine feasibility of habitat conservation planning, perhaps on a county-by-county basis. Determine funding source for production and implementation of HCP. Develop incentives for landowners (H)

Develop public awareness of this endangered species, perhaps through travelling museum exhibits, regular TPWD presentations, and development of the ocelot license plate. The license plate may also provide revenues to support private landowner incentives to enhance habitat. (M)

Compile and summarize available information concerning restoration of ocelot habitat in south Texas. This effort might also address available information on succession in Texas brushlands. Variables of interest would include species composition, stocking rates, evaluation techniques, current projects (TPWD, USFWS, private), acreages involved, cost estimates, greenhouse techniques, planting techniques, etc.). (M)

Develop guidelines for treatment of road and bridge projects relative to cat habitat and cat dispersal corridors (M)

Develop and implement procedure for treatment of killed or injured ocelots (to be used by Law Enforcement Division). Include transport guidelines, facilities identified to receive injured cat, facilities identified to receive (and prepare) dead cat, provision for notification of appropriate personnel. (M)

3. Scientific Name: *Vulpes velox*
Common Name: Swift Fox

Contact and survey local TPWD, ADC and SCS biologists to assess population trends and locations. (H)

Encourage and publicize reporting of sightings and develop standardized method for recording sightings. (H)

Determine method for estimating population and trends (scat, tracks, dens). (M)

Identify and map areas with existing populations and periodically estimate numbers. (M)

Inform landowners, hunters and trappers of preferred habitat and encourage voluntary protection. Contact private landowners willing to cooperate and develop a conservation and habitat management plan through some type of incentive package. (H)

4. Scientific Name: *Felis yagouaroundi*
Common Name: Jaguarundi

Document and confirm sightings using a systematic method. (H)

Evaluate and support captive population experimentation to determine the feasibility of captive breeding and release, as well as providing insight into aspects of the biology that are difficult to monitor in the field. (H, one area where we can get reasonable information.)

Develop effective means of verifying sightings. This may entail modified trapping procedures including

use of jaguarundi urine, more extensive precautions of leaving scent on the trap, use of dogs, or infra-red tripped photodocumentation. Impact of method will be considered. (H)

Develop and implement GIS for jaguarundi information to allow informed management decisions. Include in this information set areas in public ownership and private lands in active management for ocelot habitat. (M)

Improve private landowner participation in recovery. This will entail coordination with USFS because of Section 9 concerns. The Services's biggest concern is that habitat will be produced, become occupied and then the landowner will decide that he wants to do something else with the land and be in violation of the ESA. Determine feasibility of habitat conservation planning, perhaps on a county-by-county basis. (H)

Develop public awareness of this endangered species. This may be accomplished through travelling museum exhibit, regular TPWD presentations, and development of the jaguarundi license plate. The license plate may also provide revenues to support private landowner incentives to enhance habitat. (H)

Compile and summarize available information concerning restoration of jaguarundi habitat in south Texas. This effort might also address available information on succession in Texas brushlands. Variables of interest would include species composition, stocking rates, evaluation techniques, current projects (TPWD, USFWS, private), acreages involved, cost estimates, greenhouse techniques, planting techniques, etc. (H)

5. Scientific Name: *Ursus americanus luteolus*
Common Name: Louisiana Black Bear

Document and confirm sightings using a systematic method. Track sightings in western Louisiana. (M-ongoing)

Develop protocol for dealing with potential nuisance bears, including marking procedures for documenting movements. (M)

Assess suitable habitat in East Texas using GIS techniques for reintroduction purposes. (H)

Once (and if) suitable habitat is identified, conduct vegetation surveys to determine available hard and soft mast as well as den sites. (H)

Conduct surveys of local landowners to solicit opinions concerning cooperation to reintroduce bears in their area. (M)

Develop a task force to draft a Department policy that discourages the decline of bottomland hardwoods through clear cutting; develop incentives for private landowners to maintain their bottomland hardwood forests. (H)

In areas where a harvest has already occurred, encourage regeneration of the area back into hardwoods rather than a change of land use such as residential or agriculture. (H)

Encourage an increased harvest rotation of hardwoods to increase the diversity of food resources and availability of den sites; encourage small tract clearcuts rather than total area clearcuts to enhance some areas of herbaceous forage. (H)

Seek to increase effective size of existing habitat through conservation agreements and other options in contiguous areas. (M)

Identify and protect corridors between fragmented suitable habitat through private landowner incentives. (M)

MEDIUM PRIORITY MAMMALS

1. Scientific Name: *Canis lupus baileyi*
Common Name: Mexican Wolf

Participate in Recovery Team Working Groups in other states and assess which recovery efforts might be valid for Texas. (H)

Provide information to public upon request. (H)

2. Scientific Name: *Choeronycteris mexicana*
Common Name: Mexican Long-tongued Bat

Identify, map, and revisit all known roost sites and recent capture sites to determine current occurrences (H)

3. Scientific Name: *Conepatus leuconotus texensis*
Common Name: Gulf Coast Hog-nosed Skunk

Once populations are located, estimate population size. (H)

Determine habitat requirements. (H)

Determine threats to population. (H)

4. Scientific Name: *Euderma maculatum*
Common Name: Spotted Bat

Identify, map, and revisit all known roost sites and recent capture sites to determine current occurrences. (H)

Conduct field surveys to identify new roost sites. (H)

5. Scientific Name: *Eumops perotis californicus*
Common Name: California (Western) Mastiff Bat

Identify, map, and revisit all known roost sites and recent capture sites to determine current occurrences. (H)

Conduct field surveys to identify new roost sites. (H)

6. Scientific Name: *Geomys arenarius*
Common Name: Desert Pocket Gopher

Identify populations for monitoring population trends periodically. (H)

Develop a method of estimating population density and trends. (H)

Determine threats to population if any. (H)

7. Scientific Name: *Geomys knoxjonesi*
Common Name: Jones' Pocket Gopher

Identify populations for monitoring population trends periodically. (H)
Develop a method of estimating population density and trends. (H)
Determine threats to population if any. (H)

8. Scientific Name: *Geomys personatus davisii*
Common Name: Davis's Pocket Gopher

Assess taxonomic status to determine validity of subspecies. (H)
Identify largest populations for monitoring population trends periodically. (H)
Develop a method of estimating population density and trends. (H)
Determine threats to population if any. (H)

9. Scientific Name: *Geomys personatus fuscus*
Common Name: Fuscus Pocket Gopher

Assess taxonomic status to determine validity of subspecies. (H)
Survey and trap historic locations where possible to determine current presence of this species. (H)
Identify populations for monitoring population trends periodically. (H)
Develop a method of estimating population density and trends. (H)
Determine threats to population if any. (H)

10. Scientific Name: *Geomys personatus maritimus*
Common Name: Maritime Pocket Gopher

Assess taxonomic status to determine validity of the subspecies and clarify its distribution. (H)
Identify populations for monitoring population trends periodically. (H)
Develop a method of estimating population density and trends. (H)
Determine threats to population if any. (H)

11. Scientific Name: *Geomys personatus streckeri*
Common Name: Carrizo Springs Pocket Gopher

Assess taxonomic status to determine validity of subspecies. (H)
Identify populations for monitoring population trends periodically. (H)
Develop a method of estimating population density and trends. (H)
Determine threats to population if any. (H)

12. Scientific Name: *Geomys texensis bakeri*
Common Name: Baker's Pocket Gopher

Survey and trap historic locations where possible to determine current presence of this species. (H)
Identify populations for monitoring population trends periodically. (H)
Develop a method of estimating population density and trends. (H)
Determine threats to population if any. (H)

13. Scientific Name: *Geomys texensis texensis*
Common Name: Llano Pocket Gopher

Survey and trap historic locations where possible to determine current presence of this species. (H)
Identify populations for monitoring population trends periodically. (H)
Develop a method of estimating population density and trends. (H)
Determine threats to population if any. (H)

14. Scientific Name: *Lasiurus ega*
Common Name: Southern Yellow Bat

Identify, map, and revisit all known roost sites and recent capture sites to determine current occurrences. (H)
Accumulate data from efforts directed at overall monitoring of bat species. (H)
Protect and restore naturally occurring palm forests along Rio Grande. (H)

15. Scientific Name: *Leptonycteris nivalis*
Common Name: Mexican Long-nosed Bat

Establish a standard method for estimating roost population size and obtain an annual population estimate of Lepto's occupying the Emory Peak cave roost. (H)
Determine whether Leptos are utilizing habitat outside the Park. (H)
Determine the minimum number of *Agave* plants needed for one Lepto and a population of 1000 Lepto's; conversely, estimate the number of flowering *Agave* plants in the Park and determine how many Lepto's could be sustained on that number. (H)
Cooperate with Mexican counterparts in research and management efforts; encourage public educational information on benefits of bats, differences between species (not vampires), and preventing roost destruction. (H)

16. Scientific Name: *Mustela nigripes*
Common Name: Black-footed Ferret

Investigate credible black-footed ferret sightings. (H)
Maintain contact and information exchange with the Black-footed Ferret Interstate Conservation Committee (BFF ICC) and Black-footed Ferret Recovery Team. (H)
Contact private landowners willing to cooperate and develop a conservation and habitat management plan through some type of private landowner incentive package. (H)

17. Scientific Name: *Myotis austroriparius*
Common Name: Southeastern Myotis

Identify, map, and revisit all known roost sites and recent capture sites to determine current occurrences. (H)

Conduct field surveys to identify new roost sites. (H)

Develop a task force to draft a Department policy that discourages the decline of bottomland hardwoods through clear cutting; develop incentives for private landowners to maintain their bottomland hardwood forests. (H)

Discourage landowners from capping open cisterns and develop a grating technique. (H)

Discourage landowners from removing abandoned buildings and standing snags which may serve a roost sites. (H)

In areas where a harvest has already occurred, encourage regeneration of the area back into hardwoods rather than a change of land use such as residential or agriculture. (H)

18. Scientific Name: *Peromyscus truei comanche*
Common Name: Palo Duro Mouse

Map the known recent capture sites. (H)

Map the preferred habitat (using GIS methods) and identify populations and methods for a long-term periodical monitoring program. (H)

19. Scientific Name: *Plecotus rafinesquii*
Common Name: Rafinesque's Big-eared Bat

Identify, map, and revisit all known roost sites and recent capture sites to determine current occurrences. (H)

Conduct field surveys to identify new roost sites. (H)

Quantify their use of bottomland hardwoods and other habitat types. (H)

Cooperate in efforts to discourage the decline of bottomland hardwoods through clear cutting; develop incentives for private landowners to maintain their bottomland hardwood forests. (H)

Discourage landowners from capping open cisterns and develop a grating technique. (H)

Discourage landowners from removing abandoned buildings and standing snags which may serve a roost sites. (H)

In areas where a harvest has already occurred, encourage regeneration of the area back into hardwoods rather than a change of land use such as residential or agriculture. (H)

20. Scientific Name: *Spilogale putorius interrupta*
Common Name: Plains Spotted Skunk (Eastern Spotted Skunk)

Survey TX wildlife biologists and public health officials (rabies testing) as well as review literature and trapping records to determine occurrences and population trends. Map results. (H) (ongoing)

Investigate credible sightings. (H) (ongoing in Panhandle)

Identify populations in different regions of its range and develop methods for monitoring. (H)

Determine threats if any. (H)

21. Scientific Name: *Sylvilagus floridanus robustus*
Common Name: Davis Mountain Cottontail

Assess taxonomic status to determine validity of subspecies. (H)
Identify populations within GMNP, BBNP and DMSP to determine periodic population estimates and trends. (H)

22. Scientific Name: *Tamias canipes*
Common Name: Gray-footed Chipmunk

Identify populations within GMNP and determine periodic population estimates and trends. (H)

23. Scientific Name: *Thomomys bottae guadalupensis*
Common Name: Guadalupe Southern Pocket Gopher

Assess taxonomic status to determine validity of subspecies. (H)
Identify any threats to the Guadalupe National Park population if the population is declining. (H)

24. Scientific Name: *Thomomys bottae limpiaie*
Common Name: Limpia/Limpia Southern Pocket Gopher

Assess taxonomic status to determine validity of subspecies. (H)
Determine threats to population if any. (H)

25. Scientific Name: *Thomomys bottae texensis*
Common Name: Davis Mountains/Limpia Creek Pocket Gopher

Assess taxonomic status to determine validity of subspecies. (H)
Determine threats to population if any. (H)

26. Scientific Name: *Ursus americanus*
Common Name: American Black Bear

Map all confirmed sightings of presumably wild individuals (not released captive bears) and gather any relevant biological information. (H) (ongoing)
Develop nuisance bear management plan. (H) (ongoing)

HIGH AND MEDIUM-HIGH PRIORITY REPTILES

1. Scientific Name: *Crotaphytus reticulatus*
Common Name: Reticulate Collard Lizard

Determine current distribution. (H)

Evaluate habitat characteristics. Soil, topographic location, and geologic basement may be important and easily mapped parameters for this species. (M)

Support efforts to monitor and research population of this species occurring on Chaparral Wildlife Management Area. (H)

Obtain permission to access private lands with known populations to develop monitoring study. (M)

Research is needed to provide important baseline data on the natural history of this species (reproduction, foraging ecology, thermoregulation, etc.). (H)

Determine impacts associated with invading species such as buffalograss. (M)

Determine impacts of grazing. Evaluate mechanism of any impact detected (indirectly through impacts to insect prey or directly through impacts to nesting substrate?). (M)

Evaluate policy/regulations adversely affecting habitat for this species. (M)

An area near Laredo has been identified as an important conservation areas for this species.

Conservation agreements or other options should be explored. (M)

2. Scientific Name: *Graptemys caglei*
Common Name: Cagle's Map Turtle

Correlate abundance with detailed physical map of stream reach. (M)

Determine effects of surrounding land use parameters on fluvial habitat characteristics. (M)

Locate cooperative landowners for access to land for surveys. (M)

Quarterly document presence of Cagle's Map Turtles throughout the range. (M)

Monitor annual inflow regime. (M)

Determine demographic characteristics. (M)

Determine nesting behavior and nest site characteristics, and influence of both on hatchling sex ratios. (M)

Determine in-stream flow requirements. (H)

Discourage further reservoir construction. (H)

Integrate species' needs into river management plans. (H)

Protect from pet trade and shooting. (H)

Work with landowners to protect the integrity of river banks and water quality. (H)

3. Scientific Name: *Kinosternon hirtipes murrayi*
Common Name: Chihuahuan Mud Turtle

Determine extent of distribution. (M)

Determine status of Cienega Creek population on Big end State Natural Area. (H)

Locate cooperative landowners for access to land for annual surveys. (H)

Annually document presence of Chihuahuan Mud Turtles at known sites. (M)

Determine flow regimes and inflow needs of springs and creeks of the Alamito Creek system. (M)

Determine demographic characteristics. (M)
Determine daily and seasonal activity patterns of individual turtles. (M)

4. Scientific Name: *Lepidochelys kempii*
Common Name: Kemp's Ridley Sea Turtle

Support maintenance of stranding and salvage network. (M)
Determine presence of nesting activity on the Texas coast. (M)
Monitor and support, where possible, the efforts of Padre Island Seashore to maintain data on nesting efforts on Padre Island. (M)
Identify important marine habitats in Texas that may be used by adult, migrant, or juvenile turtles. Juveniles, particularly, may use estuarine habitats to an extent that is largely overlooked. (H)
Develop agreement with National Marine Fisheries Service to provide Section 6 funding for sea turtle research. (H)
Provide comments relative to the importance of developing "incidental take" procedures associated with use of underwater explosives. (H)
Provide information and direction towards developing oil/toxic spill contingency plans along the Texas coast giving high priority to areas known to be utilized by this species. Include limiting petroleum/toxic transport in particularly critical areas. Incorporate importance of chronic low level leaks and spills in degrading marine habitats. (M)
Provide educational materials and make presentations to distribute information concerning the needs of this and other species of sea turtle. Public support of use of TED's would improve survivability of the species. Increase awareness of threats imposed by marine debris. Returns on marked turtles might be improved if educational opportunities are expanded. (M)
Continue participation in KRWG, attended by Endangered Resources branch staff. (M)
Help enforce and expand TED regulations. (M)
Support maintenance of stranding and salvage network. (M)
Support efforts to improve enforcement of laws prohibiting dumping of plastics at sea (Marine Plastic Research and Control Act of 1987 and MARPOL Annex V). (M)
Deter the use of the Gulf as a dumping or burning site for materials that may negatively impact water quality. (M)

5. Scientific Name: *Macrolemys temminckii*
Common Name: Alligator Snapping Turtle

Determine population abundance and locations of individuals (pop. no's unknown). (H)
Surveys need to be conducted to determine locations, population trends and number and distribution of occurrences. (H)
Establish a propagation program for re-introduction of the turtle into currently depleted areas. (M)
Discourage further reservoir construction. (H)
Because it stays just below the water surface or partially buried in the mud during the day, the species is difficult to spot. Difficulty in field monitoring is further increased due to the species wide range. Any sightings or incidence of catches or illegal harvesting should be recorded. (M)/
Enforce water pollution legislation. (M)
Avoid further channelization of streams and rivers. (H)

6. Scientific Name: *Malaclemys terrapin littoralis*
Common Name: Texas Diamondback Terrapin

Determine status of population in Texas. Population locations known to some extent, population levels unknown. Monitoring of this species could be done in conjunction with studies on *Nerodia clarkii*. (H)

Verify occurrence in areas where populations are suspected but were none have been documented. (M)

Request biologists at coastal Wildlife Management Areas and those of Coastal Fisheries that may encounter the species to provide information concerning sightings and incidences of catches. (M)

Once locations of populations are established, population estimates can be made and populations can be monitored on an annual or semi-annual basis to determine trends. Monitoring sites may be chosen on the basis of perceived impacts from the various threats. (M)

Determine effects of reduction to freshwater inflows, crabbing take, and contaminant discharge on populations of the species. (M)

Develop mark/recapture study to evaluate population levels in Nueces Bay, Lavaca Bay (upper Lavaca Bay may be heavily impacted by Formosa Plastics discharge) and San Antonio Bay. (H)

Provide information concerning natural history of the species in Texas. (H)

Evaluate modifications to crab trap designs to determine efficacy in terms of terrapin survival and relative to effect on crab harvest. (H)

Define demographic parameters for the species in Texas, evaluate with respect to prey base, salinity, water quality. (M)

Evaluate impacts discussed in research and develop plan to reduce threats to be species. Determine incidental take and limit if possible. Redesign of crab traps may be sufficient to save incidentally captured terrapins. (M)

Maintain adequate freshwater inflows and limit discharges of pollutants into estuarine waters where the species is known to occur. (H)

Evaluate wetland impacts with particular consideration for the possible occurrence of this species, particularly with respect to nesting sites. (M)

Continue to provide information and support for efforts to provide contingency plans for oil spills. (M)

7. Scientific Name: *Nerodia clarkii*
Common Name: Gulf Saltmarsh Snake

Determine extent of distribution. (H)

Characterize habitat requirements. (H)

Locate cooperative landowners for access to land for annual surveys. (M)

Annually document presence of Gulf Saltmarsh Snakes at known sites. (M)

Assess degree and rate of habitat modification. (M)

Determine demographic characteristics. (M)

Determine dietary profile. (M)

Determine ecological physiology parameters. (M)

Assess freshwater inflow needs. (H)

Incorporate species' needs into water management agreements regarding freshwater inflows. (H)

8. Scientific Name: *Nerodia harteri paucimaculata*
Common Name: Concho Water Snake

Implement the Federal Recovery Plan. (H)
Monitor hydrology and physical habitat rangewide. (H)
Monitor 40 sites for 10 years, plus 5 years post-recovery. (H)
Translocate and monitor snakes among Concho, Lower Colorado and Upper Colorado Rivers.- (H)
Evaluate, reintroduce and monitor snakes above San Angelo. (H)
Protect and assure adequate instream flows rangewide. (H)
Assess and abate threats to water quality including sedimentation. (H)
Enforce existing laws and regulations. (H)

9. Scientific Name: *Pituophis melanoleucus ruthveni*
Common Name: Louisiana Pine Snake

Determine extent of distribution. (H)
Locate cooperative landowners for access to land for annual surveys. (M)
Annually document presence of Louisiana Pine Snakes at known sites. (M)
Determine nature and extent of traffic in the pet trade. (M)
Determine biotic and abiotic correlations to distribution. (H)
Determine daily and seasonal activity patterns of individual snakes. (H)
Determine demographic characteristics. (M)
Determine dietary preferences. (M)
Determine preferred habitat characteristics and effects of habitat modifications. (H)
Determine effects of burning on behavior and survivorship. (H)
Develop brochures on snake identification. (H)
Encourage conservation of native longleaf stands. (H)

10. Scientific Name: *Sceloporus arenicolus*
Common Name: Sand Dunes Lizard

Determine the extent of the distribution of the taxon. (H)
Determine the extent of oak clearing within suitable habitat. (H)
Locate cooperative landowners for access to land for surveys. (H)
Annually document presence of Dunes Sagebrush Lizards at known sites. (H)
Determine demographic characteristics. (M)
Determine effects of shin oak removal on selected populations. (H)
Encourage conservation of habitat. (H)

MEDIUM PRIORITY REPTILES

1. Sea Turtles, including:

<i>Caretta caretta</i>	Loggerhead Sea Turtle
<i>Chelonia mydas</i>	Green Sea Turtle
<i>Dermochelys coriacea</i>	Leatherback Sea Turtle
<i>Eretmochelys imbricata</i>	Hawksbill Sea Turtle

Develop agreement with the National Marine Fishery Service to provide Section 6 funding for research on sea turtles. (H)

Provide educational materials to ensure public awareness of the plight of the sea turtles. (H)

Support enforcement of Turtle Excluder Device regulations. Provide information to the public concerning the effectiveness of these devices. (H)

Protect nesting areas from impacts from exploitation and predation from pets and predators. Perhaps protection and monitoring of remote beaches would most effectively provide successful nesting areas. (H)

Provide comments relative to the importance of developing "incidental take" procedures associated with the use of underwater explosives. (H)

Support efforts to improve enforcement of laws prohibiting dumping of plastics at sea (Marine Plastic Research and Control Act of 1987 and MARPOL Annex V). (H)

Deter the use of the Gulf as a dumping or burning site for materials that may negatively impact water quality. (H)

2. Scientific Name: *Crotalus horridus*
Common Name: Timber Rattlesnake

Further loss of bottomland hardwoods should be discouraged.

Deter unnecessary killing of individual snakes by educating the general public about the usefulness of the species for rodent control and its non-aggressive behavior towards humans. (H)

3. Scientific Name: *Drymarchon corais*
Common Name: Indigo Snake

Determine sites appropriate for monitoring population levels and establish monitoring program to evaluate population trends. (H)

Little is known about the biology of this species. Develop quantitative information concerning habitat preferences, home range size, demographic parameters and prey preferences. (H)

Cooperative efforts to protect and re-establish large tracts of Tamaulipan thornscrub. (H)

Provide guidance to landowners interested in maintaining and/or establishing habitat for the species. (H)

4. Scientific Name: *Gopherus berlandieri*
Common Name: Texas Tortoise

Evaluate disease status of south Texas populations to use as background information if Upper Infectious Respiratory Disease Syndrome is introduced into the populations. (H)

Develop educational resources to alert public as to the importance of not releasing captive individuals due to the potential introduction of disease (bring zoos and museums into this process). (H) —

5. Scientific Name: *Opheodrys vernalis*
Common Name: Smooth Green Snake

Protect and restore coastal prairie along the upper Texas coast. (H)

6. Scientific Name: *Phrynosoma cornutum*
Common Name: Texas Horned Lizard

Increase education and public outreach efforts. (H)

Encourage landowners with horned lizards to manage appropriately for them. (H)

SUMMARY OF PRIORITY PLANT CONSERVATION NEEDS

Abronia macrocarpa

large-fruited sand verbena

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends, succession	High--reproductive biology, genetics, demographics, disturbance studies	Medium/Low--disturbance? Some uncertainty

Ambrosia cheiranthifolia

South Texas ambrosia

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends	High--demographics, disturbance studies, reproductive biology	Low--probably some type of infrequent disturbance

Amsonia tharpii

Tharp's blue-star

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	Medium--population trends	Medium--demographics, reproductive biology, habitat characterization	Low--presently unknown

Ancistrocactus tobuschii

Tobusch fishhook cactus

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends	High--demographics	High--keep habitat open

Arenaria livermorensis

Livermore sandwort

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends	High--demographics, reproductive biology	Low--presently unknown

Asclepias prostrata

prostrate milkweed

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends	High--demographics, successional stage, need for disturbance, reproductive biology	Medium--probably disturbance

Aster puniceus ssp. elliotii var. scabricalis

rough-stem aster

TPWD Species Priority: High/Medium

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends	Medium--taxonomic verdict	Medium--leave natural mesic/marsh areas unaltered

Astrophytum asterias

star cactus

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends, collection impacts	High--demographics, reproductive biology	High--protect populations from collectors

Ayenia limitaris

Texas ayenia

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--very frequent monitoring, population or plant trends	High--reproductive biology, get into cultivation	Low--presently unknown

Bonamia ovalifolia

bigpod bonamia

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends	High--demographics, reproductive biology, response to disturbance	Low--presently unknown

Callirhoe scabriuscula

Texas poppy-mallow

TPWD Species Priority: Medium/High

Status Needs	Monitoring Needs	Research Needs	Management Needs
Medium--more exhaustive surveys	High--population trends	Medium--demographics, more soil seed bank studies, response to disturbance	Medium--possible disturbance

Campanula reverchonii

Basin bellflower

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more complete surveys	High--population trends	High--reproductive biology, demographics	Medium--trail management

Castilleja elongata

tall paintbrush

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--exhaustive surveys	High--population trends (change the current monitoring scheme)	High--taxonomic verdict, demographics, effects of browsing, fire adapted?	High--some uncertainty

Coryphantha minima

Nellie cory cactus

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
Low--very narrow edaphic niche	High--population trends, collection pressures	High--reproductive biology	Medium--conservation of the rare Novaculite outcrops

Cryptantha crassipes

Terlingua Creek cat's-eye

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends	High--reproductive biology	High--possibly fence known populations

Cyperus onerosus

dune umbrella-sedge

TPWD Species Priority: Medium/High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys esp. private lands	High--population trends	Medium--demographics	Medium--maintain hydrologic regime

Cypripedium kentuckiense

southern lady's-slipper

TPWD Species Priority: Medium/High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys, relocate populations to monitor	High--population trends	Low--demographics	Medium--maintain habitat

Echinocereus chisoensis var. *chisoensis*

Chisos hedgehog cactus

TPWD Species Priority: Medium/High

Status Needs	Monitoring Needs	Research Needs	Management Needs
Medium--more surveys	High--population trends	High--reproductive biology, demographics, response to fire, effect of herbivory	Medium--assure protection within Big Bend National Park

Echinocereus viridiflorus var. *davisii*

Davis' green pitaya

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends, collection pressures	High--demographics, reproductive biology	Low--conservation of the Novaculite outcrops

Esenbeckia runyonii

jopoy

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends	High--demographics, reproductive biology	High--do not clear habitat

Festuca ligulata

Guadalupe Mountains fescue

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends	High--demographics, reproductive biology	High--carefully monitor park trails and horse trails

Frankenia johnstonii

Johnston's frankenia

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys esp. on private lands and Webb County	High--phenology, population trends	High--demographics, grazing exclosure experiments, reproductive biology	High--try to avoid clearing when possible, reduce grazing pressures when possible

Helianthus paradoxus

puzzle sunflower

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
Low--more surveys	High--population trends	High--seed bank, response to disturbance	High--secure water

Hibiscus dasycalyx

Neches River rose-mallow

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	Low--population trends	Medium--taxonomic verdict, demographics, reproductive biology	Low--maintain natural ponds and wetland areas

Hoffmannseggia tenella

slender rush-pea

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends	High--demographics, reproductive biology, mowing experiments	High--conserve what little habitat is left

Hymenoxys texana

prairie dawn

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys by habitat	High-- population trends	High--demographics, succesional stage studies, seed bank, response to fire	High--conservation of the coastal prairie pimple mounds

Lesquerella pallida

white bladderpod

TPWD Species Priority: High/Medium

Status Needs	Monitoring Needs	Research Needs	Management Needs
Low--more surveys	High--population trends, succession	High--demographics, succesional stage, seed bank, reproductive biology	High--conserve known site

Lesquerella thamnophila

Zapata bladderpod

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends, succession	High--demographics, response to disturbance, reproductive biology, seed bank	High--possibly some type of infrequent disturbance is needed, attempt to keep the buffelgrass from choking out the populations

Manihot walkerae

Walker's manioc

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more exhaustive surveys	High--populations in Mexico should be monitored	High--habitat characterization, reproductive biology	Low--presently unknown

Paronychia congesta

bushy whitlow-wort

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys esp. in cooperation with private land owners	High--population trends	High--demographics	Medium--maintain adequate stocking rate, attempt to avoid clearing

Pediomelum humile

Rydberg's scurfpea

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends	High--demographics, reproductive biology	High--although unknown on the ground, seed should be sent to seed banks and the species preserved in cultivation

Philadelphus ernestii

canyon mock-orange

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more exhaustive surveys	High--population trends	High--demographics, reproductive biology	Medium--attempt to avoid alterations of habitat

Phlox nivalis ssp. *texensis*

Texas trailing phlox

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more exhaustive surveys	High--population trends, and response to management	High--reproductive biology	High--maintain fire

Potamogeton clystocarpus

Little Aguja pondweed

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more exhaustive surveys (is the species extant?)	High--population trends	High--reproductive biology, demographics	Low--presently unknown

Prunus murrayana

Murray's plum

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys in cooperation with private land owners	High--population trends	High--detailed life history, reproductive biology	Low--presently unknown

Quercus hinckleyi

Hinckley's oak

TPWD Species Priority: High/Medium

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys, esp. in BBNP and BBRNSA and Mexico	Medium--population trends	High--demographics, final verdict hybrid origin, establishment into cultivation	Low--presently unknown

Rudbeckia scabrifolia

bog coneflower

Status Needs	Monitoring Needs	Research Needs	Management Needs
Medium--more surveys	High--population trends, response to management regimes	Medium--demographics, reproductive biology, response to fire	High--Maintain naturally occurring hydrologic regimes

Salvia penstemonoides

big red sage

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys esp. Lost Maples SNA	High--population trends	High--reproductive biology, demographics	High--mow highway right-of-way in winter

Spiranthes parksii

Navasota ladies'-tresses

TPWD Species Priority: High/Medium

Status Needs	Monitoring Needs	Research Needs	Management Needs
Medium--more exhaustive surveys	High--population trends	High--demographics, reproductive biology	Medium--maintain natural openings within habitat

Streptanthus bracteatus

bracted twistflower

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends	High--demographics, reproductive biology, seed bank studies	High--Maintain natural habitat openings, possible fencing

Streptanthus cutleri

Cutler's twistflower

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends	High--demographics, seed bank studies	Low--presently unknown

Styrax texana

Texas snowbells

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends	High--demographics, reproductive biology, establishment studies	High--control herbivory, fence, reduce browsing animal populations when and where possible

Thalictrum texanum

Texas meadow-rue

TPWD Species Priority: High/Medium

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	Medium-population trends	High--demographics, taxonomy	Low--presently unknown

Thymophylla tephroleuca

Ashy dogweed

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys in cooperation with landowners, and in Mexico	High--population trends	High--demographics, seed back studies, response to disturbance	Low--presently unknown

Tillandsia baileyi

Bailey's ballmoss

Status Needs	Monitoring Needs	Research Needs	Management Needs
High--more surveys	High--population trends, impact of collection	High--demographics, air quality a concern?	Low--presently unknown

Zizania texana

Texas wild-rice

TPWD Species Priority: High

Status Needs	Monitoring Needs	Research Needs	Management Needs
Low	High--population trends, continue monitoring reintroduced populations	High--demographics, habitat characterization, expanded reintroductions?	High-- ground water conservation

OVERVIEW OF INVERTEBRATE ACTION PLAN

INTRODUCTION

Traditionally, conservation efforts have been directed at saving large vertebrates, especially birds and mammals, and their habitats. Some attention has been given to the conservation of some invertebrate groups in other states. Primarily, these efforts have centered on lepidopterans (butterflies and moths), beetles, and odonates (dragonflies and damselflies). Little attention has been given other groups. In Texas, invertebrates, exclusive of karst-dwelling species, have gone largely unstudied with respect to their conservation. Recently several efforts have been started to study invertebrates in Texas including surveys of caddisflies (Trichoptera), mayflies (Ephemeroptera), craneflies (Tipulidae), stoneflies (Plecoptera), karst invertebrates, and freshwater mussels. The survey work for mussels being done by the Texas Parks and Wildlife Department, Heart of the Hills Research Station is particularly important given the alarming rate at which members of this group are being extirpated from Texas. Most of these studies, however, are not specifically addressing candidate species.

Most extinct or critically endangered invertebrates have highly restricted distributions and unique habitats. When the distribution of a species is limited in this way, declines in its populations are easier to detect. Recently, emphasis has been placed on listing or protecting groups of animals and plants through the habitat or ecosystem approach rather the single species approach. Invertebrates, given their often habitat-limited distributions, are perhaps a prime example of a group that can be best managed and protected using an ecosystem approach. Habitat destruction is the most serious threat to invertebrate diversity. Fragmentation of widespread habitats, the primary artifact of habitat destruction, can present serious threats to invertebrate diversity by leaving small patches of habitat that may not be of sufficient quality to maintain the species. Two species included herein, the endangered American burying beetle (*Nicrophorus americanus*) and the candidate *Lordithon niger*, are prime examples of what happens to species in such fragmented habitats.

Herein are presented the action plans for 86 species of invertebrates in Texas that are federally endangered, candidates for such listing, or petitioned for candidate status. Any taxon that has not had a preliminary status survey is here assigned a default "high priority" ranking. The tables provided at the end of this document show a preliminary breakdown of the species by Texas ecoregions. The aquatic fauna is further examined by primary habitat type. There are far too many unaccountable variables associated with the habitats of terrestrial species to provide a similar analysis. Terrestrial invertebrates often are associated with a particular food plant (e.g., moths and butterflies), or there is an uncertainty involved in their original collection as to where they are actually found. However, the majority of the terrestrial invertebrates presented here are inhabitants of karst (cave) systems and primarily those of the Edwards Plateau. The majority of the aquatic fauna presented here is distributed chiefly on the Edwards Plateau and in the Trans-Pecos region, and the primary habitats are spring systems stemming from the Edwards Aquifer and the aquifers of the Trans-Pecos region. The streams of the Rio Grande drainage and those of eastern Texas are interesting in

An assessment of the candidate invertebrates shows that the majority of these species are found in only a few ecosystems. For instance, 11 species are associated with the Edwards Aquifer while an additional 19 species are associated with karst systems in Bexar, Travis and Williamson counties. The aftermentioned ecosystems should receive priority attention with respect to conservation efforts.

Many of the candidate and endangered invertebrates presented here occur entirely or in part on lands owned by the Texas Parks and Wildlife Department, U.S. Bureau of Reclamation, National Park Service, local municipalities, and the Nature Conservancy. Some of these localities include Comal Springs, Diamond Y Spring, several state parks and natural areas in Texas, and Big Bend National Park and Guadalupe Mountains National Park. Of the aquatic species, only five species are definitely known to occur on private lands, and, of those three species occur at Diamond-Y Spring, which is owned and managed by the Nature Conservancy. However, 27 terrestrial species are located on private lands with one species occurring at Diamond-Y Spring. Only ten terrestrial species are known to occur on public lands. The occurrence of candidate species on public lands and other refuges facilitates research projects related to their conservation. In addition, any management decisions relating to public land holdings should carefully consider potential impacts on candidate invertebrates..

Table 1. The distribution of endangered and candidate invertebrates of Texas by ecoregions. Some overlap occurs among ecoregions because some species are represented in more than one ecoregion. Two species could not be assigned to an ecoregion and are not included here.

Group	Ecoregions											
	1	2	3	4	5	6	7	8	9	10	11	
Coleoptera				6	3	3	6					3
Diptera	1	1										
Lepidoptera				1	1	1	1					1
Orthoptera				1	1							
Arachnida												
Harvestmen							3					
Pseudoscorpions							1					1
Spiders							6					
Gastropoda		1	1					1				3
TOTALS		2	2	8	5	4	18					8

1. Piney Woods
2. Oak Woods and Prairies
3. Blackland Prairies
4. Gulf Coast Prairies and Marshes
5. Coastal Sand Plains
6. South Texas Brush Country
7. Edwards Plateau
8. Llano Uplift
9. Rolling Plains
10. High Plains
11. Trans-Pecos

Table 2. The distribution of endangered and candidate aquatic invertebrates of Texas by ecoregions. Some overlap occurs among ecoregions because some species are represented in more than one ecoregion. One species could not be assigned to an ecoregion and is not included here.

Group	Ecoregions										
	1	2	3	4	5	6	7	8	9	10	11
Coleoptera							2				2
Trichoptera	1	1					2	1			1
Odonata	1		1								1
Plecoptera							1	1			
Amphipoda							7				2
Decapoda							1				
Gastropoda							1				7
Bivalvia	1	1	2	1		2	3	1			2
TOTAL 3	2	3	1		2	17	3			15	

1. Piney Woods
2. Oak Woods and Prairies
3. Blackland Prairies
4. Gulf Coast Prairies and Marshes
5. Coastal Sand Plains
6. South Texas Breush Country
7. Edwards Plateau
8. Llano Uplift
9. Rolling Plains
10. High Plains
11. Trans-Pecos

Table 3. A comparison of primary habitat types for endangered and candidate aquatic invertebrates of Texas.

Group	Habitat Type					
	1	2	3	4	5	6
Coleoptera	2	2				
Trichoptera	1	1	1		1	1
Odonata		1			1	1
Plecoptera			1			
Amphipoda	7	2				
Decapoda	1					
Gastropoda	1	7				
Bivalvia				3	2	
TOTAL	12	13	2	3	4	2

1. Hypogean/epigean spring systems associated with the Edwards Aquifer
2. Hypogean/epigean spring systems associated with aquifers of the Trans-pecos (Trinity, El Capitan, Rustler, and other minor aquifers)
3. Streams of the Edwards Plateau
4. Streams of the Rio Grande Drainage
5. Streams of eastern Texas (mostly coastal)
6. Unknown

Table 4. The distribution of candidate invertebrates of Texas by primary ecosystems. Only ecosystems having more than one species represented are included.

Habitat	Species
Diamond Y Springs	<i>Assimineea pecos</i> <i>Gammarus pecos</i> <i>Tryonia adamantina</i> <i>T. stocktonensis</i>
Edwards Aquifer	<i>Haedioporus texanus</i> <i>Palaemonetes antrorum</i> <i>Phreatodrobia imiitata</i> <i>Stygobromus balconis</i> <i>S. bifurcatus</i> <i>S. flagellatus</i> <i>S. hadenoecus</i> <i>S. longipes</i> <i>S. pecki</i> <i>S. reddelli</i>
Limpia Creek	<i>Fonticella davisi</i> <i>Limnebius texanus</i>
Phantom Cave Spring	<i>Cochliopa texana</i> <i>Gammarus hyalleloides</i> <i>Tryonia brunei</i> <i>T. cheatumi</i>
Rio Grande	<i>Disconaias salinasensis</i> <i>Popenaisis popei</i> <i>Truncilla cognata</i>
San Marcos Springs	<i>Protoptila arca</i> <i>Heterelmis comalensis</i>
San Soloman Springs	<i>Argia balmorhea</i> <i>Protoptila balmorhea</i>

Table 4. Continued.

Habitat	Species
Franklin Mountains	<i>Ashmunella pasonis</i> <i>Sonerella metcalfi</i>
Karst Systems	
Bexar County	<i>Batrisodes venyivi</i> <i>Rhadine exilis</i> <i>R. infernalis</i> <i>Texella cokendolpheri</i> <i>Cicurina baronia</i> <i>C. madla</i> <i>C. venii</i> <i>C. vespera</i> <i>Neoleptoneta microps</i>
Travis/Williamson Counties	<i>Batrisodes texanus</i> <i>Rhadine persephone</i> <i>Tartarocreagris texana</i> <i>Texamaurops reddelli</i> <i>Texella reddelli</i> <i>T. reyesi</i> <i>Neoleptoneta myopica</i>

Explanation of Terms and Symbols

*Rank- Two ranking categories are provided for each plant as follows:

Global Rank (denoted by G and a number, 1-5 or H)

- G1 = less than 6 occurrences known globally; critically imperiled, especially vulnerable to extinction
 G2 = 6-20 occurrences known globally; imperiled and very vulnerable to extinction throughout its range
 G3 = 21-100 occurrences known globally; either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single state or physiographic region), or because of other factors making it vulnerable to extinction throughout its range
 G4 = more than 100 occurrences known, apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery
 G5 = demonstrably secure globally, though it may be quite rare in parts of its range
 GII = of historical occurrence throughout its range, i.e., formerly part of the established biota, with expectation that it may be rediscovered

State Rank (denoted by S and a number, 1-5 or H)

- S1 = less than 6 occurrences known in Texas; critically imperiled in Texas; especially vulnerable to extirpation from the state
 S2 = 6-20 known occurrences in Texas; imperiled in the state because of rarity; very vulnerable to extirpation from the state
 S3 = 21-100 known Texas occurrences; either rare or uncommon in the state
 S4 = more than 100 occurrences in Texas; apparently secure in the state, though it may be quite rare in some areas of the state
 S5 = demonstrably secure in Texas
 SH = historical in Texas, perhaps having not been verified in the past 50 years, but suspected to be extant
 SX = believed extirpated from the state

A global or state rank followed by "Q" indicates that the taxonomic status of the plant is a matter of conjecture. A rank followed by "?" indicates that the rank is not certain. A "T" subrank following a global rank denotes the rank for subspecific taxa. Two G or S ranks together (G2G3; S1S2; etc.) indicate that the plant is borderline between the ranks. All state and most global ranks are assigned by the Texas Natural Heritage Program.

**Status- Two status categories are provided for each plant as follows:

Federal Legal Status (according to the United States Fish & Wildlife Service)

- LE = listed as a federally endangered plant
 LT = listed as a federally threatened plant
 PE = proposed to become listed as endangered
 PT = proposed to become listed as threatened
 C1 = federal candidate category 1 plant with enough information available to propose for listing
 C2 = federal candidate category 2 plant under current review for possible listing as either endangered or threatened, but USFWS is in need of more information
 3B = taxa that are no longer considered taxonomically valid
 3C = no longer under federal review for listing; either more abundant or widespread than was previously thought

State Legal Status (according to the Texas Parks & Wildlife Department)

- E = listed as a state endangered plant
 T = listed as a state threatened plant

