# UPPER COLORADO RIVER WATERSHED RESTORATION AND MANAGEMENT PLAN

**February 2006**

**Prepared for:**

**Colorado River Municipal Water District (CRMWD)**

Upper Colorado River Watershed
Restoration and Management Plan
CMD05203


**Freese and Nichols, Inc.**
10814 Jollyville Road
Building 4, Suite 100
Austin, Texas  78759
(512) 451-7955

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## 1.0 EXECUTIVE SUMMARY

In December 2004, the U.S. Fish and Wildlife Service (USFWS) issued a revised Biological Opinion regarding the threatened status of the Concho water snake (*Nerodia harteri paucimaculata*). The terms and conditions in the Opinion included the requirement that the Colorado River Municipal Water District (CRMWD) study a methodology for riparian rehabilitation and restoration of the watersheds of the Upper Colorado River Basin and seek funding for implementation of the recommendations presented in the study. An additional element in the revised Biological Opinion was the commitment of the CRMWD to cooperate with the U.S. Army Corps of Engineers (USACE), the USFWS, the U.S. Bureau of Reclamation (BUREC), the City of San Angelo, the Upper Colorado River Authority (UCRA), and the Tom Green County Water Improvement District No. 1 to consider ways to increase instream flows in the Concho River downstream of San Angelo.

In West Texas, the upper Colorado River and its tributaries provide public drinking water to several communities, including Odessa, Big Spring, and Snyder through large reservoirs that are owned and operated by the CRMWD. Three of these surface water supplies and their surrounding watersheds, the Lake J.B. Thomas watershed, the E.V. Spence Reservoir watershed, and the O.H. Ivie Reservoir watershed, are the focus of this restoration and management plan. In addition to providing water supplies to nearby communities, these reservoirs and their watersheds provide critical riparian habitat for many wildlife species such as the Concho water snake.

Throughout the past several decades, the Lake J.B. Thomas, E.V. Spence Reservoir, and O.H. Ivie Reservoir watersheds have been affected by many point and non-point sources of pollution, including industrial/oil field contamination and natural salt deposits, as well as invasive plant species and undesirable land use/management practices. These impacts have affected the water quality, water quantity, and riparian habitats in the watersheds.

In order to restore the habitat of threatened and endangered species such as the Concho water snake, and improve the environmental health of the Upper Colorado River Basin as a whole, a combination of saltcedar (*Tamarix* spp.) control, upland brush management, and riparian restoration should be undertaken. Each of these strategies will require significant funding sources, but these funding sources can possibly overlap. In addition to funding, education and awareness of landowners and the general public must be increased. If the public is educated on the importance of watershed health, and successes of initial restoration and management projects can be quantified, funding for future projects through various governmental and non-governmental agency programs will follow.

This Upper Colorado River Watershed Restoration and Management Plan along with the Implementation Plan (Section 8.0) fulfills the requirement and additional element set forth in the revised Biological Opinion by addressing the enhancement and restoration of the watersheds of the Upper Colorado River Basin and by providing a selection of strategies to implement the restoration and water management solutions. This plan was prepared with cooperation and input from the following stakeholders:

## CONTRIBUTING STAKEHOLDERS

Senator John Cornyn
C/O Jessica Adams
3405 22nd Street, Suite 203
Lubbock, TX 79410

Charles Anderson
NRCS
3812 Sherwood Way
San Angelo, TX 76901
(325) 944-0147
charles.anderson@tx.usda.gov

Ricky Anderson
TCEQ Region 8
622 South Oakes, Suite K
San Angelo, TX 76903
(325) 655-9479
randerso@tceq.state.tx.us

Mike Arrott, W.L. Metcalf & Fred Taylor
Coke SWCD
P.O. Box 50
Robert Lee, TX 76945
(325) 453-4686
cokecountyswcd@tx.nacdnet.org

Congressman K. Michael Conaway
C/O Michael Beckerman
511 Cannon H.O.B.
Washington, DC 20515

Mike Berger, PhD
TPWD
4200 Smith School Road
Austin, TX 78744

Congressman Randy Neugebauer
C/O Kathy Reding Bergren
1026 Longworth H.O.B.
Washington, DC 20515

Congressman Randy Neugebauer
C/O Terri Blackshear
1510 Scurry Street, Suite B
Big Spring, TX 79720
(432) 264-0722

Cindy Breiten
Upper Pecos SWCD
P.O. Box 1027
Pecos, TX 79772
(915) 445-3190
upperpecosswcd@tx.nacdnet.org

Chuck Brown
UCRA
512 Orient
San Angelo, TX 76903
(325) 655-0565
chuckb@ucratx.org

David Brown
USGS
2775 Altamesa Boulevard
Fort Worth, TX 76133
(817) 263-9545

Rep. Scott Campbell
P.O. Box 2910, Rm. EXT E2.820
Austin, TX 78768

Ruben Cantu
TPWD
3407B South Chadburn
San Angelo, TX 76904
(325) 651-4748
ruben.cantu@tpwd.state.tx.us

Bobby C. Cathey
Howard SWCD
302 West Highway 1-20, Suite 101
Big Spring, TX 79720
(432) 267-1871
howardswcd@tx.nacdnet.org

Congressman Randy Neugebauer
C/O Jimmy Clark
611 University Avenue, Suite 220
Lubbock, TX 79401
(806) 763-1611
jimmy.clark@mail.house.gov

Ronnie Cooper
Pecos County WID #3
P.O. Box 69
Imperial, TX 79743
(432) 536-2340

Sherry Cordry
TWDB
P.O. Box 13231
Austin, TX 78711
(512) 936-0824
scordry@twdb.state.tx.us

Charles Coffman
NRCS
4609 West Loop 289
Lubbock, TX
(806) 791-0581
charles.coffman@tx.usda.gov

Speaker Tom Craddick
C/O Joe Cox
P.O. Box 2910, Rm. CAP 2W.13
Austin, TX 78768

C. Jack DeLoach, PhD
Grassland, Soil, & Water Research Lab
808 E. Blackland Road
Temple, TX 76502
(254) 770-6531
agriffith@spa.ars.usda.gov

James R. Dixon, PhD
Texas A&M University
705 Inwood Drive
Bryan, TX 77845
(979) 846-6804
jrdixon5@verizon.net

Senator Robert Duncan
P.O. Box 12068
Capital Station
Austin, TX 78711

Michael Edmiston
TCEQ Region 7
3300 North A Street, Building 4-107
Midland, TX 79705
(432) 570-1359
wedmisto@tceq.state.tx.us

Michael R.J. Forstner, PhD
Texas State University
Department of Biology
San Marcos, TX 78666
(512) 787-5639
mf@txstate.edu

## CONTRIBUTING STAKEHOLDERS (CONTINUED)


Rebecca Griffith, PhD
USACE
P.O. Box 17300
Fort Worth, TX 76102
(817) 886-1820
rebecca.s.griffith@swf02.usace.army.mil

Faith Hambleton
TCEQ
P.O. Box 13087, MC 150
Austin, TX 78711
(512) 239-4600
fhamblet@tceq.state.tx.us

Winona Henry
TCEQ Region 3
1977 Industrial Boulevard
Abilene, TX 79602
(325) 698-9674
whenry@tceq.state.tx.us

Chris Higgins
TSSWCB
P.O. Box 658
Temple, TX 76503
(254) 773-2250
chiggins@tsswcb.state.tx.us

Rep. Harvey Hildebran
P.O. Box 2910, Rm. CAP GW.12
Austin, TX 78768

Preston Irwin
NRCS
610 Highland
Big Spring, TX 79720
(915) 267-1871
preston.irwin@tx.usda.gov

Robert Joseph
USGS
8027 Exchange Drive
Austin, TX 78754
(512) 927-3500
rljoseph@usgs.gov

Allen E. Knutson, PhD
TCE – Research & Extension Center
17360 Coit Road
Dallas, TX 75252
(972) 952-9222
a-knutson@tamu.edu

Wade Kress
USGS
944 Arroyo Drive
San Angelo, TX 76901
(325) 944-4600
wkress@usgs.gov

Elisha Kuehn
NRCS
3812 Sherwood Way
San Angelo, TX 76901
(325) 944-0147
elisha.kuehn@tx.usda.gov

Rep. Pete Laney
P.O. Box 2910, Rm. CAP 3N.05
Austin, TX 78768

Greg Larson
TCEQ Region 7
3300 North A Street, Building 4-107
Midland, TX 79705
(432) 570-1359
glarson@tceq.state.tx.us

Wayne Lea
Chief, Regulatory Branch
USACE
CESWF-PER-R
P.O. Box 17300
Fort Worth, TX 76102

George H. Martin & Tommy Morris
Mitchell SWCD
P.O. Box 910
Colorado City, TX 79512
(325) 728-3473
mitchellswcd@tx.nacdnet.org

Mike Martin
BuREC Oklahoma-Texas Area
5316 Highway 290 West, Suite 510
Austin, TX 78735
(512) 899-4159
mmartin@gp.usbr.gov

Michael McColloch, DVM
Upper Pecos SWCD
P.O. Box 1027
Pecos, TX 79772
(432) 445-3196
permiansea@cableone.net

Allan McGinty, PhD
TCE
7887 U.S. Highway 87 North
San Angelo, TX 76901
(325) 653-4576
a-mcginty@tamu.edu

Jimmy McMillan
Upper Colorado SWCD
5309 Big Spring Highway
Snyder, TX 79549
(325) 573-6317
uppercoloradoswcd@tx.nacdnet.org

Mike Miller
TPWD, Tarleton State University
Box T-0070
Stephenville, TX 76402
(254) 968-9879
mike.miller@tpwd.state.tx.us

Senator Kay Bailey Hutchinson
C/O Jamie D. Moore
284 Russell Senate Office Building
Washington, DC 20510

Steve Nelle
NRCS
3812 Sherwood Way
San Angelo, TX 76901
(325) 944-0147
steve.nelle@tx.usda.gov

Senator John Cornyn
C/O Deon Nelson
517 Hart Senate Office Building
Washington, DC 20510

Mark Newman
TCEQ Region 8
622 South Oakes, Suite K
San Angelo, TX 76903
(325) 655-9479
mnewman@tceq.state.tx.us

Kerry Niemann
TCEQ
P.O. Box 13087, MC 203
Austin, TX 78711
(512) 239-0483
kniemann@tceq.state.tx.us

## CONTRIBUTING STAKEHOLDERS (CONTINUED)

Robert Pine
USFWS
10711 Burnet Road, Suite 200
Austin, TX 78758
(512) 490-0057
robert_pine@fws.gov

Andy Price, PhD
TPWD
4200 Smith School Road
Austin, TX 78744

Randall Rush
USEPA Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202
(214) 665-7107
rush.randall@epa.gov

Jim Schiller
USGS
944 Arroyo Drive
San Angelo, TX 76901
(325) 944-4600
jbschill@usgs.gov

Duane Schlitter, PhD
TPWD
3000 South IH-35, Suite 100
Austin, TX 78704
(512) 912-7041
duane.schlitter@tpwd.state.tx.us

Senator Kel Seliger
P.O. Box 12068
Capital Station
Austin, TX 78711

Steve Shrode
NRCS
2302 North Highway 208
Colorado City, TX 79512
(325) 728-3473
steven.shrode@tx.usda.gov

Mark Sides
NRCS
P.O. Box 50
Robert Lee, TX 76945
(325) 453-2751
mark.sides@tx.usda.gov

Eddy Spurgin
NRCS
610 Highland
Big Spring, TX 79720
(915) 267-1871
eddy.spurgin@tx.usda.gov

Rep. Buddy West
P.O. Box 2910, Rm. CAP GS.02
Austin, TX 78768

Bradford Wilcox, PhD
Rangeland Ecology and Management
2126 TAMU
College Station, TX 77843
(979) 458-1899
bwilcox@tamu.edu

Will Wilde
City of San Angelo
P.O. Box 1751
San Angelo, TX 76902
(325) 657-4241
wwilde@wcc.net

Patricia Wise
TCEQ Clean Rivers Program
P.O. Box 13087
Austin, TX 78711
(512) 239-2240
pwise@tceq.state.tx.us

Senator Kay Bailey Hutchinson
C/O Shea Woodard
500 Chestnut Street, Suite 1570
Abilene, TX 79602

Kevin Wright
NRCS
5309 Big Spring Highway
Snyder, TX 79549
(325) 573-6317
kevin.wright@tx.usda.gov

Congressman Michael Conaway
C/O Ricky Wright
6 Desta Drive, Suite 2000
Midland, TX 79705
(432) 687-2390
ricky.wright@mail.house.gov

# 2.0 INTRODUCTION

## 2.1 Purpose and Scope

In December 2004, the U.S. Fish and Wildlife Service (USFWS) issued a revised Biological Opinion (Appendix A) regarding the threatened status of the Concho water snake (*Nerodia harteri paucimaculata*). The terms and conditions in the Opinion included the requirement that the Colorado River Municipal Water District (CRMWD) study a methodology for riparian rehabilitation and restoration of the watersheds of the Upper Colorado River Basin and seek funding for implementation of the recommendations presented in the study. An additional element in the revised Biological Opinion was the commitment of the CRMWD to cooperate with the U.S. Army Corps of Engineers (USACE), the USFWS, the U.S. Bureau of Reclamation (BUREC), the City of San Angelo, the Upper Colorado River Authority (UCRA), and the Tom Green County Water Improvement District No. 1 to consider ways to increase instream flows in the Concho River downstream of San Angelo. The attached copy of the Biological Opinion includes a consultation history, summaries of past studies, water supply issues, and strategies implemented by the CRMWD.

This Upper Colorado River Watershed Restoration and Management Plan fulfills the requirement and additional element set forth in the revised Biological Opinion by addressing aquatic ecosystem restoration, improvements in water quality, increases in water quantity, and habitat condition improvements for the Concho water snake in the watersheds of the Upper Colorado River Basin in Texas (Figure 1, Upper Colorado River Watershed Location Map). The Implementation Plan (Section 8.0) describes strategies (i.e., responsible groups, funding sources, etc.) to accomplish the restoration and water management solutions and best management practices.

## 2.2 Objective

Watershed "health" is a concept that attempts to characterize the overall physical, chemical, and biological functions and conditions of a watershed or catchment compared to a condition when the watershed was not negatively altered or degraded by human activity. The quality and quantity of water in aquatic systems (river, lake, or wetland) are tightly linked to the watershed in which they are found (Baron *et al*., 2003). The water that falls as precipitation on a watershed is acted upon by many natural and manmade forces. Changes in the quantity and quality of water can be altered as it flows across the landscape. The quantity and quality of

Freese and Nichols
4055 International Plaza, Suite 200
Fort Worth, TX 76109 - 4895
Phone - (817) 735 - 7300

# Upper Colorado River Watershed

Colorado River Basin

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| DATE | August 31, 2005 |
| SCALE | 1:7,000,000 |
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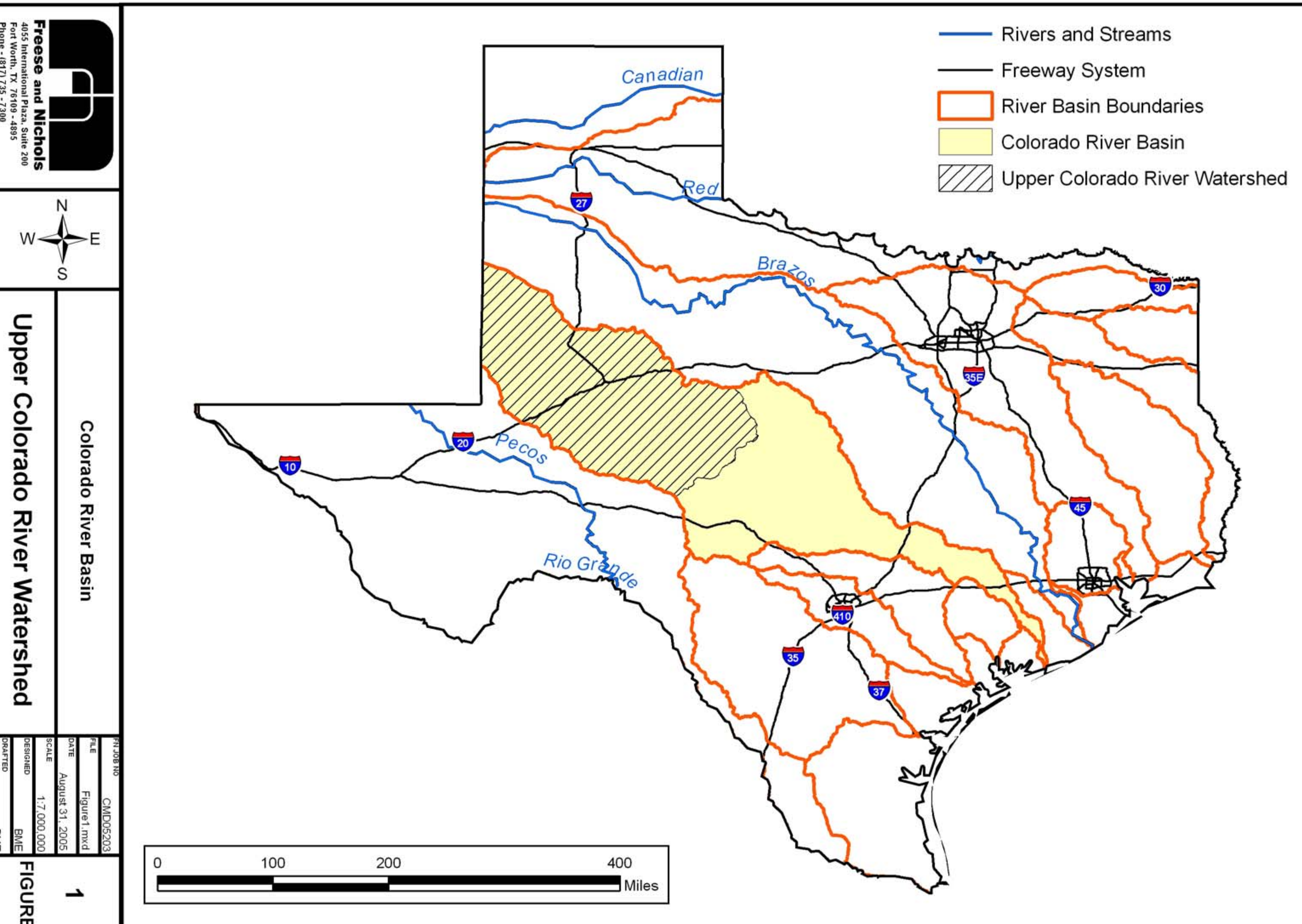
FIGURE 1



water that eventually reaches a river is the net result of all of the effects within the watershed such as impoundments, agriculture, urbanization, geological formations, irrigation, soil conditions, effluent discharges, and many others. Therefore, in order to change the quantity or quality of water in a river, changes in watershed characteristics need to be made. Management practices to be implemented in this plan are proposed so that there may be increased water quantity and quality in the upper Colorado River and some of its tributaries, thereby helping to restore conditions beneficial to the Concho water snake (e.g., increased prey base, more feeding habitat, etc.).

Enhancement and restoration of the watersheds of the Upper Colorado River Basin will attempt to establish many of the pre-disturbance functions of the watersheds; however, funding sources for implementation are integral to the success of the plan. If the restoration and water management strategies discussed in this plan are implemented, the environmental health of the watersheds will be improved so that they will continually benefit the environment and the people who have a stake in the watersheds.

## 3.0 RATIONALE FOR SELECTION OF UPPER COLORADO RIVER BASIN

In West Texas, the Colorado River and its tributaries provide public drinking water to several communities, including Odessa, Big Spring, and Snyder through large reservoirs that are owned and operated by the CRMWD. Three of these surface water supplies and their surrounding watersheds, the Lake J.B. Thomas watershed, the E.V. Spence Reservoir watershed, and the O.H. Ivie Reservoir watershed, are a focus of this restoration and management plan, but opportunities exist in all of the watersheds of the upper Colorado River and its tributaries. These three reservoirs have a combined capacity of 1.272 million acre-feet and provide a large portion of the water for municipal and industrial activities in the Upper Colorado River Basin (CRMWD, 2005). In addition to providing water supplies to nearby communities, these reservoirs and their watersheds provide habitat for many wildlife species including the Concho water snake.

In December 1986, a Biological Opinion was issued by the USFWS in which the CRMWD was required to comply with terms and conditions that would protect the threatened Concho water snake and its critical habitat. However, in July 2004, the USACE reinstated consultation with the USFWS because a water supply crisis was affecting CRMWD municipal customers. This limited water supply was caused by a decade of drought conditions and the implementation of regulated water releases from the reservoirs that were imposed to protect the Concho water snake and its habitat. In response to this emergency situation, a revised Biological Opinion was issued in December 2004 which contained two requirements for avoiding or minimizing impacts to the Concho water snake while also taking into consideration the water supply crisis occurring in West Texas. One of these requirements was to study and seek funds to complete a watershed analysis of the Upper Colorado River Basin. The other was to periodically relocate adult snakes from below Robert Lee and S.W. Freese Dams to above the dams (USFWS, 2004). Implementation of these efforts should allow the Concho water snake to be delisted from the threatened species list.


*Concho Water Snake*

This watershed restoration and management plan for the Lake J.B. Thomas, E.V. Spence Reservoir, and O.H. Ivie Reservoir watersheds explores the concerns and issues in these three areas and suggests restoration and water management solutions that can be implemented to fulfill the USFWS requirements as well as enhance and restore the environmental health of the watersheds.

# 4.0 DESCRIPTION OF UPPER COLORADO RIVER BASIN AND WATERSHEDS

## 4.1 Physical and Geographic Setting

### 4.1.1 *High Plains Eco-Region*

The Upper Colorado River Basin is located in portions of the High Plains and Rolling Plains (or Southwestern Tablelands) eco-regions in West Texas (Appendix B, Eco-Regions of Texas). The High Plains eco-region is characterized by a relatively level plateau that contains many seasonal playa lakes, which form small siltation depressions. The lakes can often cover as much as 40 acres and contain several feet of water after heavy rains (Griffith *et al*., 2004). These recharge wetlands provide important habitat for many species of migratory waterfowl, such as ducks, geese, sandhill cranes (*Corus canadensis*), and shorebirds, as well as amphibians and small mammals (TSSWCB, 2002; Griffith *et al*., 2004).

Grama-buffalograss is the typical natural vegetation in this region compared to mostly wheatgrass-needlegrass to the north, Trans-Pecos shrub savanna to the south, and taller grasses to the east (Griffith *et al*., 2004). The High Plains eco-region is mostly free from brush, but sand sagebrush (*Artemisia filifolia*) and western honey mesquite (*Prosopis glandulosa* var. *torreyana*) have invaded sandy and sandy loam areas (Telfair, 1999). The upland soils in the High Plains eco-region are dark brown to reddish brown, mostly deep, neutral to calcareous clay and clay loams in the north to sandy loams and sands in the south. Caliche is present under many soils at various depths (TSSWCB, 2002).

### 4.1.2 *Rolling Plains Eco-Region*

The Rolling Plains eco-region is separated from the High Plains area by the Llano Estacado Escarpment. The Rolling Plains eco-region is characterized by a nearly level to rolling plain which contains red-hued canyons, mesas, badlands, and dissected river breaks (Griffith *et al*., 2004). Upland soils in this region are typically pale brown to reddish brown to dark grayish brown, neutral to calcareous sandy loams, clay loams, and clays. Saline soils and shallow, stony soils with pockets of deep sand are common. Bottomlands have only minor areas of reddish brown, loamy to clayey, calcareous alluvial soils (TSSWCB, 2002).

The natural vegetation in this region consists of grama-buffalograss with some mesquite-buffalograss in the southeast, juniper-scrub oak-midgrass savanna on escarpment bluffs, and shinnery (midgrass prairie with low oak brush) along parts of the Canadian River (Telfair, 1999; Griffith *et al*., 2004). Mesquite, lotebush (*Ziziphus obtusifolia*), pricklypear (*Opuntia humifusa*), algerita (*Berberis trifoliolata*), and tasajillo (*Opuntia kleiniae*) are common invaders on all soils. Shinnery oak (*Quercus havardii*) and sand sagebrush invade the sandy lands, and redberry juniper (*Juniperus erythrocarpa*) has spread from rocky slopes to grassland areas. Dense stands of these species can be found throughout the Rolling Plains eco-region on overgrazed rangeland and abandoned cropland (TSSWCB, 2002).

### 4.1.3 *Edwards Plateau Eco-Region*

A portion of the O.H. Ivie Reservoir contributing zone is located in the semiarid Edwards Plateau, which is the segment of the Edwards Plateau eco-region that lies west of the 100$^{th}$ meridian (Griffith *et al*., 2004). This area is characterized by sharp hills and canyons with mostly intermittent streams, although some perennial streams are present (Schmidly, 2002; Griffith *et al*., 2004). The hills are sharper in this western portion of the Edwards Plateau eco-region because erosion occurs due to rockfall rather than limestone dissolution (Griffith *et al*., 2004). Soils in this eco-region are mostly shallow and underlain by limestone, granite, or caliche (USGS, 2005).

This semiarid portion of the Edwards Plateau eco-region supports short-to-midgrass mixed vegetation consisting of buffalograss (*Buchloë dactyloides*), tobosa (*Hilaria mutica*), and black grama (*Bouteloua eriopoda*) (TSSWCB, 2002; Griffith *et al*., 2004). There are also several brush species present, including lotebush, lechuguilla (*Agave lechuguilla*), and sotol (*Dasylirion wheeleri*) (Griffith *et al*., 2004). Common woody species found in the semiarid Edwards Plateau eco-region are live oak (*Quercus fusiformis*), post oak (*Quercus stellata*), shinnery oak, ashe juniper (*Juniperus ashei*), redberry juniper, and honey mesquite (Telfair, 1999; Griffith *et al*., 2004).

### 4.1.4 *Lake J.B. Thomas Watershed*

The Lake J.B. Thomas watershed is located in portions of Borden, Scurry, Dawson, Howard, Fisher, Garza, Mitchell, Lynn, and Nolan Counties, and the lake itself is located on the Colorado River northwest of San Angelo in Borden and Scurry Counties (Figure 2, Watershed Location Map). Originally, Lake J.B. Thomas was planned to be located below the confluence of Bull Creek and the Colorado River in Scurry County, but the dam site was moved approximately 20 miles upstream to avoid a portion of the Colorado River that contained highly mineralized water. Construction of the 7,808-acre lake was completed in 1952, and it stores 204,604 acre-feet at its conservation pool (CRMWD, 2005).

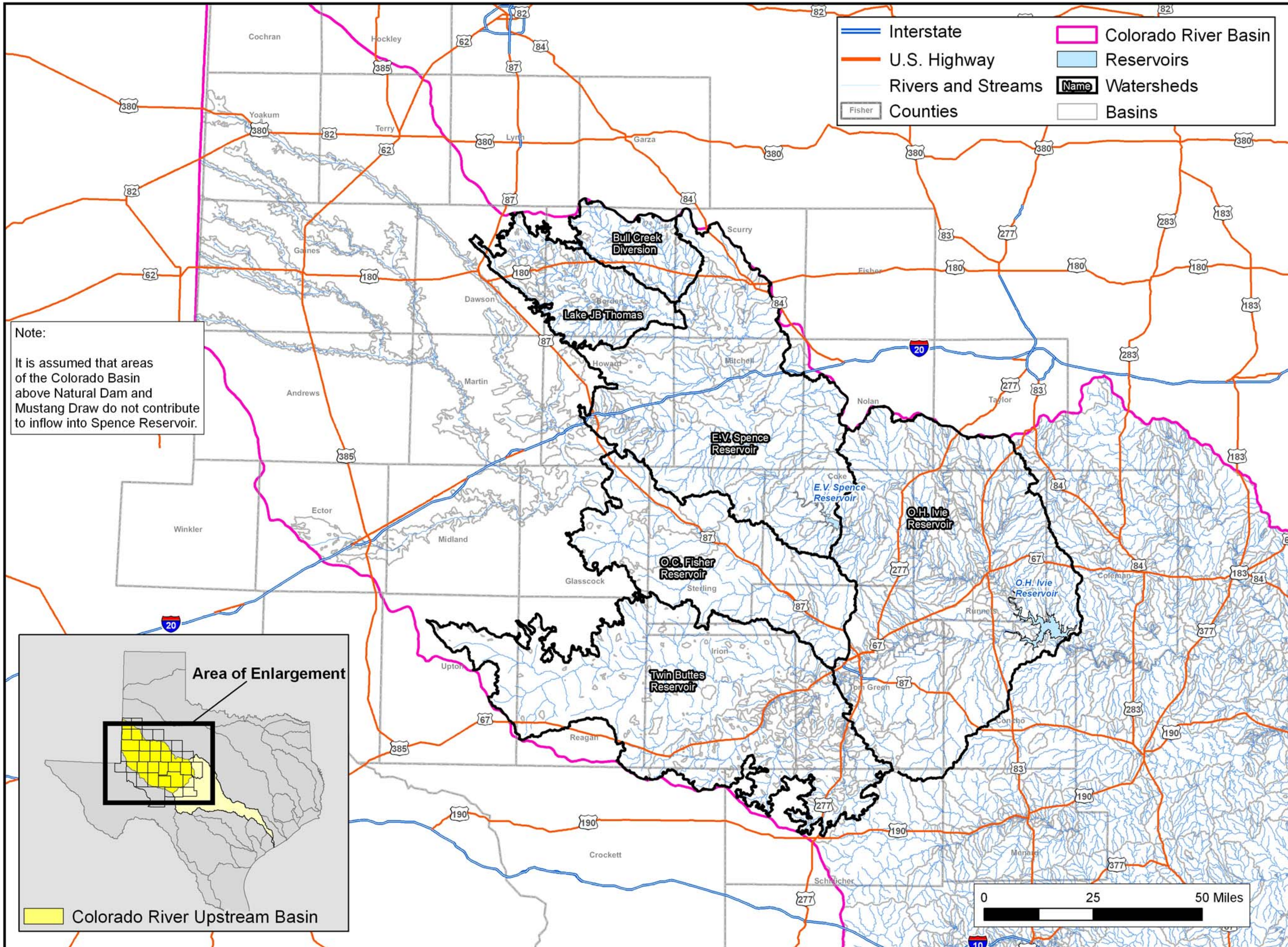



Figure 2

Colorado River Basin

Watershed Location Map

| | |
|---|---|
| FN JOB NO | CMD05203 |
| FILE | Basins.mxd |
| DATE | September 2005 |
| SCALE | 1:1,370,000 |
| DESIGNED | BME |
| DRAFTED | BME |

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Fort Worth, Texas 76109-4895
817-735-7300

The surficial geology of the Lake J.B. Thomas watershed consists of windblown sands and sandy clays which are underlain by a series of gravels that increase with close proximity to the Colorado River and its tributaries (Reed, 1961). These alluvial deposits overlie a series of Triassic formations, and the base of the Triassic is marked by a bed of uniformly distributed, coarse sandstone called the Santa Rosa Formation. In most areas of the watershed, the water table lies between the alluvial deposits and the Triassic formations. Permian deposits consisting of sandstone, shale, gypsum, and selenite typically underlie the Santa Rosa Formation (Reed, 1961).

### 4.1.5 *E.V. Spence Reservoir Watershed*

*E.V. Spence Reservoir Watershed*

The E.V. Spence Reservoir watershed is located in West Texas in portions of Borden, Scurry, Howard, Mitchell, Nolan, Glasscock, Sterling, and Coke Counties and collects drainage from 5,018 square miles (Figure 2, Watershed Location Map). This watershed contains the sub-watersheds of Beals Creek and Morgan Creek, which drain 1,988 square miles and 313 square miles, respectively (TCEQ, 2003). The reservoir itself is located on the Colorado River just north of San Angelo and southeast of Big Spring in Coke County. Construction of the 15,893-acre reservoir was completed in 1969, and it stores 517,272 acre-feet at its conservation pool (TCEQ, 2003).

In the northeastern portion of the E.V. Spence Reservoir watershed, Tertiary-aged sand, silt, clay, gravel, and caliche of the Ogallala Formation are the primary surficial deposits. Throughout the rest of the watershed, however, Quaternary and Triassic-aged formations are visible at the surface (UCRA, 2000). The Quaternary deposits mainly consist of sand, clay, caliche, and gravel in gently sloping alluvial fans and low fluviatile terraces. Deposits of the Triassic-aged Dockum Group consist of fine to coarse-grained reddish silty sand and clay with interbedded conglomerate (UCRA, 2000). Permian-aged deposits of the Quartermaster Formation are also exposed at the surface along the Colorado River near E.V. Spence Reservoir. These rocks consist of shale, silt, and fine-grained sandstone with interbedded gypsum and dolomite (UCRA, 2000).

### 4.1.6 *O.H. Ivie Reservoir Watershed*

The O.H. Ivie Reservoir watershed is located in portions of Nolan, Coke, Tom Green, Runnels, Coleman, and Concho Counties, and has a contributing drainage area of approximately 12,647 square miles (Figure 2, Watershed Location Map) (UCRA, 2000). Construction of the O.H. Ivie Reservoir was completed in 1990, and it stores 554,340 acre-feet at its conservation pool (CRMWD, 2005). The primary feeding tributaries to the O.H. Ivie Reservoir are the Colorado River below E.V. Spence Reservoir, Elm Creek, and the Concho River below San Angelo (UCRA, 2000).

In the northern portion of the O.H. Ivie Reservoir watershed, Permian-aged formations are the predominant surficial deposits. The younger portion of this Permian sequence consists of massive fine-grained sandstone, shale, gypsum, and selenite, whereas the lithology of the older portions is typically shale and fossiliferous limestone (UCRA, 2000). In the southern portion of the watershed, these Permian deposits are unconformably overlain by Quaternary floodplain and terrace alluvial deposits of the Leona Formation that consist of clay, fine-grained sand, and gravel conglomerates (UCRA, 2000).

### 4.1.7 *O.C. Fisher Lake and Twin Buttes Reservoir Watersheds*

In addition to providing water supplies to its member cities of Odessa, Big Spring, and Snyder, the CRMWD is under contract to provide specified quantities of water to other nearby cities, including the City of San Angelo. The remainder of San Angelo's water supply comes from O.C. Fisher Lake and the Twin Buttes Reservoir (UCRA, 2000; USACE, 2005).

O.C. Fisher Lake and its corresponding watershed are located in portions of Sterling, Howard, Glasscock, Coke, and Tom Green Counties (Figure 2, Watershed Location Map). The lake itself is located on the North Concho River, approximately 6.3 miles above the river's confluence with the South Concho River and 65 miles above its confluence with the Colorado River in the northwest corner of Tom Green County, adjacent to the city limits of San Angelo (USACE, 2005). Construction of O.C. Fisher Lake was completed in 1952, and it is owned and operated by the USACE. The conservation pool is approximately 5,440 surface acres and the flood pool is 12,700 surface acres (USACE, 2005). In addition to providing water supplies to the City of San Angelo, O.C. Fisher Lake is used for flood control, recreation, and wildlife habitat. The lands surrounding O.C. Fisher Lake are also owned by the USACE, but they are operated and maintained by the Texas Parks and Wildlife Department (TPWD) and Angelo State University (ASU) through license agreements with the USACE (USACE, 2005).

The USACE has written a plan for the ecosystem restoration of government-owned lands within the O.C. Fisher Lake watershed, and the City of San Angelo has offered their support of the plan in the forms of cost-share funding and operation and maintenance of the restoration activities (USACE, 2005). In addition to increasing perennial surface water, decreasing loss of riparian woodland habitat, and restoring current woodland habitat, the implementation of this plan will augment and increase the effectiveness of this Upper Colorado River Watershed Restoration and Management Plan. In 2004, the USACE also provided funding for the Upper Colorado River Authority (UCRA) Kickapoo Creek Aquatic Ecosystem Restoration Project (Section 206) in the nearby Kickapoo Creek watershed. This project utilizes Geographic Information System (GIS) software to develop a conceptual hydrogeologic/hydrologic model that illustrates the management of riparian and plant vegetation and how the management influences baseflows to Kickapoo Creek and its tributaries. The O.C. Fisher Lake Ecosystem Restoration Project can be found in Appendix C, and additional information about the Kickapoo Creek Aquatic Ecosystem Restoration Project (Section 206) can be found in Appendix D.

The Twin Buttes Reservoir watershed is located in portions of Irion, Tom Green, Upton, Reagan, Crockett, Schleicher, and Sterling Counties (Figure 2, Watershed Location Map). This 3,868-square mile watershed contains the sub-watersheds of Spring Creek, the Middle Concho River, Dove Creek, and the South Concho River (UCRA, 2000). The Twin Buttes Reservoir was completed in 1963, and its primary feeding tributaries are the Middle Concho River, Spring Creek, and the South Concho River. The reservoir stores a combined 186,200 acre-feet in the South Concho and Middle Concho-Spring Creek conservation pools (UCRA, 2000). The Twin Buttes Reservoir is owned by the City of San Angelo, and in addition to providing municipal water supplies, it is used for flood control and irrigation (UCRA, 2000).

## 4.2 Land Use

Prior to European settlement in the late 1800s, the West Texas region, including the watersheds of the Upper Colorado River Basin, was described in several personal accounts as an open country with numerous streams that supported many types of trees, grasses, and wildlife species (Schmidly, 2002; TSHA, 2005). Following the removal of the Native Americans and the extermination of the bison, cattle ranches became prevalent throughout West Texas during the 1880s. These ranches were made possible through the invention and sale of barbed wire and the utilization of windmills for adequate supplies of water (TSHA, 2005). During the late 1800s and the early 1900s, the extension of railroads into West Texas provided markets for cattle, sheep, goats, and wool, but the railroads also brought in a large number of new farmers. The greatest period of growth in West Texas occurred from 1880 through 1910, when the number of farms increased by 310 percent. Eventually, the rise of farming brought an end to many of the ranches in the area (TSHA, 2005).

The 1920s was also a period of extensive growth in West Texas. The amount of farmland under cultivation grew rapidly, the number of farms continually increased, and the population exploded due to the discovery of oil and gas reserves (TSHA, 2005). However, during the Great Depression of the 1930s, people began abandoning their farms at alarming rates because of the extremely low rainfall and disastrous wind erosion that damaged roughly 80 percent of the High Plains eco-region. This area was economically devastated by the end of the 1930s (TSHA, 2005).

During the 1940s, the return of “good” weather in West Texas coincided with the onset of World War II and the return of high prices for agricultural products. Farmers moved back into the area and began to plant grain and fiber crops to meet the huge demands of the war effort (TSHA, 2005). From 1950 to 1957, however, low rainfall and extremely high temperatures again brought drought conditions to West Texas. Agriculture and ranching industries were negatively affected, and water supplies were substantially depleted when many wells, creeks, rivers, and springs dried up completely (NOAA, 2003). In 1957, the drought ended when rainfall increased, surface water and groundwater supplies were replenished, and soil moisture conditions were returned to normal (NOAA, 2003).

Throughout the 1940s and 1950s, new oil wells were also brought into production, substantially increasing the amounts of oil and gas produced in West Texas (TSHA, 2005). Though the oil industry fluctuated from the 1940s to the 1990s, the subsidiary industries and employment opportunities the oil industry provided offset rural population loss that was fostered by drought and farm consolidations. In the later part of the 20$^{th}$ century, West Texas continued to be a major farming and oil-producing area (TSHA, 2005).

Currently, approximately 60 percent of the High Plains eco-region (Figure 3, Upstream Land Use Types; Appendix B, Eco-Regions of Texas) is cropland, half of which is irrigated (TSSWCB, 2002; Griffith *et al*., 2004). The major crops in this area are cotton, corn, sorghum, wheat, vegetables, and sugar beets. High winds, dry winters, and low annual rainfall cause cultivation and erosion control problems, and as groundwater availability diminishes, use of pasture and range for livestock production increases (TSSWCB, 2002). Many of the playa lakes in this region have been hydrologically modified or converted to cropland for feedlot uses (TSSWCB, 2002; Griffith *et al*., 2004). Rangeland grazing comprises approximately 40 percent of the area and oil/gas production also occurs in many parts of the region (TSSWCB, 2002).

<u>High Plains Eco-Region</u>
60% Cropland
40% Rangeland

<u>Rolling Plains Eco-Region</u>
75% Rangeland
25% Cropland

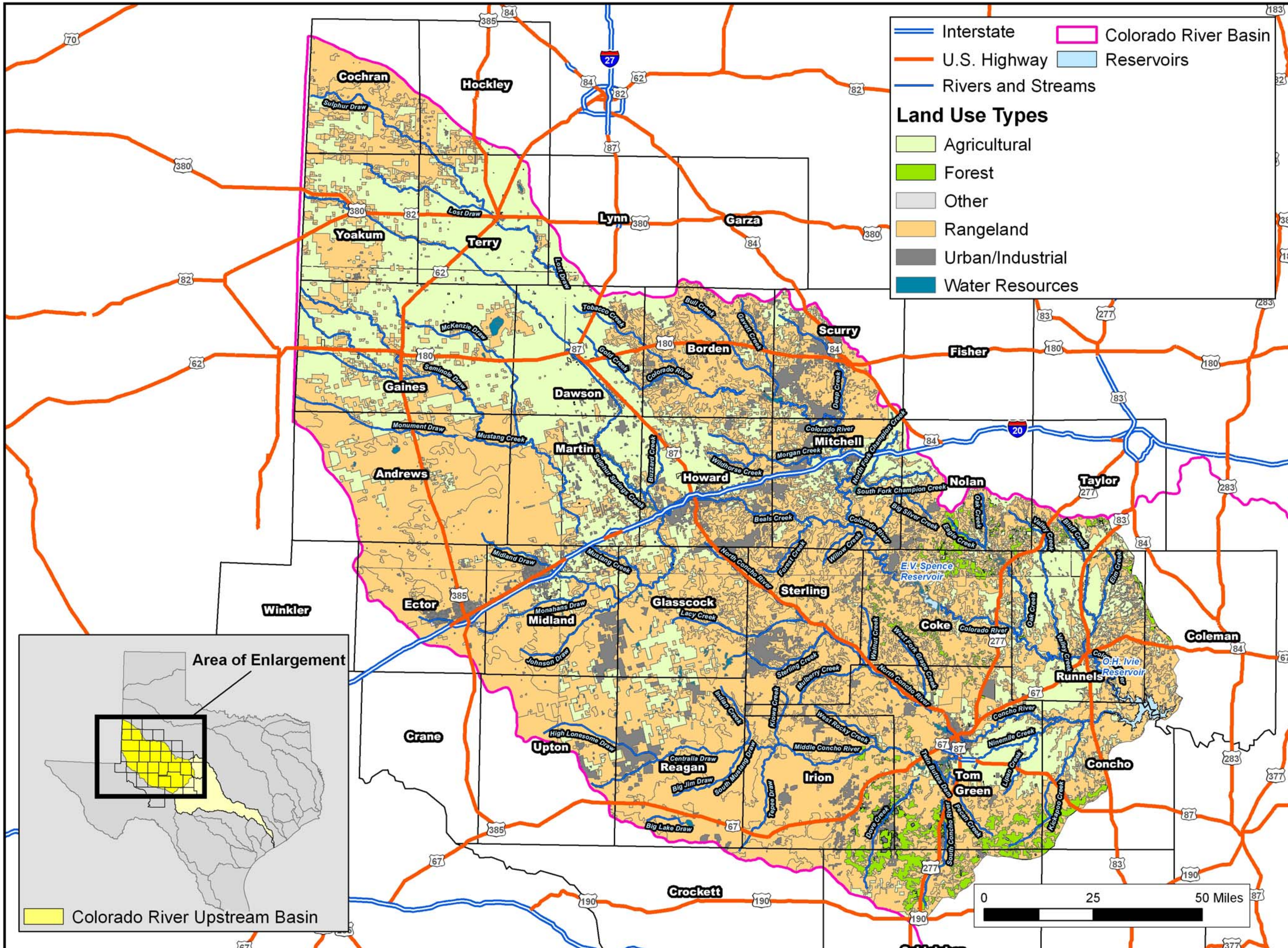


Figure 3

Colorado River Basin

Upstream Land Use Types

| | |
|---|---|
| FN JOB NO | CMD05203 |
| FILE | Figure3.mxd |
| DATE | August 2005 |
| SCALE | 1:1,370,000 |
| DESIGNED | BME |
| DRAFTED | BME |

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Fort Worth, Texas 76109-4895
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Unlike the High Plains eco-region, little cropland occurs in the Rolling Plains area (Figure 3, Upstream Land Use Types; Appendix B, Eco-Regions of Texas). About 75 percent of this region is rangeland, but dryland and irrigated sorghum, small grain, cotton, and forages are important crops (TSSWCB, 2002; Griffith *et al*., 2004). Livestock production, the major enterprises being cow-calf and yearling operations, includes the use of rangeland forage, crop residue, and winter cereals (TSSWCB, 2002). The intermixing of rangeland and cropland allows habitat for wildlife such as mourning dove (*Zenaida macroura*), quail, white-tailed deer (*Odocoileus virginianus*), and turkey (*Meleagris gallopavo*), providing good to excellent recreational hunting opportunities (TSSWCB, 2002). A detailed map of the current land use in the Upper Colorado River Basin is provided as Figure 3.

## 4.3 Water Body Use

Lake J.B. Thomas and the E.V. Spence and O.H. Ivie Reservoirs are the largest water bodies within the project area, and were originally constructed as regional public drinking water supplies for West Texas communities such as Odessa, Big Spring, and Snyder (CRMWD, 2005). The Texas Commission on Environmental Quality (TCEQ) has classified Lake J.B. Thomas as Segment 1413, the E.V. Spence Reservoir as Segment 1411, and the O.H. Ivie Reservoir as Segment 1433. All three reservoirs have been designated as suitable for aquatic life, contact recreation, fish consumption, and public water supply uses (TCEQ, 2002).

## 4.4 Water Supply Issues

Lake J.B. Thomas and the E.V. Spence and O.H. Ivie Reservoirs have continuously been plagued by water supply issues relating to water quantity and water quality since they were constructed in 1952, 1969, and 1990, respectively. A combination of drought conditions, the proliferation of invasive brush species, undesirable land use/management practices, as well as oil field, industrial, and natural salt deposit contamination has dramatically affected water quantity and quality in these reservoirs.

The average rainfall in this area is approximately 21.02 inches per year, and the average gross evaporation rate is approximately 65.32 inches per year (USFWS, 2004; TWDB, 2005). As a result of the surface water evaporation, water reserves in the reservoirs are significantly depleted each year (TWDB, 2005). In addition, elevated concentrations of sulfate, chloride, and total dissolved solids (TDS) have consistently been detected above those allowed for the designated uses of the reservoirs (Freeman and Schertz, 1986). Specific point and non-point sources of pollution, and their effects on water quality and quantity, will be discussed in detail in a later section.

It should be noted that the use of groundwater as a public drinking water supply is somewhat undesirable because the low rainfall in West Texas yields a low recharge rate, and due to naturally-occurring salt deposits and drilling operations, the groundwater can also be very saline. Groundwater has typically been used to augment surface water supplies (USFWS, 2004).

### 4.5 Threatened and Endangered Wildlife Resources

The Lake J.B. Thomas, E.V. Spence Reservoir, and O.H. Ivie Reservoir watersheds provide a number of diverse habitats for wildlife and vegetation. These habitats consist of riverine, lacustrine, wetland, forested, and prairie environments. The USFWS has identified a number of endangered species that live in these watersheds. These species include the black-capped vireo (*Vireo atricapilla*), the Texas poppy-mallow (*Callirhoe scabriuscula*), the whooping crane (*Grus americana*), the golden-cheeked warbler (*Dendroica chrysoparia*), and the least tern (*Sterna antillarum*). Additionally, the bald eagle (*Haliaeetus leucocephalus*) and the Concho water snake live in portions of the watersheds and are classified by the USFWS as threatened species (USFWS, 2004; USFWS, 2005).

The black-capped vireo is a small, neotropical migrant bird that lives in open grasslands which contain scattered clumps of shrubs and abundant woody foliage below six feet in height (Cimprich, 2003). These habitats can be located on steep slopes of canyons or ravines where slow succession and microclimates provided by the rugged terrain perpetuate the clumping of vegetation (Graber, 1961). On level terrain, black-capped vireo habitat seems to change from open grassland prairie to juniper-oak woodlands. Overgrazed pastures and areas exhibiting browse lines are not suitable habitats for the black-capped vireo (Graber, 1961). These birds typically winter in Mexico and nest in Texas from April through July. A decreased frequency of range fires and the overgrazing of livestock have reduced preferred habitat for these birds (TPWD, 2005).

The Texas poppy-mallow thrives in wind-blown, river-deposited deep sands in the watersheds of the Upper Colorado River Basin, specifically in Coke, Mitchell, and Runnels Counties. This species is very localized in its distribution and is restricted to soil types that are extremely vulnerable to erosion (Poole and Riskind, 1987). The Texas poppy-mallow is typically found in areas that also contain shinnery oak, bull nettle (*Solanum carolinense*), Indian blanket (*Gaillardia pulchella*), three awns (*Aristida* spp.), and dropseed (*Sporobolus heterolepis*) plant species (TPWD, 2005). This perennial plant is typically 10 to 15 inches tall and has a thick, erect stem with slender taproots up to four feet long (USFWS, 1985). The Texas poppy-mallow supports a red or purple flower that has a deep red basal spot. This flower will only remain open throughout the pollination process (TPWD, 2005). Much of the Texas poppy-mallow habitat has either been developed or converted into farmland and pastureland (TPWD, 2005).

The whooping crane is an elegant white bird approximately five feet tall that breeds in isolated, marshy areas of Wood Buffalo National Park, Northwest Territories in Canada and winters in portions of Texas (Griggs, 1997). These cranes are the tallest birds in North America and adults have a wingspan of six to seven feet (TPWD, 2005). The whooping crane depends on large wetland areas for habitat, including tidal flats, uplands, and barrier islands, but these birds can occasionally be found in marshes, river bottoms, potholes, cropland, and prairies (Howe, 1989). Many of the environments used for whooping crane habitat have been severely impacted by intense agricultural practices such as the filling and draining of wetlands for pasture and farmland (TPWD, 2005).

The golden-cheeked warbler is a songbird approximately 4.5 inches long that eats insects and spiders found on the leaves and bark of oaks and other trees (Pulich, 1976; TPWD, 2005). In March, these birds come to the Edwards Plateau eco-region of Texas to nest and raise their young, after which they return to Mexico or Central America to winter in pine-oak woodlands (Ladd, 1985). The nesting habitat of the golden-cheeked warbler is limited to central Texas, in ravines and canyons that contain mixed ashe juniper and oak woodlands (Diamond and True, 2002). Mature ashe juniper bark is an important nest-building material required by these birds. In recent years, many tall juniper and oak woodlands have been cleared for urban development, cropland and livestock grazing areas, or have been flooded during the man-made construction of lakes and reservoirs (TPWD, 2005).

Interior least terns are small birds with a habitat that includes riverine sandbars with little or no vegetation, or the shorelines of lakes and reservoirs. Least terns feed on small fish in either flowing or standing water (North American Association for Environmental Education, 2005). In Texas, these birds nest on the Red, Canadian, and Rio Grande Rivers (Downing, 1980). Much of the historic habitat of these birds has been destroyed by dams, reservoirs, and altered channels that have eliminated wide channels which contain abundant sandbars (North American Association for Environmental Education, 2005).

The bald eagle is a large hawk-like bird with a six- to seven-foot wingspan and unfeathered feet (Lish, 1975). Adult eagles have a white head, neck, and tail. Bald eagle nesting habitat consists of quiet coastal areas, rivers, or lakeshores that contain large, tall trees, which include loblolly pine (*Pinus taeda*), bald cypress (*Taxodium distichum*), oak, cottonwood (*Populus deltoides*), and sycamore (*Platanus occidentalis*) (TPWD, 2005). Many eagles also find habitat near reservoirs (TPWD, 2005). Bald eagles were most notoriously endangered by the widespread use of DDT before its use was banned in 1972. Although these birds are still recovering from the effects of DDT and are only listed as a threatened species, they are also suffering from the loss of nesting habitat due to urban development (TPWD, 2005).

As mentioned previously, the Concho water snake is also a threatened species in the watersheds of the Upper Colorado River Basin. This species can be found in crayfish burrows, exposed bedrock, thick herbaceous vegetation, debris piles, concrete low-water crossings, and riffles near relatively still reservoirs or fast-moving rivers (USFWS, 2004). However, siltation of rocky streambeds, encroaching vegetation, and loss of riffles, all caused by unnatural flow regimes, has diminished the habitat of the Concho water snake. Efforts to restore stream flows and habitat are being made in many areas (TPWD, 2005). Because Concho water snakes feed almost exclusively on fish (Dixon *et al*., 1988, 1989, 1990, 1992; Greene *et al*., 1999), restoring stream flows, especially in areas with little or no water, provides habitat (water) for fish that can potentially serve as a prey base for the Concho water snake. Increased water quantity also benefits other components such as invertebrates, periphyton, algae, etc. that are needed for a functioning aquatic community. Increased stream flows also increase riffle habitat, which is preferred feeding habitat for Concho water snakes (Dixon *et al*., 1988; Rose, 1989; Dixon, 2004). In West Texas, the critical habitat of the Concho water snake has been designated by the USFWS as the following (USFWS, 2004; TPWD, 2005):

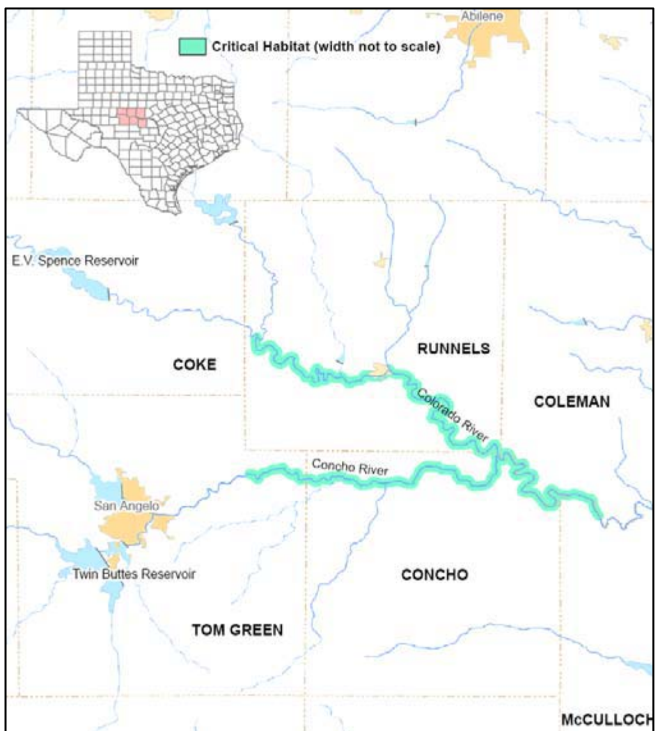
*E.V. Spence Reservoir Watershed*

- *Concho River in Concho and Tom Green Counties.* The mainstem river channel and river banks up to a level on both banks that is 15 vertical feet above the water level at median discharge (but not extending more than a ½ mile upstream on any tributary stream), extending from Mullin's Crossing northeast of the town of Veribest, downstream to the confluence of the Concho and Colorado Rivers.

- *Colorado River in Coleman, Concho, McCulloch, and Runnels Counties.* The mainstem river channel and river banks up to a level on both banks that is 15 vertical feet above the water level at median discharge (but not extending more than a ½ mile upstream on any tributary stream), extending from the Farm to Market Road (FM) 3115 bridge near the town of Maverick downstream to the confluence of the Colorado River and Salt Creek, northeast of the town of Doole.

- *O.H. Ivie Reservoir in Coleman, Concho, and Runnels Counties.* The entire O.H. Ivie Reservoir basin up to the conservation pool level of 1,551.5 foot elevation MSL, including reservoir banks up to 15 vertical feet above the 1,551.5 foot elevation, and including any tributary streams for not more than a ½ mile upstream from the conservation pool level.

In riverine habitats, the Concho water snake is typically found near riffles, which are portions of a river with a high velocity and shallow water, both due to an increase in channel gradient (USFWS, 2004). Riffles are usually dominated by jumbled gravel, rock, and bedrock that provide areas for the snakes to forage and refuge. It has been documented that along the Colorado and Concho Rivers, limestone shelf rock that contains numerous splits, crevices, and cracks supports large snake populations (USFWS, 2004). In 2003, it was estimated that the upper Colorado River segment contains 21 percent, the lower Colorado River segment contains 36 percent, and the Concho River contains 25 percent of the suitable riverine habitat for the Concho water snake (USFWS, 2004). Approximately 15504.0 meters of stream length were considered to be of the highest quality for the Concho water snake along the Concho River and along the upper and lower segments of the Colorado River, 35878.5 and 15641.4 meters of stream length were considered to be of the highest quality, respectively (USFWS, 2004).



***Concho Water Snake Critical Habitat***

In reservoir settings, the Concho water snake habitat is typically broken rock along the shoreline near shallow, silty areas containing submersed vegetation and schools of small fish. These snakes can occasionally be found on steeper shorelines when similar habitats are available (USFWS, 2004). Both juvenile and adult snakes will forage and seek refuge in these rocky environments, but bask on dead shrubs and trees that have been killed by fluctuating reservoir levels. Near the E.V. Spence Reservoir, however, Concho water snakes bask on the ground among the protection of broken rock because there is little dead vegetation available (USFWS, 2004). In December 2003, it was estimated that the E.V. Spence and O.H.

Ivie Reservoirs contained 7 percent and 11 percent of suitable habitat for the Concho water snake, respectively. Both of these reservoirs have significant lengths of shoreline habitat available for the Concho water snake, but due to fluctuating pool elevation levels, this habitat is not constant (USFWS, 2004). When the surface water levels fluctuate, shoreline habitat is submerged in some areas and exposed in others. There is evidence, however, that the snakes will move to seek their preferred habitat. It has been estimated that one meter elevation changes in the E.V. Spence Reservoir are enough to significantly alter the habitat quality for the snakes (USFWS, 2004).

In 1998, the CRMWD summarized data that had been collected on Concho water snake population and distribution from 1987 through 1997. The three methods that were used to assess these parameters were mark and recapture, “rock flipping,” and trapping. The number of snakes collected over this eleven-year period varied with a high of 1,633 snakes captured in 1988 and a low of 448 snakes collected in 1995 (USFWS, 2004). In the Colorado River, a total of 5,586 snakes had been captured, and in the Concho River a total of 1,517 snakes were collected. In the E.V. Spence and O.H. Ivie Reservoirs, a total of 374 and 361 snakes were collected over the eleven-year period (USFWS, 2004).

The dorsal surface of the Concho water snake is typically gray, brown, or reddish brown with dark brown spots, and contains 21 to 23 rows of scales. The ventral surface is usually pink or light orange in color (USFWS, 2004). At maturity, male Concho water snakes average 15 inches Snout-Vent Length (SVL) and females average approximately 18 inches (USFWS, 2004). The rocky and shallow water habitats of the Concho water snake most likely provide protection from many terrestrial and aquatic predators, including other species of snakes, raccoons (*Procyon lotor*), hawks (*Buteo* spp.), bass (*Micropterus* spp.), and channel catfish (*Ictaclurus punctatus*). Concho water snakes are thought to be opportunistic predators on most small fish that are found in shallow water habitats, primarily red shiner (*Cyprinella lutrensis*) and bullhead minnow (*Pimephales vigilax*) (USFWS, 2004). Additional information regarding the habitat and biological characteristics of the Concho water snake can be found in the USFWS revised Biological Opinion in Appendix A.

# 5.0 UPPER COLORADO RIVER WATERSHED CONCERNS AND ISSUES

The Lake J.B. Thomas, E.V. Spence Reservoir, and O.H. Ivie Reservoir watersheds have been affected by many point and non-point sources of pollution, including industrial/oil field contamination and natural salt deposits, and by other issues such as invasive plant species and undesirable land use/management practices. The major pollutants affecting these reservoirs are elevated concentrations of sulfate, chloride, and TDS (Paine and Collins, 2005). Freeman and Schertz (1986) estimated that waters of the Upper Colorado River Basin exceed the secondary drinking water standard for dissolved solids (500 mg/L), chloride (250 mg/L), and sulfate (250 mg/L) approximately 95 percent of the time.

## 5.1 Point Sources

### 5.1.1 *Ice Melt Products, Inc.*

Ice Melt Products, Inc. produces liquid magnesium chloride at a facility west of Lake J.B. Thomas for use as a dust control and deicer on roadways and parking lots. The magnesium chloride is manufactured by evaporating brine from producing oil wells on a 30-acre solar pond in West Texas. The high concentrations of chloride that are produced during this manufacturing process are a concern for contamination in the Colorado River and its tributaries.

### 5.1.2 *American Magnesium Plant*

A magnesium plant formerly owned by the American Magnesium Company is located approximately 3,000 feet west of Bluff Creek and 1,000 feet north of an unnamed tributary to Bluff Creek near Snyder, Texas (TCEQ, 2003). This facility began operation in the early 1970s using an electrolytic process to purify magnesium metal from magnesium chloride brine solutions. During the manufacturing process, plant personnel utilized storage ponds and underground injection to dispose of wastes at the plant. The plant changed ownership several times and operations were finally terminated in 1987 (TCEQ, 2003). Throughout the 1970s and 1980s, the TCEQ regional office documented several unauthorized discharges of highly concentrated chloride water from the plant, but since the closure of the site, remedial actions and habitat restoration activities have taken place. In January 1998, however, CRMWD staff members collected water samples containing high concentrations of chloride from a well near the property line of the plant and a seep located down-slope from the well (TCEQ, 2003). Discharge from this seep was visible on a nearby county road, and a vegetation kill zone along both sides of the road was documented (TCEQ, 2003). The location of the plant continues to pose a threat to the water quality of Bluff Creek and the Colorado River.

### 5.1.3 *Col-Tex Refinery*

The former Col-Tex Refinery is located immediately west of Colorado City in Mitchell County, Texas on approximately 175 acres, and was in operation from 1924 to 1969 (TCEQ, 2005(a)). In the 1970s, the refinery was dismantled except for four above-ground storage tanks, three of which are adjacent to the Colorado River. These three tanks are believed to be a source of benzene, toluene, and xylene contamination found at the site (TCEQ, 2005(a)). In 1994, this property was listed as a Texas State Superfund Site, and since its acceptance into this program, remedial and habitat restoration activities have been undertaken (TCEQ, 2005(a)).

## 5.2 Non-Point Sources and Other Issues

### 5.2.1 *Natural Salt Deposits*

Natural salt deposits from the Permian Epoch are extensive in West Texas and are a significant source of elevated salinity in the Colorado River and its tributaries. In the watersheds of Lake J.B. Thomas, the E.V. Spence Reservoir, and the O.H. Ivie Reservoir, Permian beds reach a thickness of 4,500 feet, of which the upper 1,000 feet consists of sandstones, shales, anhydrites, and salt deposits containing halite and gypsum (Reed, 1961). The salt beds typically occur below a depth of 650 to 700 feet beneath the land surface, and all groundwater that flows through these beds is highly mineralized (Reed, 1961).

The water table in the Upper Colorado River Basin dips in the same direction and in relatively the same degree as the land surface. Groundwater that flows through the overlying upper Triassic sandstones and is above the fresh water/salt water contact with the Permian salt deposits is characterized by high calcium and magnesium sulfates, but the bicarbonate and chloride levels are generally tolerable (Reed, 1961). This contact elevation results in relatively good quality water to the east and southeast, but the water becomes highly mineralized in the vicinity of the Colorado River (Reed, 1961). Therefore, the highly mineralized baseflow of the Colorado River and its tributaries is partially derived when natural underground sulfur-bearing mineral deposits undergo dissolution into groundwater that eventually discharges to the surface. Surface water bodies can also be affected when flow occurs across outcropping mineral beds (Reed, 1961; TCEQ, 2003).

### 5.2.2 *Oil Field Contamination*

Since the 1920s, oil and gas exploration has been a major industry in the counties of West Texas. In 1998, the combined total production from oil fields in Mitchell, Scurry, and Howard Counties was 17,917,877 barrels (TCEQ, 2003). The oil extraction process creates brine, and when the ratio of salt water to oil increases, the well becomes unprofitable and is, in most cases, abandoned. Many abandoned wells develop cracks and leaks that can eventually contaminate groundwater and surface water (TCEQ, 2003).

From the 1920s through 1969, brine disposal pits were utilized to dispose of the brine that accompanies oil production. These disposal sites consisted of large, shallow, unlined pits where water was disposed of by evaporation and seepage (TCEQ, 2003). However, when brine evaporated from these pits, salts were left behind that eventually infiltrated the shallow subsurface and local groundwater. When brine disposal pits were banned in 1969, oil companies began to inject brine into the subsurface strata to dispose of the excess salt water and to recover oil deposits from under-pressurized geologic formations (TCEQ, 2003). As technology has improved and the costs of injection have decreased, the volume of brine injected into these wells has increased. In many cases, the geologic formations that are utilized for brine injection are located beneath shallow aquifers (TCEQ, 2003). Groundwater can become contaminated from salt water migration or within the injection well itself, and surface water bodies can be affected where these formations outcrop. Contamination from injection wells has usually been attributed to cracked casings, leaking boreholes, or wells that have not been operated properly (TCEQ, 2003).

## 5.3 Invasive Plant Species

Invasive plant species such as saltcedar, juniper, and mesquite have become dominant in the western portions of Texas, and as a result, have caused extensive problems relating to water quality and quantity in the watersheds of the Upper Colorado River Basin. Ashe juniper, redberry juniper, honey mesquite, and saltcedar have higher water consumption rates and more extensive root systems than most native vegetation, and therefore out-compete many native species in disturbed areas (UCRA, 2000; Teague *et al*., 2001).

Most Invasive Plant Species in West Texas

- Ashe Juniper
- Redberry Juniper
- Honey Mesquite
- Saltcedar

### 5.3.1 *Ashe Juniper, Redberry Juniper, and Honey Mesquite*

Ashe juniper, redberry juniper, and honey mesquite are all Texas range plants that have become more dominant in many portions of Texas over the past 50 years (UCRA, 2000). Both ashe juniper and redberry juniper typically reach heights of 15 to 20 feet and can easily dominate other native grasses and vegetation because they have extensive lateral root systems that consume excessive amounts of water (Owens and Ansley, 1997; Teague *et al*., 2001). The proliferation of juniper has also contributed to the disappearance of springs in West Texas (Brune, 2002). In general, juniper has been found to have an annual interception loss averaging 73 percent of precipitation (Thurow and Hester, 1997). This high interception loss indicates that in areas with dense juniper stands, most of the rainfall returns to the atmosphere through evaporation or transpiration and there is little potential for water yield. This is not the case with grassland areas because grass has an annual interception loss of 14 percent (Thurow and Hester, 1997). In West Texas, ashe and redberry juniper tend to dominate upland areas in the watersheds, whereas honey mesquite thrives in riparian zones (UCRA, 2000).

Honey mesquite is a small tree or shrub that typically reaches heights less than 30 feet and utilizes a dual root system to consume excessive amounts of water from shallow depths. This species also has deep tap roots that are used to penetrate into deeper groundwater sources (UCRA, 2000). Ansley *et al*. (1998) reported that a honey mesquite tree approximately 8 to 12 feet tall will consume up to 20 gallons of water per day during mid-summer growing conditions. In addition to affecting water quantity, understory species diversity may be reduced in areas where dense honey mesquite has suppressed grass growth. The increase in honey mesquite on West Texas rangelands has been attributed to cattle spreading seeds through their dung and the less frequent occurrence of wildfires that limit the amount of young trees (UCRA, 2000).

<u>Water Consumption Rates of Invasive Plant Species in West Texas</u>

- Ashe Juniper – **33.1** gallons/tree/day
- Redberry Juniper – **46.8** gallons/tree/day
- Honey Mesquite – **20.9** gallons/tree/day
- Saltcedar – **80.0 to 200.0** gallons/tree/day

### 5.3.2 *Saltcedar*

Saltcedar is a non-native species that was introduced to the United States in the 1800s from southern Europe or the eastern Mediterranean region (DiTomaso, 1998). Several species of saltcedar were used for ornamental purposes, but they quickly spread to many of the floodplains in the western United States (Robinson, 1965; DiTomaso, 1998). These plants are approximately five to twenty feet tall with brown or blackish basal branches or trunks that can flower in both the spring and summer seasons (Allred, 2002; DiTomaso and Healy, 2003).

Floodplains, riparian communities, seasonal wetlands, and lake margins are particularly susceptible to saltcedar invasion (Johnson, 1986), and the plants typically occupy areas that contain silt loams and silt clay loams high in organic matter (Brotherson and Winkel, 1986). A single saltcedar plant can produce 500,000 seeds per year (DiTomaso, 1998) that are subsequently transported by wind or water (Brotherson and Field, 1987). In 2003, it was estimated that approximately 3.6 million acres were infested by saltcedar in 17 western states (McDaniel *et al*., 2004).

In the watersheds of Lake J.B. Thomas and the E.V. Spence and O.H. Ivie Reservoirs, these plants have become alarmingly dominant and have greatly affected water quality and water quantity because they consume large volumes of water and then transport salts from the water to the surfaces of their leaves (Wilcox *et al*., 2005). When the leaves are dropped in the fall, the salt is concentrated at the soil surface. Saltcedar continually thrives in these watersheds because it can tolerate high salinity concentrations (i.e., up to 36,000 mg/L) (UCRA, 2000; McDaniel *et al*., 2004). The E.V. Spence Reservoir and O.H. Ivie Reservoir watersheds are currently crowded with an estimated 7,000 acres and 9,000 acres of saltcedar, respectively (Boisseau, 2003).


Saltcedar

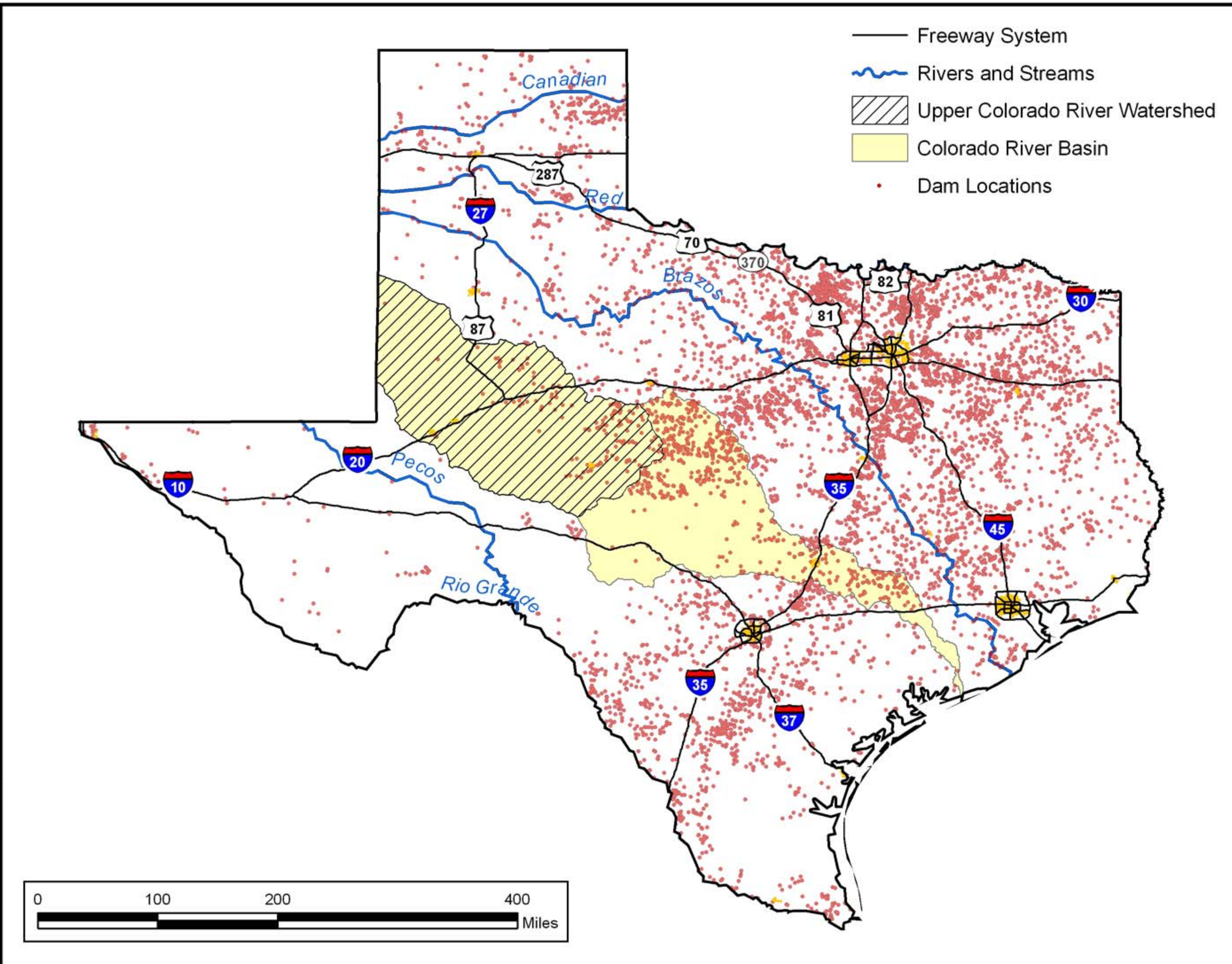
### 5.4 Land Use/Management Practices

The rapid increase of ranching and agricultural operations in West Texas during the late 1800s and early 1900s drastically altered the rangeland and farmland in the area. Livestock grazing pressure was often continuous and heavy, which reduced the ability of grasses to suppress tree seedling establishment on the rangelands, and the aggressive suppression of fires also created an environment that favored shrubs and trees rather than grasslands and savannas (TSSWCB, 2002). Livestock overgrazing resulted in reduced groundcover by grasses, destruction of riparian vegetation, and a trend toward more shrubs and trees. This produced conditions that resulted in increased sod erosion by wind and water, increased consumption of groundwater by woody species, deterioration of water quality, and reduced surface water quantity (TSSWCB, 2002; TSHA, 2005).

The European demand for food intensified following World War I, and this led many farmers in West Texas to over-expand their operations and overuse their land. Good farmland was burdened with endless cropping, and marginal land that was extremely susceptible to severe erosion and gullying was also cultivated (TSSWCB, 2002; TSHA, 2005). The amount of scrubland, woodland, and unplowed land in West Texas steadily decreased from 1900 to 1930. It has been estimated that between 1926 and 1937, land used for cotton production lost a yearly average of seven tons of soil per acre, and land used for corn production lost a yearly average of ten tons of soil per acre (TSSWCB, 2002; TSHA, 2005).

During the Great Depression, the number of farms in West Texas rapidly declined because of the extreme drought conditions and severe wind erosion; however, federal programs provided some assistance. The U.S. Soil Conservation Service (SCS) offered funding and technical expertise to local farmers and ranchers for the construction of dams, water storage tanks, and wells (TSHA, 2005). Funds were also provided to purchase seed and fertilizer and to eradicate pricklypear cactus. Currently, there are approximately 35 Natural Resource Conservation Service (NRCS) (formally SCS) dams or floodwater retarding structures in the Upper Colorado River Basin as well as over 100 other dams constructed by private and public entities (Figure 4, Texas Dam Inventory). All of these structures alter (both negatively and positively) the downstream flow regime sediment transport process. By the 1940s, proper tillage implements, contour plowing, terracing, and other soil-management efforts were in wide use throughout West Texas (TSHA, 2005). These practices were very effective for reducing soil erosion, conserving soil moisture, and improving crop yields, but they also altered drainage and runoff patterns and used water for crops rather than native vegetation (TSHA, 2005).

In the spring of 1949, a catastrophic drought began in the southern portions of Texas and spread to nearly all of the state by the summer of 1951. This drought was characterized by very low rainfall and excessively high temperatures (NOAA, 2003). Many wells, creeks, rivers, and springs that had survived previous droughts dried up completely, and water had to be hauled in by trucks to many communities. Some cities lowered their water rates to ease the cost of increased consumption, but this exacerbated the water crisis when cheaper water led to increased use (TSHA, 2005). The drought conditions devastated agricultural production in West Texas, and crop yields in some areas dropped as much as 50 percent. Low rainfall and high temperatures scorched grasslands that were typically used for livestock grazing and hay production, and as a result, many ranchers opted to feed their cattle with a mixture of pricklypear cactus and molasses (NOAA, 2003). Debt climbed into the billions and many counties experienced a reduction in population. By the end of 1956, 244 of Texas' 254 counties were declared federal disaster areas (NOAA, 2003). A year of soaking rains in 1957 ended the drought by replenishing depleted surface water reservoirs and groundwater aquifers and by returning soil moisture conditions to normal (NOAA, 2003; TSHA, 2005).




Freese and Nichols
4055 International Plaza, Suite 200
Fort Worth, TX 76109 - 4895
Phone - (817) 735 - 7300

# Texas Dam Inventory

## Colorado River Basin

| | |
|---|---|
| FN JOB NO | CMD05203 |
| FILE | Figure4.mxd |
| DATE | August 31, 2005 |
| SCALE | 1:7,000,000 |
| DESIGNED | BME |
| DRAFTED | BME |

FIGURE 4

The discovery of new oil and natural gas fields during the 1940s and 1950s brought new technologies to the region. Windmills that were previously used to supply shallow groundwater for the ranching and agricultural operations of the 1800s and early 1900s were replaced by well-drilling technologies that could pump water from greater depths (TSHA, 2005). Agricultural operations began to rely on irrigation when rainfall was unpredictable. In the 1950s through the 1970s, there were several periods when low rainfall and wind erosion damaged land in the High Plains. However, the experiences of the 1930s were avoided because of government aid, better soil-conservation practices, and irrigation (TSHA, 2005).

In the early 1980s, the SCS conducted a survey of West Texas and determined that the top five conservation problems were improper grazing management, undesirable brush and weeds, water erosion on cropland, wind erosion on cropland, and ineffective irrigation water management. During this survey, farmers cited high costs of conservation methods, absentee ownership of lands, contradictory objectives of government policies, and increased restriction on agricultural chemicals as indirect problems (TSHA, 2005). In addition to impacting agricultural production, cropland erosion also contributes to sediment loading in surface waters, including the reservoirs of the Upper Colorado River Basin. Sedimentation can fill the reservoirs, clog navigable waterways, reduce recreational use of waters, increase operating costs of water-treatment facilities, and decrease light for submerged aquatic vegetation. The CRMWD has experienced problems with sedimentation in Lake J.B. Thomas and the E.V. Spence Reservoir (TSHA, 2005).

Currently, poor rangeland management practices have increased the density of invasive plant species such as mesquite, snakeweed (*Gutierrezia* spp.), pricklypear, and sagebrush in many portions of the Rolling Plains (Telfair, 1999). In the High Plains eco-region, wind erosion is continuing to affect soils as agriculture has changed from grazing to dryland farming to irrigation. As a result of poor irrigation management practices, groundwater aquifers are also lowering at alarming rates (Telfair, 1999). The current water quality and quantity problems in the watersheds of the Upper Colorado River Basin are the results of over 100 years of anthropogenic alterations to the landscape coupled with the natural climatic and geologic features of the region. The restoration of the watersheds will not be a "quick fix," but will require a long period of time, just as the watershed problems developed over a long period of time.

## 6.0 RESTORATION AND WATER MANAGEMENT STRATEGIES

### 6.1 Current Restoration and Management Projects

Several government agencies have become involved in water quality, water quantity, and restoration issues in the Upper Colorado River Basin in the past several decades. Many of these agencies are involved in long-term management projects, whereas others are involved in short-term projects with long-term positive impacts to the watersheds.

### 6.1.1 *Colorado River Municipal Water District Reservoir Management*

In 1949, the 51st Texas Legislature authorized the creation of the CRMWD to provide water to its member cities of Odessa, Big Spring, and Snyder. The CRMWD also has contracts to provide specified quantities of water to the cities of Midland, San Angelo, Stanton, Robert Lee, Grandfalls, Pyote, and Abilene (CRMWD, 2005). In addition to the three major surface water supplies of Lake J.B. Thomas, the E.V. Spence Reservoir, and the O.H. Ivie Reservoir, the CRMWD owns and operates four groundwater well fields which are primarily used to supplement surface water deliveries during the summer months. In order to supply water to nearby communities, the CRMWD operates and maintains over 600 miles of water transmission pipelines ranging in diameter from 18 to 60 inches and 22 pump stations (CRMWD, 2005). The CRMWD also collects routine water quality samples from several locations throughout the Lake J.B. Thomas, E.V. Spence Reservoir, and O.H. Ivie Reservoir watersheds and performs analysis for sulfates, chlorides, TDS, and continuous flow (CRMWD, 2005).

*E.V. Spence Reservoir*

### 6.1.2 *River Diversion for Water Quality Control*

The CRMWD has been concerned with water quality since its establishment in 1949. In fact, the original design location of Lake J.B. Thomas was moved upstream to avoid highly mineralized water in that area of the Colorado River. In 1969, a diversion facility was constructed on the Colorado River between Lake J.B. Thomas and Colorado City (CRMWD, 2005). This facility captures highly mineralized low flow of the Colorado River and Beals Creek and deposits it in a side storage reservoir for evaporation. The higher quality flood flows bypass the diversion system and are allowed to travel downstream to the E.V. Spence Reservoir. Since

1969, the CRMWD has constructed two additional diversion systems and four off-channel storage and evaporation reservoirs (CRMWD, 2005).

### 6.1.3 *Colorado Basin Water Availability Model*

In 2001, the TCEQ developed the Water Availability Model (WAM) for the Colorado River Basin as part of a larger state-wide program authorized under Senate Bill One, the landmark water legislation passed in 1997. TCEQ developed the water availability models specifically "to determine whether water would be available for a newly requested water right or amendment" (TCEQ, 2005(b)). Although several different scenarios, referred to as "runs," were part of the original WAM program, the agency retained only two runs for use in processing permits:

- *Full Authorization (Run 3)* in which all water rights are assumed to use their full permitted amount. There are no return flows unless they are specified in a water right (100% reuse). This scenario is used to evaluate new permanent water rights or amendments.

- *Current Conditions (Run 8)* in which water rights are assumed to be used at current levels. Return flows are also set at current levels. This scenario is used to process temporary permits and amendments, usually referred to as "term" permits.

TCEQ staff maintains these two runs, updating them as new water rights applications are received. The Texas Water Development Board (TWDB) requires the use of Run 3 to determine surface water availability in Senate Bill One regional water planning.

There are several assumptions made in the WAM Run 3 that are significantly different than the historical operation of the Upper Colorado River Basin (TCEQ, 2005(b)):

- *Priority is the determining factor when allocating available water.* Water availability in Texas is determined by the Prior Appropriation Doctrine, or "first in time is first in right." In times of shortage, water is distributed based upon the priority date of the water right. In Texas, both the right to divert and the right to store water are assigned a priority date. Many rights have multiple priority dates for diversion or storage of water. The WAM models assume a perfect application of this doctrine, which would be difficult, if not impossible, to achieve in practice.

- *Storing water in a reservoir is given the same importance as diverting water for use.* For senior rights with storage, the model assumes that junior water rights can only divert if there is enough water to both completely satisfy a senior water rights diversion amount and fill all of the senior water rights empty storage. This occurs even if a senior water right does not need to store the full amount of water to make its diversion reliable. If there is not enough water to fulfill both diversion and storage requirements of senior water rights, junior water rights must either use their own stored water or, if no storage is available, the junior water right will experience a shortage.

- *All water rights divert and store water at their full authorized amounts.* Run 3 assumes that every water right in the basin stores and diverts water at the maximum amount authorized by its water right. No adjustments are made to account for storage capacity that has been lost due to accumulation of sediment in older reservoirs.

- *Instream flow requirements apply not only to the original water right, but also to all water rights junior to the original water right.* Instream flow requirements are minimum flows that must be maintained in the stream before a water right can divert or store water. Diversions by a water right may not cause flows to go below the minimum flow requirements. The TCEQ has assumed that instream flow requirements have the same priority as the associated water right. The TCEQ has also elected to impose these requirements to every upstream junior water right even if that water right has no instream flow requirements.

- *Return flows from either surface water or groundwater sources are not available unless specifically required by a water right.* Return flows consist of either surface water or groundwater that is returned to a stream after first being used for a beneficial purpose. Most return flows consist of treated municipal effluent, although other water discharged into a stream can also be considered return flow. Run 3 does not include return flows unless the water right permit specifies a volume of water that must be returned to the stream after being used.

- *Existing agreements between water right holders are not included in the model.* There are several existing agreements between major water right holders in the Upper Colorado River Basin in which the downstream senior water right holder agrees not to make priority calls on an upstream junior water right holder. These agreements make a significant difference in the water supplies for the reservoirs owned and operated by the CRMWD and Twin Buttes Reservoir.

These assumptions are appropriate for processing water rights applications. However, because of these assumptions, the WAM Run 3 does not give a realistic assessment of available water supplies or flows in the Upper Colorado River Basin. The WAM shows that most reservoirs in the Upper Colorado River Basin have no reliable supply, which is contrary to historical experience. Therefore, the WAM should be not used for other purposes without significant modifications to the assumptions used in the model (TCEQ, 2005(b)).

The WAM Run 8, the Current Conditions run, modifies assumptions about reservoir storage, authorized diversions, and return flows to reflect conditions at the time the model was developed. However, assumptions about the perfect application of prior appropriation and storage of water should be kept in mind when using this model for purposes other than processing term water rights applications (TCEQ, 2005(b)).

### 6.1.4 *Saltcedar Control Project*

As mentioned previously, saltcedar is a particularly detrimental invasive plant species that has reduced water quantity and quality in the Upper Colorado River Basin. In an effort to increase water yield and reduce salt concentrations in the E.V. Spence Reservoir, the Texas State Soil and Water Conservation Board (TSSWCB) has initiated a saltcedar control project which includes spraying an herbicide to eradicate mass concentrations of saltcedar and then using a leaf beetle for biological control of new plant growth. Saltcedar control was listed as a Best Management Practice (BMP) in the *Implementation Plan for Sulfate and Total Dissolved Solids (TDS) TMDLs in the E.V. Spence Reservoir (Segment 1411)*, which will be discussed in the next section. Previously, shredding has been used to remove saltcedar; however, this technique only slows plant growth. The herbicide that will be used in this project, Arsenal, is slow-acting and non-toxic to animals. It has been approved by the Texas Department of Agriculture (TDA) and the U.S. Environmental Protection Agency (EPA) for use on saltcedar in selected counties (Boisseau, 2003; CRMWD, 2004; TSSWCB, 2004).


*Saltcedar Stands along the Colorado River*

The spraying portion of the project is anticipated to take two years, and it will be managed in two phases. During the first year, the treatment will begin along the Colorado River from below Lake Thomas Dam to the confluence of Beals Creek in Mitchell County from August through September 2005 (TSSWCB, 2004). Beals Creek from near Big Spring to its confluence with the Colorado River will also be treated at that time. The second year will complete the Colorado River and include the shoreline and basin of Lake Spence from August through September 2006 (TSSWCB, 2004). Throughout the project, approximately 9,775 total acres are expected to be treated along 270 river miles. A planned future project will include treatment of areas around the O.H. Ivie Reservoir from August through September 2007 and August through September 2009 (TSSWCB, 2004).

After the herbicide has been used to eradicate massive saltcedar stands, leaf beetles that have an exclusive appetite for saltcedar will be used to control new growth. The beetle that is currently being tested is from Crete and is a sub-species of *Diorhabha elongata*, an olive-colored leaf beetle that measures about ¼-inch from end to end (CRMWD, 2004). Entomologists and range specialists from the Texas Cooperative Extension (TCE), Texas A&M University (TAMU), and the U.S. Department of Agriculture (USDA) have been studying this beetle at sites near Big Spring (CRMWD, 2004). Preliminary results using this beetle have been positive. In one study, saltcedar plants died after they were stripped twice by the beetle larvae (CRMWD, 2004).

#### 6.1.5 *Total Maximum Daily Load Projects*

The TCEQ administers a Total Maximum Daily Load (TMDL) Program for surface water bodies in the state of Texas. In this program, water quality analyses are performed for water bodies to determine the maximum load of pollutants the water body can handle and still support its designated uses (TCEQ, 2005(c)). The load is then allocated to potential sources of pollution in the watershed and implementation plans are developed which contain measures to reduce the pollutant loads. The *Implementation Plan for Sulfate and Total Dissolved Solids (TDS) TMDLs in the E.V. Spence Reservoir (Segment 1411)* was established in August 2001, and the TCEQ is currently analyzing the Colorado River below E.V. Spence Reservoir (Segment 1426) for chloride, sulfate, and TDS concentrations (TCEQ, 2005(c)).

### 6.2 Proposed Restoration and Management Strategies

In order to restore Concho water snake habitat and improve the environmental health of the Upper Colorado River Basin as a whole, a combination of saltcedar control, upland brush management, and riparian restoration should be undertaken. Each of these strategies will require significant funding sources, but these funding sources can possibly overlap. In addition to funding, education and awareness of landowners and the general public must be increased. If the public is educated on the importance of watershed health, and successes of initial restoration and management projects can be quantified, funding for future projects will follow.

<u>Restoration & Management Strategies</u>

- Saltcedar Control
- Upland Brush Management
- Riparian Restoration
- Geographic Information Systems
- Public Education and Awareness

#### 6.2.1 *Saltcedar Control*

One of the most crucial aspects of improving water quality and quantity in the Upper Colorado River Basin is the control of saltcedar. The CRMWD, in cooperation with the TCE, the TDA, the USDA Agricultural Research Service (USDA-ARS), and the TSSWCB, is currently undertaking the massive chemical and biological control program discussed in a previous section. This project is an excellent first step in the recovery of the Upper Colorado River Basin back to many of its prior infestation functions, including native riparian habitat for wildlife and improved habitat for fish and other aquatic organisms.

As mentioned previously, saltcedar has had a negative impact on the watersheds in the Upper Colorado River Basin because these plants consume large quantities of water and increase the salinity of surrounding soils. Dense saltcedar stands can also narrow channels and divert water flows, leading to increased erosion, sedimentation, and possible flooding in areas that do not usually carry flood waters (Lovich, 2000; UCRA, 2000). Because saltcedar grows most successfully along the edges of water bodies, these detrimental effects have negatively impacted Concho water snake habitat, including riffles. When saltcedar stands crowd riffle areas, the balance of high velocity, shallow water is disrupted, and these areas are no longer as suitable for the snakes to forage and seek refuge. Because saltcedar alters the geomorphology of stream channels by stabilizing sediments and reducing width, depth, and water-holding capacity (Dudley *et al*., 2000; Lovich, 2000), the removal or control of saltcedar will encourage reformation of riffle areas, increase stream flow, and reduce sediment deposition. This will improve in-stream habitat for the Concho water snake and other aquatic species.

### 6.2.2 *Upland Brush Management*

Invasive brush species such as juniper and mesquite have become dominant in upland areas of the Upper Colorado River Basin and as a result, water quantity has been greatly affected in West Texas. The NRCS estimates that brush in Texas uses approximately 10 million acre-feet of water annually, versus 15 million acre-feet per year for human use and consumption (TSSWCB, 2002). As woody cover increases, costs of management for ranching operations also increase and livestock carrying capacity decreases. Thus, ranchers have a vested interest in controlling brush on their property. In addition, upland brush control can also positively affect surface water supplies, groundwater aquifer supplies, and spring flows in West Texas (TSSWCB, 2002).

The proliferation of invasive brush species is primarily due to altered grazing and fire characteristics on rangelands during initial European settlement in West Texas. Livestock grazing pressure was often continuous and heavy, which reduced the ability of grasses to suppress tree seedling establishment on the rangelands (Archer, 1994). Juniper and mesquite also have noxious chemicals in their leaves, so livestock would avoid consuming these tree seedlings and instead opt for more palatable grasses (Archer, 1994; TSSWCB, 2002). Also, European settlers often aggressively suppressed fires, which in combination with heavy grazing pressures, created an environment that favored increased dominance of shrubs and trees rather than grasslands or savannas (Archer, 1994; TSSWCB, 2002).

The NRCS is currently involved in brush management projects in several counties in West Texas. Eligible practices for the removal of brush are included in the following list. Further information regarding cost-shares, incentive payments, and landowner eligibility requirements for NRCS programs will be discussed in a later section.

- chemical or biological brush management practices;
- mechanical treatment including pitting, contour furrowing, ripping, shearing, grubbing, or subsoiling;
- prescribed burning;
- range planting of native perennial vegetation (e.g., grasses and forbs in the uplands and trees and shrubs in riparian areas);
- fencing as a barrier to livestock; and
- watering facilities for livestock to protect and enhance vegetative cover through proper distribution of grazing.

### 6.2.3 *Riparian Restoration*

Riparian areas along the Colorado River and its tributaries play a vital role in improving water quality, preserving biodiversity, and protecting streamside environments. However, in many places in West Texas, riparian areas have been destroyed through the elimination of native vegetation, which is caused by the proliferation of native brush species and constant heavy livestock grazing practices (Archer, 1994; Teague *et al*., 2001). In many parts of the United States, riparian buffer zones have been designed and engineered to protect and enhance surface and groundwater quality and aquatic ecosystem health in areas where natural riparian zones have previously been destroyed.

These man-made riparian buffers intercept and remove nutrients, sediments, organic matter, certain pesticides, and other pollutants from surface runoff and shallow subsurface flow from upland sources prior to entry into surface water bodies (Jacobs and Gilliam, 1985; Oklahoma Cooperative Extension Service, 1998). The riparian buffers accomplish this by deposition, absorption, plant uptake, and denitrification (Oklahoma Cooperative Extension Service, 1998). Riparian buffers can also preserve the natural breeding, foraging, and resting areas of native wildlife species (Zale *et al*., 1989; Oklahoma Cooperative Extension Service, 1998).

***Natural Riparian Areas along the Colorado River at U.S. Highway 277***

The Concho water snake could benefit from the installation of these types of buffers. However, riparian buffers must be used in conjunction with sound upland management, saltcedar control, and juniper and mesquite brush control to be effective. They are not intended to mitigate the effects of poor rangeland or cropland management above the riparian zone; rather, they should complement these techniques to enhance water and critical habitat protection (Oklahoma Cooperative Extension Service, 1998). If man-made riparian buffers are utilized in West Texas, the types of native riparian species planted, the amount of plantings, and the sizes of the riparian buffers will be determined based on the soil types, current range management practices, current hydrology, and funding availability for each area considered. There are several programs that currently offer assistance to landowners interested in protecting riparian areas. Two NRCS programs use the following eligible practices in their associated projects and will be discussed in more detail in a later section:

- mechanical, chemical, or biological brush management practices;
- prescribed burning;
- range planting of perennial vegetation; and
- prescribed grazing in accordance with plant sensitivities and management goals.

### 6.2.4 *Geographic Information Systems*

A GIS database will be established and used for storing, managing, and using information pertinent to the watersheds of the Upper Colorado River Basin. This GIS database will be useful for mapping and understanding the topography, soils, water bodies, and locations of man-made structures in the watershed. In addition, GIS can be used as an environmental management and water modeling tool to determine the effectiveness of restoration and management activities if surface water data from the monitoring stations upstream and downstream of the restoration activities are incorporated and compared. The structure of the GIS database will be described in more detail in the Implementation Plan that will be prepared after the approval of this restoration and management plan.

### 6.2.5 *Public Education and Awareness*

The majority of the programs administered by governmental organizations such as the NRCS are greatly dependent upon landowner participation, especially in areas such as the Upper Colorado River Basin where the majority of the land is privately owned. Many landowners are reluctant to become involved in programs if they have to pay a portion of the costs for implementation of the eligible practices, and although increased funding in the form of cost-shares and incentive payments might quell this reluctance, landowner education should not be discounted. Landowners should be educated on the importance of saltcedar control, upland brush management, sustainable grazing, riparian restoration, and the reestablishment of native vegetation in grassland and riparian corridor climax communities in order to stress the value of these strategies to the overall health of the watershed and future water supplies in West Texas. Educational materials can be provided to landowners through direct mail-outs and visits from personnel affiliated with governmental and non-governmental agencies such as the TPWD and the TCE, respectively. Also, a participating landowner in this area, who is willing to volunteer, could be designated to lead the effort and encourage others to participate.

In addition to educating the landowners themselves, the general public should also be made aware of the critical situations affecting water quality, water quantity, and overall environmental health of the watersheds in the Upper Colorado River Basin. A website should be designated to these restoration and management issues and consistently updated to keep the public aware of changing conditions in their watersheds. Educational materials can be disseminated through pamphlets in utility bills, a public exhibit possibly sponsored by local environmental organizations, and/or in school programs, like the Major Rivers Program (TCEQ), which stress the importance of water conservation. Writers from local environmental and agricultural organizations can possibly submit articles to local newspapers and organization publications discussing the importance of these issues. Successes of individual projects should also be presented in a public symposium to keep landowners and the general public aware of the progress occurring in the watersheds. In addition, a designated individual should be assigned to monitor the dissemination of information to the landowners and the general public.

One of the primary difficulties in the Upper Colorado River Basin is that many of the governmental funding options are limited to individual landowner participation rather than on a larger scale including a whole watershed. In order to pursue unprecedented large-scale sources of funding, a task force should be formed, possibly led by the CRMWD or one of its member cities (Odessa, Big Spring, and Snyder) to meet and discuss the progress of projects occurring within the Upper Colorado River Basin watersheds, while meeting on a regular basis. In these meetings, the task force should not only discuss the progress of small-scale landowner dependent projects, but they should also plan presentations for local congressmen and senators which could possibly lead to federal or state funding and/or a proclamation for a watershed-scale project. In addition, stakeholder meetings involving personnel from pertinent governmental and non-governmental agencies, and possibly landowners, should be held periodically. Two stakeholder meetings have already been held in preparation for this Upper Colorado River Watershed Restoration and Management Plan. During these meetings, topics such as related projects in and around the Upper Colorado River Basin, prioritization of watershed concerns, landowner awareness/education, and funding were discussed. Ideas and feedback from these meetings were incorporated into this plan, and summaries from both of these meetings are provided in Appendix E.

### 6.3 Potential Restoration and Management Funding Sources

Several governmental and non-governmental sources of funding can potentially be utilized for the implementation of the restoration and water management strategies presented in this plan. Table 1 contains a brief listing of several government grants and the organizations that administer them, as well as basic information about the programs. Appendix F contains more detailed information about the grants that are listed in Table 1. It is recommended that a grant writer be utilized to acquire funding from these sources.

As mentioned previously, in order for the solutions presented in this plan to be successful, education and awareness of landowners must be increased. Many non-governmental sources of funding, such as volunteer organizations, can be used for technical and educational assistance. Many of the following organizations and programs may be able to provide this crucial support:

- Local cattle and rancher's associations;
- National Wild Turkey Federation;
- Nature Conservancy Sustainable Rivers Project;
- Texas Parks and Wildlife Department (TPWD);
- Texas Cooperative Extension (TCE); and
- Texas State Soil Water and Conservation Board (TSSWCB).

## Table 1. GOVERNMENT FUNDING SOURCES

| Grant Name | Agency | Ownership | Land Type | Goals | Notes |
|---|---|---|---|---|---|
| Landowner Incentive Program (LIP) | USFWS | Private | Can support rare species | Provide rare species habitat | Applicant contribution ~25% |
| Private Stewardship Grants Program | USFWS | Private | All types | Native, at-risk species habitat restoration | Up to 90% funding |
| Wildlife Habitat Incentive Program (WHIP) | NRCS | All types of lands (has restrictions) | All types | Improve fish and wildlife habitat | Max 75% funding |
| Partners for Fish and Wildlife Program | USFWS | Not state/federal lands | All types | Habitat Restoration | ~50% Funding |
| Environmental Quality Incentive Program (EQIP) | NRCS | Private | Farm/ Ranchland | Agricultural Production coexisting with environmental quality | Up to 90% funding and incentives |
| Conservations Security Program (CSP) | NRCS | Private | Working land within selected watershed | Conserve and improve environmental factors | 5-10 yr contracts with annual payments up to $45,000 |
| Cooperative Endangered Species Conservation Grants | USFWS | State | All types | Conservation projects for federally listed threatened or endangered species | 4 different grant options |
| State & Tribal Wildlife Grant Program | USFWS | State FW agencies | | Wildlife habitat protection | |
| Continuous Conservation Reserve Program (CCRP) | NRCS | Private | Cropland | Encourages environmental enhancement | Rental payments for converted farmland, cost-sharing for some projects |
| Grassland Reserve Program (GRP) | NRCS | Private | Grassland | Protect, restore, or enhance grasslands | Up to 90% of restoration costs |
| Farm and Ranch Lands Protection Program (FRPP) | NRCS | Farm/ Ranchland | See Requirements | Acquire conservation easements | Matching funds to purchase development rights |
| Wetland Reserve Program (WRP) | NRCS | Unrestricted | Wetlands | Restoration, creation, enhancement, easement | Max 75% funding |
| North American Wetlands Conservation Act – Small Grants | USFWS | Unrestricted | Wetlands | Long-term wetland conservation | Max request $50,000 |
| Water Conservation Field Services Program | Bureau of Reclamation | Unrestricted | N/A | Technical help to begin implementing conservation measures | Also provides funds for constructing improvements to conserve water |
| National Integrated Water Quality Program | Dept of Agriculture | Institutions of Higher Education | | Contribute to improvement of water through research, education, and extension activities | This would require a partnership with a college or university |
| Water Quality Management Plan | TSSWCB | Private | Agriculture | Land improvement measures | Incentives are for agricultural BMPs |
| Grazing Lands Conservation Initiative (GLCI) | NRCS | Private | Grazing Lands | Support conservation activities on private grazing lands | Funds to be used directly for technical assistance and public awareness activities |

## 6.4 Most Viable Funding Options

Several governmental and non-governmental assistance programs are applicable for the Upper Colorado River Basin watersheds; however, the Environmental Quality Incentive Program (EQIP) and the Continuous Conservation Reserve Program (CCRP) appear to be the most viable options for implementing restoration and water management strategies.

### 6.4.1 *Environmental Quality Incentive Program (EQIP)*

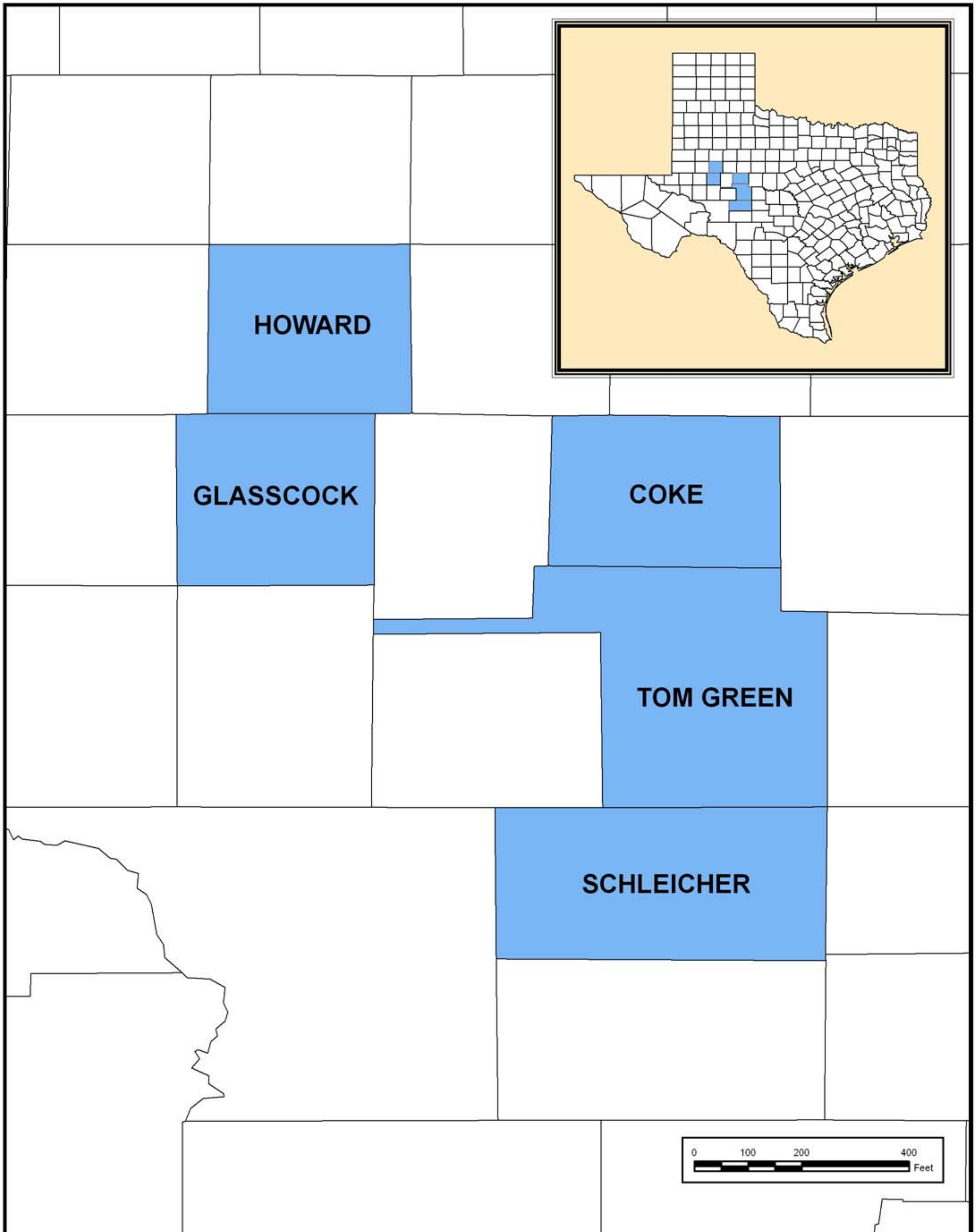
The EQIP, which is managed by the NRCS, is a voluntary conservation program for farmers and ranchers that offers financial and technical assistance to install or implement structural controls and management practices on eligible agricultural land. These activities are carried out according to an EQIP plan of operations and are subject to NRCS technical standards that are adapted for local conditions.

The EQIP offers contracts with a minimum term that ends one year after the implementation of the last scheduled practices and a maximum of ten years. Eligible participants will receive incentive payments for a maximum of three years and cost-shares of up to 75 percent of the costs for implementation. Limited resource producers and beginning farmers and ranchers may be eligible for cost-shares up to 90 percent; however, combined cost-share and incentive payments may not exceed $450,000 for an individual contract. Three specific EQIP programs beneficial for the Upper Colorado River Basin are summarized below. Detailed information regarding ranking, priority, and eligibility criteria can be found in the NRCS program data sheets located in Appendix G.

- The EQIP 2004 North Concho Brush Control program offers contracts with cost-shares of 50 percent (60 percent for limited resource farmers and ranchers) to individuals that will implement brush management practices in selected watersheds in West Texas. The counties of Coke, Glasscock, Howard, Schleicher, and Tom Green are listed as primary areas of concern (Figure 5).

- The EQIP 2004 Invasive Species program focuses on the eradication of invasive saltcedar on private agricultural land. Several counties in the Upper Colorado River Basin have been classified as medium priority locations (Figure 6). This program offers cost-shares of 75 percent for utilizing brush management (chemical or mechanical) and 50 percent for range planting following the brush management practices. Beginning farmers and ranchers, however, are eligible for cost-shares of 75 percent for brush management and 60 percent for range planting. Incentives of $0.50 per acre per year are also available for participants.

- Several West Texas counties are potentially eligible to participate in the EQIP 2004 Bobwhite Quail (*Colinus virginianus*) program (Figure 7). Selected participants must utilize prescribed grazing, brush management, prescribed burning, or range planting




Freese and Nichols
4055 International Plaza, Suite 200
Fort Worth, TX 76109 - 4895
Phone - (817) 735 - 7300

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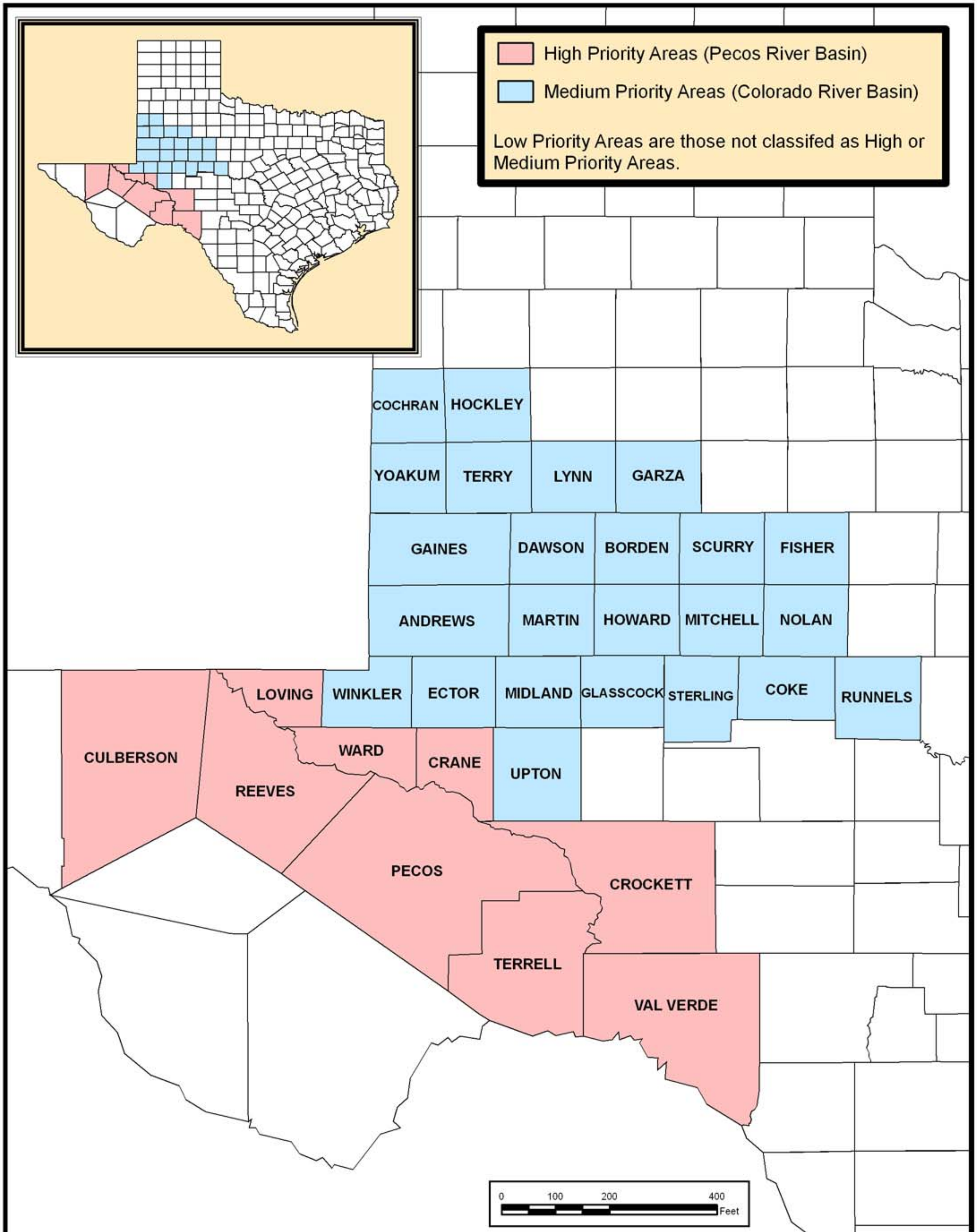
EQIP 2004 State Resource Concern
North Concho Brush Control

**Primary Areas of Concern**

| | |
|---|---|
| FN JOB NO | CMD05203 |
| FILE | H:/Brush Control.mxd |
| DATE | August 2005 |
| SCALE | 1:3,000 |
| DESIGNED | MMV |
| DRAFTED | MMV |

FIGURE 5




**Freese and Nichols**
4055 International Plaza, Suite 200
Fort Worth, TX 76109 - 4895
Phone - (817) 735 - 7300

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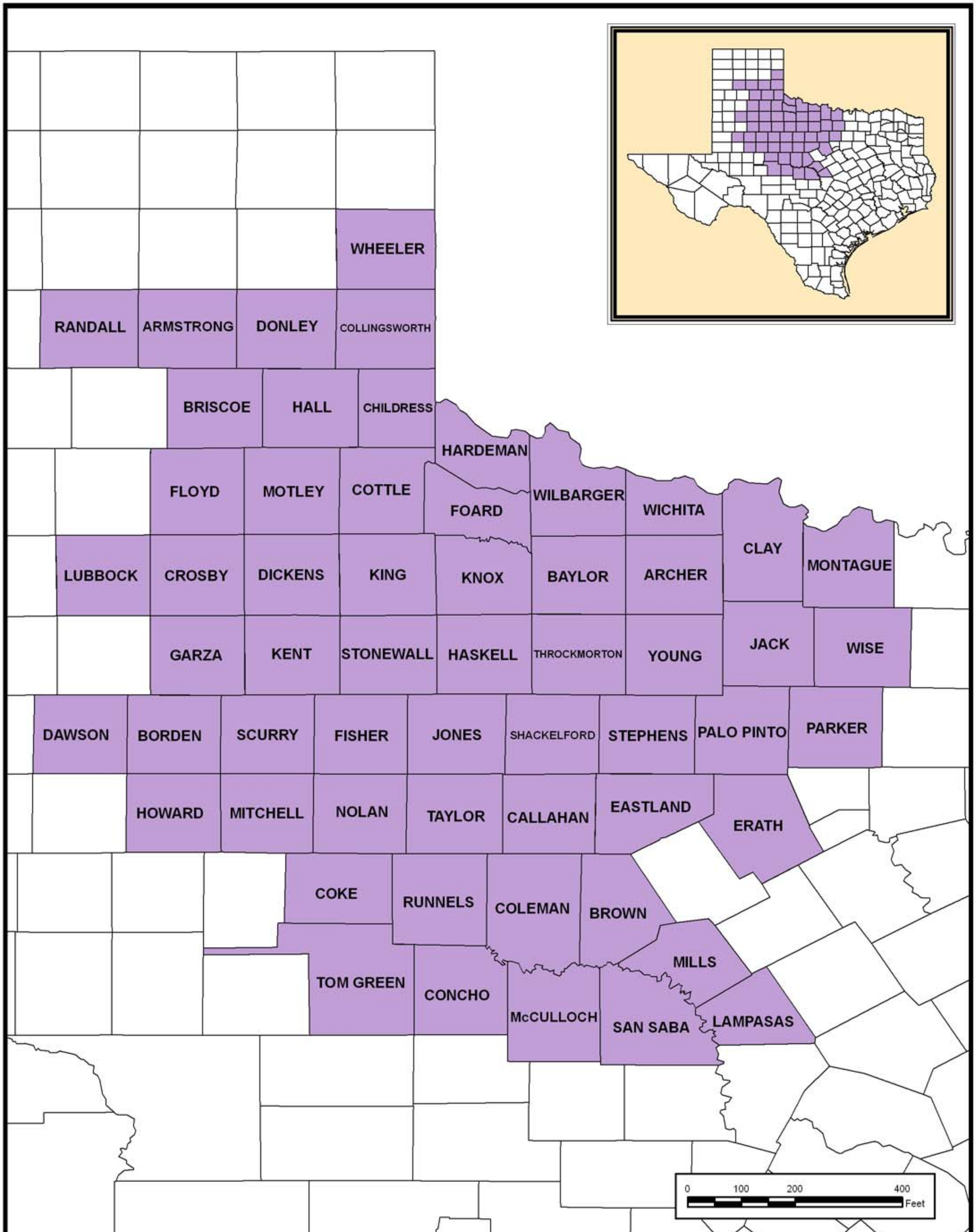
**EQIP 2004 Invasive Species**
**Invasive Species - Saltcedar**

**Priority Areas for Funding**

| | |
|---|---|
| FN JOB NO | CMD05203 |
| FILE | H:/Invasive Species.mxd |
| DATE | August 2005 |
| SCALE | 1:3,000 |
| DESIGNED | MMV |
| DRAFTED | MMV |

**6**

**FIGURE**




**Freese and Nichols**
4055 International Plaza, Suite 200
Fort Worth, TX 76109 - 4895
Phone - (817) 735 - 7300

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**Texas EQIP State Resource Concern**
**Rolling Plains - Grassland Bird - Bobwhite Quail**

# Priority Areas of Concern

| | |
|---|---|
| FN JOB NO | CMD05203 |
| FILE | H:/Bobwhite Quail.mxd |
| DATE | August 2005 |
| SCALE | 1:3,000 |
| DESIGNED | MMV |
| DRAFTED | MMV |

**7**

**FIGURE**

on their property to benefit quail and other grassland birds. This program offers cost-shares of 50 percent; however, limited resource farmers and ranchers will receive a cost-share of 60 percent. Incentives of $5 per acre are also available for participants.

### 6.4.2 *Continuous Conservation Reserve Program (CCRP)*

The CCRP, which is funded through the Commodity Credit Corporation (CCC) and partly administered by the NRCS, provides technical and financial assistance to eligible farmers and ranchers to address environmental concerns on their lands. In the watersheds of the Upper Colorado River Basin, this assistance could be particularly beneficial for the implementation of riparian buffer zones. Many of the perennial and intermittent creeks in the Lake J.B. Thomas, E.V. Spence Reservoir, and O.H. Ivie Reservoir watersheds are eligible for enrollment.

Landowners must agree to participate in this program for a period of 10 to 15 years, and during this time, grazing activities must be ceased in the riparian buffer zones. This cessation will allow for growth and the establishment of desirable riparian vegetation. The width of the buffer zones may vary from site to site, but the maximum width is 360 feet (i.e., 180 feet on each side of a creek).

This program will provide individuals with an up-front signing bonus of $100 to $150 per acre, an annual rental payment ranging from $28 to $46 per acre, and a reimbursement of 90 percent for the cost of fencing and certain types of brush control. Portions of the annual rental payment are earmarked towards the maintenance of saltcedar control because the landowner is obligated to do follow up saltcedar control for the entire enrollment period.

## 7.0 SUMMARY

This Upper Colorado River Watershed Restoration and Management Plan fulfills the requirement and additional element set forth by the USFWS in the December 2004 revised Biological Opinion by addressing the enhancement and restoration of the watersheds of the Upper Colorado River Basin and by providing a selection of strategies for implementation of the restoration and water management solutions. This plan was developed with the input, feedback, and cooperation of several governmental and non-governmental stakeholders.

Studies by Thurow and Hester (1997) have shown that at juniper brush sites with 12 to 35 inches per year of precipitation, the majority of precipitation is used for evapotranspiration. With partial brush removal, 16 percent of precipitation went to deep drainage compared to none on an untreated watershed. The increase in water that percolates into groundwater may become stream flow. Saltcedar roots in riparian areas access shallow groundwater that is often hydrologically connected to streams, rivers, and lakes (Wilcox *et al*., 2005). In order to restore the habitat of threatened and endangered species such as the Concho water snake, and improve the environmental health of the Upper Colorado River Basin as a whole, a combination of saltcedar control, upland brush management, riparian restoration, and the reestablishment of native grasslands in upland areas should be undertaken. Other management strategies such as changing agricultural practices, urban storm water management, and water conservation were not considered feasible, implementable, or fundable under this plan. This plan's recommended restoration and management solutions are those considered to have a realistic chance of being implemented and funded at some level.

Each of these strategies to improve the environmental health of the Upper Colorado River Basin will require significant funding sources; however, these funding sources are crucial to the success of the plan. In addition to funding, education and awareness of landowners and the general public must be increased. If the public is educated on the importance of watershed health, and successes of initial restoration and management projects can be quantified, funding for future projects will follow. This plan, including the Implementation Plan, describes strategies and best management practices that are designed to accomplish the objective of long-term restoration and management of the watersheds of the Upper Colorado River Basin.

# 8.0 IMPLEMENTATION PLAN

## 8.1 Introduction

### 8.1.1 *Purpose and Scope*

In December 2004, the U.S. Fish and Wildlife Service (USFWS) issued a revised Biological Opinion as a result of a consultation with the U.S. Army Corps of Engineers (USACE) on the proposed water operations by the Colorado River Municipal Water District (CRMWD) on the Colorado and Concho Rivers and its effect on the Concho water snake (*Nerodia harteri paucimaculata*). The terms and conditions in the Opinion included the requirement that the CRMWD study a methodology for riparian rehabilitation and restoration of the watersheds of the Upper Colorado River Basin and seek funding for implementation of the recommendations presented in the study.

The Upper Colorado River Watershed Restoration and Management Plan (UCRWRMP), Sections 2.0 through 7.0 above, has been approved by the USFWS. This Implementation Plan, together with the UCRWRMP, fulfills the requirement and contains a suite of strategies and activities to be implemented over time by the CRMWD in cooperation with several government and non-government entities. This Implementation Plan discusses these strategies and funding options in more detail and outlines the responsible parties for implementation of the various components introduced in the UCRWRMP. This Implementation Plan recognizes that as conditions and opportunities change over time, adaptive strategies should be implemented to take advantage of unforeseen opportunities for watershed restoration or funding.

In addition to this effort, a population status update and genetic evaluation of the *Nerodia harteri* species complex is presently underway (Reilly *et al*., 2005). These researchers have completed field work and collected tissue and blood samples from both subspecies (*Nerodia harteri harteri* and *Nerodia harteri paucimaculata*) in an effort to examine DNA and gene flow and make inferences on their genetic relationship and taxonomic status. The field work on the Concho water snake conducted in 2004 and 2005 confirmed the snake's population status as persisting in suitable habitat, despite the drought. Their work also confirmed that reproduction is occurring at sites on both the Concho and Colorado Rivers, in the E.V. Spence and O.H. Ivie Reservoirs, and in the Ballinger Municipal Lake (formerly Lake Moonen). This study will be completed in 2006 and a final report submitted to the USFWS.

### 8.1.2 *Objective*

The strategies in the UCRWRMP that have been proposed for the watersheds of the Upper Colorado River Basin include chemical and biological saltcedar (*Tamarix* spp.) control, upland brush management and the reestablishment of native grasses in these upland areas, riparian restoration, and the increased education and awareness of landowners and the general public. Implementation of the full set of recommendations will address the goals of increased water quantity, improved water quality, upland management, and restored riparian habitats in the upper Colorado River and some of its tributaries, thereby helping to restore conditions beneficial to the Concho water snake, such as an increased prey base, increased water flows, and more feeding habitat.

## 8.2 Watershed Restoration and Management Responsibilities

As discussed in the UCRWRMP, the watersheds for Lake J.B. Thomas, E.V. Spence Reservoir, and O.H. Ivie Reservoir are the focus areas in the aforementioned plan and this Implementation Plan. Because the CRMWD owns and operates these surface water supplies, it will be the facilitator for implementing most of the recommendations, but certain tasks can be divided among several different government and non-government groups that have agreed to participate in the implementation phase of this project.

There are several government grants that can potentially be utilized for the implementation of the restoration and water management strategies. These grant programs are mentioned in Section 6.0 and they will be discussed in more detail in this Implementation Plan. Some non-government entities such as volunteer organizations may be able to provide additional funding for the implementation of the recommended actions, but these organizations will be most helpful in providing educational and technical assistance. Other government organizations can also be utilized for technical assistance.

In instances where the tasks will be divided among these groups, the CRMWD will facilitate delegation of these tasks and act as a liaison for managing all restoration activities that are taking place in the watersheds. The CRMWD may:

- ***Coordinate with the Texas Cooperative Extension (TCE) in Organizing Education and Public Awareness Literature*** – This task involves formulating and organizing information to be disseminated to landowners and the general public in direct mail-outs, public exhibits, school programs, etc.
- ***Cooperate with the TCE, the Natural Resources Conservation Service (NRCS), and Soil and Water Conservation Districts (SWCDs) to Manage Information***

***Dissemination*** – This task involves managing the dissemination of the educational and informative material to landowners and the general public.

- ***Be the Lead Agency for Organizing Task Forces and Stakeholder Meetings*** – This task involves periodically gathering interested parties or stakeholders to discuss funding issues and document the progress and results of activities occurring in the watersheds.
- ***Manage and Update the Geographic Information Systems (GIS) Database*** – This database will be a subset of the CRMWD's in-house GIS program. The database will include appropriate and relevant watershed base layers which may include:
    - USGS topographic base maps;
    - TNRIS DOQQ aerial photographs;
    - Watershed or hydrologic boundaries from the USGS and the USEPA;
    - Land use and vegetation cover types;
    - Areas of brush control treatment by other entities; and
    - NRCS soil maps.

## 8.3 Watershed Restoration and Management Strategies

### 8.3.1 *Saltcedar Control*

Extensive chemical and biological saltcedar control projects are currently being executed in the watersheds of the Upper Colorado River Basin. These control projects include spraying an herbicide to eradicate mass concentrations of saltcedar and then using a leaf beetle for biological control of new plant growth. These projects are crucial to the recovery of the Upper Colorado River Basin back to many of its prior infestation functions, including native riparian vegetation habitat for wildlife and improved in-stream habitat for the Concho water snake, fish, and other aquatic organisms. Specifically, the removal or control of saltcedar will increase water quantity, improve water quality, encourage reformation of riffle areas, increase stream flow, and reduce sediment deposition in the upper Colorado River and its tributaries (Dudley *et al*., 2000; Lovich, 2000; UCRA, 2000). Replanting of saltcedar control areas may be possible, but the areas would need to be evaluated on a case-by-case basis based on site specific conditions (soils, topography, etc.) and intended land management (wildlife habitat, grazing, etc.).

These saltcedar control projects are currently being implemented by the Texas State Soil and Water Conservation Board (TSSWCB) in cooperation with the local SWCDs, the CRMWD, the TCE, the Texas Department of Agriculture (TDA), and the U.S. Department of Agriculture Agricultural Research Service (USDA-ARS). The specific tasks, implementation schedule, and responsible entities are provided in Table 2.

**Table 2. SALTCEDAR CONTROL**

<table>
<tr><th>Year 1 - 2005</th><th>Year 2 - 2006</th><th>Year 3 - 2007</th><th>Year 4 - 2008</th><th>Year 5 - 2009</th><th>2010 – 2030</th></tr>
<tr><td rowspan="3">Chemical treatment along the Colorado River from below Lake Thomas Dam to the confluence of Beals Creek in Mitchell County and Beals Creek from near Big Spring to its confluence with the Colorado River<br>Responsible Entities:<br>Local SWCDs, TSSWCB, CRMWD, TCE</td><td colspan="5">Implement biological control in all chemically treated areas; Responsible Entities: USDA-ARS, local SWCDs, CRMWD, TAMU-TCE, TDA</td></tr>
<tr><td rowspan="2">Conduct water quality monitoring program for all chemically treated areas (details are discussed in the Watershed Monitoring Plan)<br>Responsible Entities:<br>CRMWD</td><td rowspan="2">Continue water quality monitoring program; begin post-delisting monitoring for CWS.<br>Responsible Entities:<br>CRMWD, USFWS, TPWD, NGOs</td><td rowspan="2">Continue water quality monitoring program; continue post-delisting monitoring for CWS<br>Responsible Entities:<br>CRMWD, USFWS, TPWD, NGOs</td><td rowspan="2">Continue water quality monitoring program; continue post-delisting monitoring for CWS<br>Responsible Entities:<br>CRMWD, USFWS, TPWD, NGOs</td><td>Continue water quality monitoring program; continue post-delisting monitoring for CWS (completed in year 2011)<br>Responsible Entities:<br>CRMWD, USFWS, TPWD, NGOs</td></tr>
<tr><td>Analyze all previously collected data and re-evaluate monitoring program every five (5) years<br>Responsible Entities:<br>CRMWD, USFWS, TPWD</td></tr>
<tr><td rowspan="3">[See Section 6.0 for additional information on buffer widths, revegetation species, and funding options.]</td><td rowspan="3">Chemical treatment of selected tributaries and the Colorado River into the upper basin of Lake Spence<br>Responsible Entities:<br>Local SWCDs, TSSWCB, CRMWD, TCE</td><td colspan="4">Implement biological control in all chemically treated areas; Responsible Entities: USDA-ARS, local SWCDs, CRMWD, TAMU-TCE, TDA</td></tr>
<tr><td rowspan="2">Continue water quality monitoring program; begin post-delisting monitoring for CWS.<br>Responsible Entities:<br>CRMWD, USFWS, TPWD, NGOs</td><td rowspan="2">Continue water quality monitoring program; continue post-delisting monitoring for CWS<br>Responsible Entities:<br>CRMWD, USFWS, TPWD, NGOs</td><td rowspan="2">Continue water quality monitoring program; continue post-delisting monitoring for CWS<br>Responsible Entities:<br>CRMWD, USFWS, TPWD, NGOs</td><td>Continue water quality monitoring program; continue post-delisting monitoring for CWS (completed in year 2011)<br>Responsible Entities:<br>CRMWD, USFWS, TPWD, NGOs,</td></tr>
<tr><td>Analyze all previously collected data and re-evaluate monitoring program every five (5) years<br>Responsible Entities:<br>CRMWD, USFWS, TPWD</td></tr>
<tr><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3">Chemical treatment of the remaining shoreline and basin of Lake Spence<br>Responsible Entities:<br>TSSWCB, CRMWD, TCE</td><td colspan="3">Implement biological control in all chemically treated areas; Responsible Entities: USDA-ARS, local SWCDs, CRMWD, TAMU-TCE, TDA</td></tr>
<tr><td rowspan="2">Continue water quality monitoring program; continue post-delisting monitoring for CWS<br>Responsible Entities:<br>CRMWD, USFWS, TPWD, NGOs</td><td rowspan="2">Continue water quality monitoring program; continue post-delisting monitoring for CWS<br>Responsible Entities:<br>CRMWD, USFWS, TPWD, NGOs</td><td>Continue water quality monitoring program; continue post-delisting monitoring for CWS (completed in year 2011)<br>Responsible Entities:<br>CRMWD, USFWS, TPWD, NGOs</td></tr>
<tr><td>Analyze all previously collected data and re-evaluate monitoring program every five (5) years<br>Responsible Entities:<br>CRMWD, USFWS, TPWD</td></tr>
<tr><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3">Chemical treatment of Colorado River and tributaries above O.H. Ivie Reservoir<br>Responsible Entities:<br>Local SWCDs, TSSWCB, CRMWD, TCE</td><td colspan="2">Implement biological control in all chemically treated areas<br>Responsible Entities: USDA-ARS, local SWCDs, CRMWD, TAMU-TCE, TDA</td></tr>
<tr><td rowspan="2">Continue water quality monitoring program; continue post-delisting monitoring for CWS<br>Responsible Entities:<br>CRMWD, USFWS, TPWD, NGOs</td><td>Continue water quality monitoring program; continue post-delisting monitoring for CWS (completed in year 2011)<br>Responsible Entities:<br>CRMWD, USFWS, TPWD, NGOs</td></tr>
<tr><td>Analyze all previously collected data and re-evaluate monitoring programs every five (5) years<br>Responsible Entities:<br>CRMWD, USFWS, TPWD</td></tr>
<tr><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3">Chemical treatment of O.H. Ivie Reservoir basin<br>Responsible Entities:<br>CRMWD, TSSWCB, TCE</td><td>Implement biological control in all chemically treated areas<br>Responsible Entities: USDA-ARS, local SWCDs, CRMWD, TAMU-TCE, TDA</td></tr>
<tr><td>Continue water quality monitoring program; continue post-delisting monitoring for CWS (completed in year 2011)<br>Responsible Entities:<br>CRMWD, USFWS, TPWD, NGOs</td></tr>
<tr><td>Analyze all previously collected data and re-evaluate monitoring programs every five (5) years<br>Responsible Entities:<br>CRMWD, USFWS, TPWD</td></tr>
</table>

### 8.3.2 *Upland Brush Management*

The watersheds of the Upper Colorado River Basin will also be positively impacted by upland brush management practices. Invasive brush species such as juniper and mesquite have become dominant in many upland areas of the Upper Colorado River Basin and as a result, water quantity has been greatly affected in West Texas. As woody cover increases, costs of management for ranching operations also increase and livestock carrying capacity decreases. Thus, ranchers have a vested interest in controlling brush on their property. In addition, upland brush control may also positively affect surface water supplies, groundwater aquifer recharge, and increase spring flows in the watersheds of the Upper Colorado River Basin (TSSWCB, 2002; Wilcox *et al*., 2005).

The NRCS and the TSSWCB are currently supporting and administering numerous brush management projects in several counties in West Texas. Following each phase of chemical saltcedar control, it is recommended that landowners be contacted regarding their involvement in other NRCS and TSSWCB brush management cost-share programs to aid in overall watershed coordination efforts. Table 3 contains a proposed implementation schedule for the upland brush management phase of this project.

### 8.3.3 *Riparian Restoration*

Riparian areas along the Colorado River and its tributaries play a vital role in improving water quality, preserving biodiversity, and protecting streamside environments. However, in the Upper Colorado River Basin watersheds, natural riparian areas have been altered through the elimination of native vegetation, which is caused by the proliferation of native brush species and livestock grazing practices (Archer, 1994; Teague *et al*., 2001). In order to protect and enhance surface and groundwater quality and aquatic ecosystem health in areas where natural riparian zones have been altered, fully functioning riparian buffers consisting of native vegetation should be restored, possibly including saltcedar control areas. If saltcedar control areas are to be revegetated, the site specific conditions of each area will need to be evaluated.

These riparian buffers should be used in conjunction with sound upland management, saltcedar control, and juniper and mesquite brush control to be effective. They are not intended to mitigate the effects of poor rangeland or cropland management above the riparian zone; rather, they should complement these techniques to enhance water quality and habitat protection. Therefore, it is recommended that these riparian buffers be restored after saltcedar control and upland brush control projects have been completed.

**Table 3. UPLAND BRUSH MANAGEMENT**

| Year 1 – 2006 | Year 2 – 2007 | Year 3 – 2008 | Year 4 – 2009 | Year 5 – 2010 | 2011 – 2030 |
|---|---|---|---|---|---|
| Contact landowners whose land was sprayed for saltcedar control in 2005 to discuss involvement in cost-share grant programs for upland brush management<br>Responsible Entities:<br>Local SWCDs, TSSWCB, NRCS, CRMWD, TCE | Assist interested landowners in applying for upland brush control cost-share grant programs<br>Responsible Entities:<br>Local SWCDs, TSSWCB, NRCS, TCE | Assist landowners that have received government grants with eligible upland brush management practices on their lands<br>Responsible Entities:<br>Local SWCDs, TSSWCB, USFWS, TPWD, NRCS, TCE | Continue water quality monitoring program<br>Responsible Entities:<br>CRMWD | Continue water quality monitoring program<br>Responsible Entities:<br>CRMWD | Continue water quality monitoring program<br>Responsible Entities:<br>CRMWD<br><br>Analyze all previously collected data and re-evaluate the monitoring programs every five (5) years<br>Responsible Entities:<br>CRMWD and TSSWCB |
| [See Section 6.0 for additional information on landowner assistance and outreach/education.] | Contact landowners whose land was sprayed for saltcedar control in 2006 to discuss involvement in cost-share grant programs for upland brush management<br>Responsible Entities:<br>Local SWCDs, TSSWCB, NRCS, CRMWD, TCE | Assist interested landowners in applying for upland brush control cost-share grant programs<br>Responsible Entities:<br>Local SWCDs, TSSWCB, NRCS, TCE | Assist landowners that have received government grants with eligible upland brush management practices on their lands<br>Responsible Entities:<br>Local SWCDs, TSSWCB, USFWS, TPWD, NRCS, TCE | Continue water quality monitoring program<br>Responsible Entities:<br>CRMWD | Continue water quality monitoring program<br>Responsible Entities:<br>CRMWD<br><br>Analyze all previously collected data and re-evaluate the monitoring programs every five (5) years<br>Responsible Entities:<br>CRMWD and TSSWCB |
| | | Contact landowners whose land was sprayed for saltcedar control in 2007 to discuss involvement in cost-share grant programs for upland brush management<br>Responsible Entities:<br>Local SWCDs, TSSWCB, NRCS, CRMWD, TCE | Assist interested landowners in applying for upland brush control cost-share grant programs<br>Responsible Entities:<br>Local SWCDs, TSSWCB, NRCS, TCE | Assist landowners that have received government grants with eligible upland brush management practices on their lands<br>Responsible Entities:<br>Local SWCDs, TSSWCB, USFWS, TPWD, NRCS, TCE | Continue water quality monitoring program<br>Responsible Entities:<br>CRMWD<br><br>Analyze all previously collected data and re-evaluate the monitoring programs every five (5) years<br>Responsible Entities:<br>CRMWD and TSSWCB |
| | | | Contact landowners whose land was sprayed for saltcedar control in 2008 to discuss involvement in cost-share grant programs for upland brush management<br>Responsible Entities:<br>Local SWCDs, TSSWCB, NRCS, CRMWD, TCE | Assist interested landowners in applying for upland brush control cost-share grant programs<br>Responsible Entities:<br>Local SWCDs, TSSWCB, NRCS, TCE | Assist landowners that have received government grants with eligible upland brush management practices on their lands<br>Responsible Entities:<br>Local SWCDs, TSSWCB, USFWS, TPWD, NRCS, TCE<br><br>Continue water quality monitoring program<br>Responsible Entities:<br>CRMWD and TCE<br><br>Analyze all previously collected data and re-evaluate the monitoring programs every five (5) years<br>Responsible Entities:<br>CRMWD and TCE |

Many of the government grant programs that currently offer assistance to landowners interested in protecting riparian areas are greatly dependent on landowner participation and have cost-share requirements. Landowners who have participated in the saltcedar and upland brush control projects will also be contacted to become involved in riparian restoration projects. The CRMWD will facilitate task force meetings between the various state and federal agencies that will be cooperating in this Implementation Plan. Because all of these lands are under private ownership, landowner participation will be solicited by local SWCDs working in concert with the TSSWCB and the NRCS. However, personnel from the Texas Parks and Wildlife Department (TPWD), the TCE, the USDA-ARS, and the USFWS Partners for Fish and Wildlife Program will be solicited to provide educational and technical assistance.

### 8.3.4 *Public Education and Awareness*

Landowners will be provided educational information on the importance of saltcedar control, upland brush management, sustainable livestock management, riparian restoration, and the reestablishment of native vegetation in grassland and riparian communities to stress the value of these strategies to the overall health of the watersheds and water supplies in West Texas. In addition to educating the landowners, the general public will also be made aware of the conditions affecting water quality, water quantity, and overall environmental health of the Upper Colorado River Basin watersheds. If landowners and the general public are knowledgeable of the importance of watershed health, and successes of initial projects can be quantified, funding for future projects should be more attainable.

## 8.4 Implementation Costs

### 8.4.1 *Colorado River Municipal Water District (CRMWD)*

As mentioned previously, the CRMWD will be responsible for facilitating and managing the restoration activities taking place in the watersheds of the Upper Colorado River Basin and delegating or coordinating specific tasks to federal and state agencies that have agreed to participate in the implementation of the recommendations discussed in the UCRWRMP. Implementation of the recommendations presented in the UCRWRMP will entail additional administrative costs for the CRMWD.

The CRMWD has also been proactively involved in water quality improvements in the watersheds of the Upper Colorado River Basin since 1971. Annually, the CRMWD budgets and spends approximately $750,000 for water quality improvements through the maintenance and operation of its extensive diverted water system and its in-house water quality monitoring program. This water system is a network of pipelines and pump stations that divert low-flow, poor quality water (high dissolved solids and salts) into off-channel reservoirs for evaporation or use by oil companies for secondary oil recovery operations. Some of this expense is presently being used as local match for the upper Colorado River saltcedar control project to match Section 319(h) funds (see Section 8.5.3 below) provided to the TSSWCB. After the saltcedar control project has been completed, these dollars will still be available for match to help support this watershed initiative into the future.

Because of these ongoing efforts, the CRMWD and its member cities of Odessa, Big Spring, and Snyder have been working tirelessly over the past 40+ years to improve the water quality in the watersheds that ultimately supply water resources to the CRMWD's three surface water reservoirs (Lake J.B. Thomas, E.V. Spence Reservoir, and O.H. Ivie Reservoir). The CRMWD will continue this effort and will provide the dollars spent annually to be used as local matching dollars for the various state and federal programs available to assist landowners with restoration activities in the watersheds of the Upper Colorado River Basin. It will be necessary for the CRMWD to work with state and federal agencies to clarify that the CRMWD's annual water quality costs (actual dollars budgeted and spent) are considered a viable local match for landowners and producers that are participating in watershed improvements for their land.

### 8.4.2 *Government Entities*

Most of the funding for implementation of the selected strategies will likely come from federal grant programs. Therefore, these federal agencies will be providing a large portion of the operation and maintenance costs incurred through the implementation of the restoration and management plan activities.

### 8.4.3 *Local Landowners*

The majority of the grant programs administered by federal agencies are dependent upon landowner participation, especially in areas such as the Upper Colorado River Basin, where the majority of the land is privately owned. In order for many of these grant programs to be utilized, landowners must not only participate in the implementation of eligible practices, but also share in the costs of these restoration and water management strategies.

Several of the grant programs discussed in the UCRWRMP offer cost-share programs to assist landowners with restoration and water management practices. In general, practices that are eligible for cost-share funding include: mechanical (including pitting, contour furrowing, ripping, shearing, grubbing, or subsoiling), chemical, or biological brush management practices, prescribed burning, range planting of perennial vegetation, prescribed grazing in accordance with plant sensitivities and management goals, installation of fencing as a barrier to livestock, installation of watering facilities for livestock, and the establishment of riparian buffers.

Landowners are asked to contribute approximately 25 to 50 percent of the expenses for implementing best management practices in many of the government grants that are available for the watersheds of the Upper Colorado River Basin. Many of these programs also offer incentive payments and signing bonuses to eligible participants.

#### 8.4.4 *Non-Government Organizations (NGOs)*

Many non-government organizations (NGOs), including volunteer organizations, may incur some additional administrative costs when they provide technical and educational assistance for this comprehensive watershed project. Some, if not all of these costs, may be eligible as in-kind match to help meet project cost-share contributions.

### 8.5 Implementation Funding

Successful implementation of the strategies presented in the UCRWRMP hinges on the ability to adequately fund the recommended activities. Several federal and non-federal assistance programs are applicable for the watersheds of the Upper Colorado River Basin; however, the Environmental Quality Incentive Program (EQIP), the Continuous Conservation Reserve Program (CCRP), Clean Water Act Section 319(h) Funds, and non-specific sources of congressional funding appear to be the most viable options for implementing the restoration and water management strategies.

#### 8.5.1 *Environmental Quality Incentive Program (EQIP)*

The EQIP, which is managed by the NRCS, is a voluntary conservation program for farmers and ranchers that offers financial and technical assistance to install or implement structural controls and management practices on eligible agricultural land. These activities are carried out according to an EQIP plan of operations and are subject to NRCS technical standards that are adapted for local conditions.

The EQIP offers contracts with a minimum term that ends one year after the implementation of the last scheduled practices and a maximum of ten years. Eligible participants will receive incentive payments for a maximum of three years and cost-shares of up to 75 percent of the costs for implementation. Limited resource producers and beginning farmers and ranchers may be eligible for cost-shares up to 90 percent; however, combined cost-share and incentive payments may not exceed $450,000 for an individual contract.

### 8.5.2 *Continuous Conservation Reserve Program (CCRP)*

The CCRP, which is funded through the Commodity Credit Corporation (CCC) and partly administered by the NRCS, provides technical and financial assistance to eligible farmers and ranchers to address environmental concerns on their lands. In the watersheds of the Upper Colorado River Basin, this assistance could be particularly beneficial for the implementation of riparian buffer zones. Many of the perennial and intermittent creeks in the Lake J.B. Thomas, E.V. Spence Reservoir, and O.H. Ivie Reservoir watersheds are eligible for enrollment.

Landowners must agree to participate in this program for a period of 10 to 15 years, and during this time, grazing activities must be ceased in the riparian buffer zones. This cessation will allow for growth and the reestablishment of desirable riparian vegetation. The width of the buffer zones may vary from site to site, but the maximum width is 360 feet (i.e., 180 feet on each side of a creek or tributary). If riparian buffers are utilized in West Texas, the types of native riparian species planted, the amount of plantings, and the sizes of the riparian buffers will be determined based on the soil types, current range management practices, current hydrology, and funding availability for each area considered. Additional information about CCRP riparian buffers can be found in the program data sheet located in Appendix H.

This program will provide individuals with an up-front signing bonus of $100 to $150 per acre, an annual rental payment ranging from $28 to $46 per acre, and a reimbursement of 90 percent for the cost of fencing and certain types of brush control. Portions of the annual rental payment are earmarked towards the maintenance of saltcedar control because the landowner is obligated to do follow up saltcedar control for the entire enrollment period.

### 8.5.3 *Clean Water Act Section 319(h) Funds*

The Clean Water Act (CWA) Section 319(h) Grant Program provides funding to states and tribes to aid in the implementation of their approved non-point source projects and programs in accordance with Section 319 of the CWA. Non-point source pollution reduction/abatement projects can be used to protect source water areas and the general quality of water resources in a watershed. Although the Section 319(h) funds are provided by the Environmental Protection Agency (EPA), funding decisions are made by the states.

Potential recipients of Section 319(h) funds must submit their eligible projects/programs to the state Non-Point Source (NPS) agency for any given state. If the NPS agency accepts the project/program, the state will submit their proposed funding plans to the EPA. If the state's funding plan is consistent with grant eligibility requirements and procedures, the EPA can award the funds to the state. States are required to provide a 40 percent non-federal match for the Section 319(h) grant, and recipients within the state are typically required to provide a 40 percent match for each project; however, this requirement may be negotiable in some states.

In Texas, the Texas Commission for Environmental Quality (TCEQ) and the TSSWCB are the two agencies responsible for administering the Section 319(h) funds for the abatement of non-point sources of pollution that impact surface waters of the state. The TSSWCB is specifically tasked with administering their share (50 percent) of Section 319(h) funds under the State of Texas Agricultural/Silvicultural Non-Point Source Management Program. In order to apply for these funds, the CRMWD will be responsible for submitting the appropriate documentation to the TSSWCB for consideration.

### 8.5.4 *Congressional Funding*

One of the primary difficulties in the Upper Colorado River Basin is that most of the federal funding options are limited to individual landowner participation (i.e., "producers") rather than on a larger scale encompassing a whole watershed. Furthermore, many landowners are reluctant to become involved in these government programs if they have to pay a portion of the costs for implementation of the eligible practices or are required to agree to long-term constraints (i.e., "strings attached"). In order to pursue unprecedented large-scale sources of funding, a task force should by formed, possibly led by the CRMWD to plan presentations for local Congressmen and Senators, which could possibly lead to federal or state funding and/or a proclamation for a watershed-scale project.

## 8.6 Monitoring Plans

### 8.6.1 *Watershed Monitoring Plan*

The effectiveness of watershed restoration activities to improve water quality and quantity will be monitored at a number of locations along the Colorado and Concho Rivers and their tributaries. This monitoring network is already in existence and functions as part of the Texas Clean Rivers Program (CRP). Since the Texas state legislature implemented the CRP in 1991, the CRMWD has been an active participant. The CRMWD monitors surface water quality and flow in the Upper Colorado River Basin as a subcontractor to the Lower Colorado River Authority (LCRA). Clean Rivers Program activities are conducted under biennial contracts, with the current contract in effect from September 1, 2005 to August 31, 2007. Monitoring for this contract includes 28 river and stream sites in three stream segments of the Upper Colorado River Basin. In addition, three reservoir segments containing a total of seven sites are monitored annually. One site is monitored twice a year at Lake J.B. Thomas. Three sites each are monitored at E.V. Spence and O.H. Ivie Reservoirs twice a year. The CRMWD investigates pollution complaints, monitors water quality issues, and performs public outreach activities under the CRP contract.

The database along with future results will allow an evaluation of the restoration actions, particularly saltcedar control. The effectiveness of saltcedar control can be determined by comparisons of post-treatment water quality and flow data to the historical record or to “control” sites upstream.

### 8.6.2 *Concho Water Snake Monitoring Plan*

The USFWS should submit a proposal for Section 6 funding that could be used by non-agency monitors to complete the post-delisting monitoring activities should the Concho water snake status review currently underway demonstrate recovery and support delisting. Solicitations for non-agency monitors could be directed to the TPWD, universities, and NGOs, such as The Nature Conservancy. In-state universities may offer the best source for available labor by using undergraduate and/or graduate students under the direction of a professor who would be the principal investigator for the monitoring project. The USFWS should provide scientific permits as required by law to the principal investigator.

If the status review indicated that the snake was recovered, beginning with the first activity season in the year following delisting, all or a subset of the original 15 monitoring sites (Appendix I) established by the CRMWD in 1987 should be selected for follow-up monitoring for a period of five years. Three sites randomly selected by the principal investigator from the original 15 monitoring sites in each river reach above and below the O.H. Ivie Reservoir should be sampled twice annually during the snakes peak activity periods, April to June, and August to October. Additionally, two artificial riffles should be randomly selected for annual surveys. In addition to these eleven river sites, random shoreline surveys should be completed in the E.V. Spence Reservoir, the O.H. Ivie Reservoir, and the Ballinger Municipal Lake (formerly Lake Moonen). These reservoir surveys should also be completed during the peak activity periods. The objective is only to document the presence or absence of snakes at the riverine sites and within the reservoirs. The number of snakes caught and/or seen, their age class, and sex should be recorded and reported annually to the USFWS. The CRMWD may serve as a liaison between the private landowners and the principal investigator during the initial phase of re-establishing the monitoring sites.

#### 8.6.2.1 Monitoring Protocol for Riverine Sites

The survey period for riverine sites is April 15th to June 15th and August 1st to October 1st. The snakes are primarily diurnal, so searches should be conducted during daylight hours. Initially, a ground foot search should be conducted by thoroughly surveying the entire riffle site by turning over rocks using potato rakes. The search should terminate at the site when a single Concho water snake is found or the entire site has been searched and no snakes are found. If no snakes are found, then the site should be trapped using round, funnel, minnow traps. A minimum of 35 traps should be deployed within the site during the trapping season. Traps should be set in the riffles and along pools in a fashion where a foraging or moving snake will be easily directed into the funnel. In riffles, traps should be set adjacent and parallel to large rocks and smaller rocks can be positioned to facilitate the snakes' movement into the trap. Trap sets should remain in place until one Concho water snake is caught, but no longer than three consecutive days. Three subsequent, three-day periods should be completed at one-week intervals during both activity periods (spring and fall) until a snake is caught. If no snakes are caught, then the snake should be considered absent from the site for that year. Care should be taken during trapping if inclement weather threatens and there is an increased risk of rainfall runoff and a subsequent river rise. Snakes caught in traps that are inundated during a river rise will drown. Every effort should be made to pull all traps if rainfall runoff is anticipated.

#### 8.6.2.2 Monitoring Protocol for Reservoir Surveys

Because reservoir levels fluctuate significantly from year to year, selecting a defined length of shoreline to monitor repeatedly may not be possible. As reservoir elevations move up or down, preferred Concho water snake habitat (i.e., rocky structure with a moderate slope and abundant minnow populations) will typically change. Access to rocky shoreline is best achieved by boat. Searches of shoreline are conducted in a similar fashion as done at riverine sites, foot searches and turning rocks with potato rakes. The trapping of suitable shoreline habitat should also be employed; however, trap sets should be closely watched because of pilfering by local fishermen. The CRMWD will provide authorization to access the shorelines of the E.V. Spence and O.H. Ivie Reservoirs. The Ballinger Municipal Lake shoreline is readily accessible by vehicle; however, prior authorization should be received from the City of Ballinger. Each reservoir should be searched and/or trapped weekly during the peak activity periods until a

Concho water snake is caught. Once a snake is caught, then searches at the reservoir can be ended.

### 8.6.3 *Geographic Information Systems (GIS)*

The main purpose of the GIS database will be to document areas where management activities are planned and completed. The maps and data can also be used for planning to identify areas that need restoration assistance or application of management practices.

Water quality and stream flow data can be shown as they relate to watershed characteristics such as land use, proximity to restoration/management activities, and other watershed events, as they become available.

Base layers or data in the GIS database can include (if publicly available or cost effective to obtain):

- USGS topographic base maps;
- TNRIS DOQQ aerial photographs;
- Watershed or hydrologic boundaries from the USGS and EPA;
- Land use and vegetation cover types;
- Areas of brush control treatment by other entities; and
- NRCS soil maps.

## 8.7 Summary

This Implementation Plan discusses the restoration and water management strategies and funding options that were introduced in the UCRWRMP and outlines the responsible parties for implementation of the various components.

In order to restore the habitat of threatened and endangered species such as the Concho water snake, and improve the environmental health of the Upper Colorado River Basin as a whole, a combination of saltcedar control, upland brush management, and riparian restoration should be undertaken. In addition to these strategies, education and awareness of landowners and the general public must be increased. If the public is educated on the importance of watershed health, and successes of initial restoration and management projects can be quantified, funding for future projects through various federal and state agencies should be more attainable.

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# APPENDIX A

# USFWS REVISED BIOLOGICAL OPINION

United States Department of the Interior

FISH AND WILDLIFE SERVICE
10711 Burnet Road, Suite 200
Austin, Texas 78758
512 490-0057
FAX 490-0974

December 3, 2004

Wayne A. Lea
Chief, Regulatory Branch
Fort Worth District, Corps of Engineers
P.O. Box 17300
Fort Worth, Texas 76102-0300

Consultation No. 2-15-F-2004-0242

Dear Mr. Lea:

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion based on our review of the proposed water operations by the Colorado River Municipal Water District (District) on the Colorado and Concho rivers, located in Coleman, Concho, Coke, Tom Green, and Runnels counties. These actions are authorized by the U.S. Army Corps of Engineers (Corps) under Permit Number 197900225, Ivie (Stacy) Reservoir project, pursuant to compliance with the Clean Water Act. The District and the Corps have indicated, through letters dated September 10, 2004, and September 13, 2004, respectively, that an emergency condition affecting human health and safety exists with this action. We have considered the effects of the proposed action on the federally listed threatened Concho water snake (*Nerodia harteri paucimaculata*) in accordance with formal interagency consultation pursuant to section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). The emergency consultation provisions are contained within 50 CFR section 402.05 of the Interagency Regulations. Your July 8, 2004, request for reinitiating formal consultation was received on July 12, 2004. You designated District as your non-federal representative.

This biological opinion is based on information provided in agency reports, telephone conversations, field investigations, and other sources of information. A complete administrative record of this consultation is on file at the Austin Ecological Services Field Office.

**Consultation History**

Conference Report

On February 21, 1986, the Corps requested the Service prepare a section 7 Conference Report for the Concho water snake under Section 7(a)(4) of the Act. That report, dated May 5, 1986, concurred with the Corps' finding that Stacy Dam was likely to jeopardize the continued existence of the Concho water snake (then proposed for listing) and was likely to adversely modify proposed critical habitat. The Concho water snake was listed as a threatened species on September 3, 1986. Critical habitat, proposed for the snake on January 22, 1986, was deferred until the economic data on the impact of that proposal could be gathered and assessed.

Original biological opinion
On December 19, 1986, the Service issued its biological opinion, finding the proposed action was likely to jeopardize the continued existence of the Concho water snake and adversely modify the proposed critical habitat (Service 1986). The Federal action under consultation was the proposal by the Corps to issue a Section 404 (Clean Water Act) and Section 10 (Rivers and Harbors Act) permit to the District for the construction and operation of the proposed Stacy Dam, O.H. Ivie Reservoir, and pump station on the Colorado River in Coleman, Concho, and Runnels counties, Texas.

The biological opinion was the culmination of all the research that had been completed on the Concho water snake from 1979 through 1986. It provided detailed information on the snake, its known biology, distribution, and presented a comprehensive account of the potential threats plus viability of the species based upon a computer generated risk analysis model. The opinion provided ten (10) reasonable and prudent alternatives (RPAs) to be implemented by the District to avoid jeopardizing the snake. A commitment to carry out the RPAs was confirmed in a Memorandum of Agreement (MOA), signed March 1987, between the District, the Service, and the Corps. The Corps issued a Federal permit on April 8, 1987.

Amendment No. 1
On March 7, 1989, the biological opinion was amended as a result of new information that had been collected. Some of the reasonable and prudent alternatives were modified to be consistent with the new available information.

Amendment No. 2
The final rule designating critical habitat for Concho water snake was published June 29, 1989. On November 28, 1989, the biological opinion was amended to address critical habitat (adverse modification was determined) and removed some requirements to move snakes within reservoir basins.

Amendment No. 3
On November 23, 1992, the biological opinion was amended (labeled Amendment #2) to include District plans to construct a water pipeline from the San Angelo pump station to the Midland/Odessa metropolitan area. The pipeline crossed the Concho River roughly 3 miles (4.8 kilometers) northeast of the community of Paint Rock.

Amendment No. 4
On December 21, 2000, the Service issued another amendment to the biological opinion (Consultation Number 2-15-00-F-0636). This amendment included an additional action by District to construct a pump station at Ivie Reservoir, a water pipeline to Abilene and a water treatment plant in Taylor County.

Present Consultation
The Corps requested the Service reinitiate consultation on this project by letter dated July 8, 2004. The Service responded by letter to the Corps dated July 16, 2004, to reinitiate formal

consultation (Consultation Number 2-15-F-2004-0242). District indicated to the Service by letter dated September 10, 2004, that an emergency situation existed due to a limited water supply endangering public health and safety to their municipal customers (450,000 people). The Corps concurred with the emergency consultation by email to the Service, dated September 13, 2004. The Interagency Regulations define an emergency as "situations involving acts of God, disasters, casualties, national defense or security emergencies, etc." The 10-year drought and the implementation of the conditions in the Service's December 19, 1986, biological opinion, were the basis for this emergency. District documented, by letter dated September 16, 2004, their intent to decrease reservoir releases from Spence and Ivie reservoirs as a result of the ongoing low water situation. District indicated the low water situation would be alleviated when both reservoirs reach 50 percent capacity (at the time Spence Reservoir was at 7 percent capacity and Ivie Reservoir was at 30 percent capacity). The Service concurred with the District emergency procedures by letter dated September 21, 2004. This consultation will apply once the current emergency has ended, in other words when both Spence and Ivie reservoirs are at, or above, 50 percent capacity in water storage or once the District, in discussions with the Corps and the Service, has determined that other factors have ended the emergency condition. The District will notify the Corps and the Service when either of the above conditions trigger the end of the emergency condition. This Revised Biological Opinion replaces the Biological Opinion dated December 19, 1986. When the emergency condition ends, the requirements of this Revised Biological Opinion will go into effect.

## BIOLOGICAL OPINION

### I. Description of Proposed Action

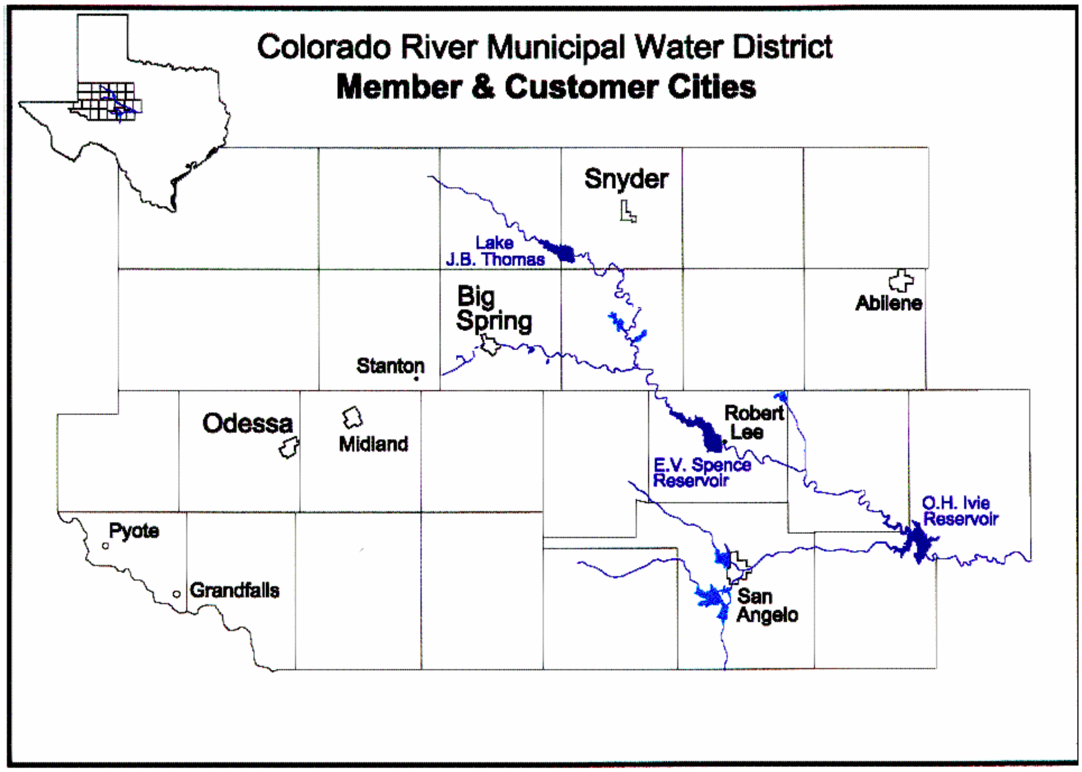
**Historical Operation.** The District was authorized in 1949 by an Act of the 51st Legislature of the State of Texas for the purpose of providing water to the District's Member Cities of Odessa, Big Spring, and Snyder (see Figure 1). The District also has contracts to provide specified quantities of water to the Cities of Midland, San Angelo, Stanton, Robert Lee, Grandfalls, Pyote, and Abilene (through the West Central Texas Municipal Water District). A twelve-member Board of Directors governs the District. Each Member City appoints four Board members. Members serve on the Board for two-year terms.

The District owns and operates three major surface water supplies on the Colorado River in west Texas. These are Lake J. B. Thomas, the E. V. Spence Reservoir, and the O. H. Ivie Reservoir. Together, the full combined capacity of these reservoirs is 1.247 million acre-feet (1,538 million cubic meters).

Additionally, District operates four well fields for water supply. The Member Cities prior to 1949 developed two of these fields. The third field, located in Martin County, began delivering water in 1952. The fourth field, located in Ward County southwest of Monahans, can supply up to 21 million gallons (79,500 cubic meters) of water per day. The District primarily uses these well fields to supplement surface water deliveries during the summer months when municipal demand is high.

The District also operates a "diverted water" supply system. The primary function of this system is to prevent the highly mineralized low flow of the Colorado River and Beals Creek (a tributary of the Colorado River) from reaching the Spence Reservoir. The system delivers this highly mineralized water to oil companies for use in oil field secondary recovery operations.

Figure 1. Member and customer cities of the District.




**Colorado River Municipal Water District Water Supply System.** The District's water supply system includes three major reservoirs, three diversion works, numerous storage reservoirs, and more than 600 miles (966 kilometers) of transmission line. Lake J. B. Thomas is the oldest water supply reservoir. It was constructed in Borden and Scurry counties in 1952. The E. V. Spence Reservoir was completed in Coke County in 1969, and the O. H. Ivie Reservoir, the District's newest water supply reservoir, was finished in 1990.

Five of the reservoirs are used to control and evaporate poor quality "diverted water". The Barber Reservoir and its diversion works, located near Colorado City, were built in 1969 to reduce the chloride pollution entering the Spence Reservoir downstream. Red Draw Reservoir was constructed in 1985 along with a diversion works on Beals Creek. Both the Natural Dam Lake improvements and the Sulphur Draw Reservoir were built following the 1986 spill of poor quality water from Natural Dam Lake. The Mitchell County Reservoir was created to expand the District's ability to store and dispose of poor quality water. The complete scope of the District's Water Quality Enhancement System will not be addressed within this document.

Table 1 presents a summary of the District reservoirs, their purpose, year of construction, and maximum capacity in acre-feet (million cubic meters).

Table 1. District Reservoirs.

| Reservoir | Purpose | Year | Max. Capacity | |
|---|---|---|---|---|
| J.B. Thomas | Water Supply | 1952 | 204,000 | (251.6) |
| E.V. Spence | Water Supply | 1969 | 488,760 | (602.9) |
| O.H. Ivie | Water Supply | 1990 | 554,340 | (683.8) |
| Barber | Quality Control | 1969 | 2,500 | (3.1) |
| Red Draw | Quality Control | 1985 | 8,538 | (10.5) |
| Natural Dam | Quality Control | 1988 | 54,560 | (67.3) |
| Mitchell Co. | Quality Control | 1991 | 27,266 | (33.6) |
| Sulphur Draw | Quality Control | 1993 | 8,000 | (9.9) |

The District operates four well fields for municipal water supply. Two of these fields, located at Snyder and near Odessa, served as those city water supplies prior to the District's inception. The District developed the third field, located in Martin County northwest of Stanton, in the early 1950's. The fourth field, which is the largest District well field, is located in Ward County, southwest of Monahans, and was developed in 1971. Table 2 lists the District's well fields, their locations, and production rates.

Table 2. District well fields; Production in millions of gallons per day (cubic meters per day)

| Well Field | Location | Year | Production | |
|---|---|---|---|---|
| Snyder W.F. | Scurry Co. | 1940's | 1.2 | (4,500) |
| Odessa W.F. | Ector Co. | 1940's | 1.1 | (4,200) |
| Martin Co. W.F. | Martin Co. | 1951 | 2.0 | (7,600) |
| Ward Co. W.F. | Ward Co. | 1971 | 21.0 | (79,500) |

The District also owns and operates a water distribution network encompassing twenty-two pump stations and more than 600 miles (970 kilometers) of water transmission pipeline. The system features numerous miles of parallel lines and interconnects, which makes it quite flexible. Consequently, the District is able to furnish almost any customer with water from any source.

**Conjunctive Use.** Groundwater throughout most of West Texas is essentially mined. Recharge rates are quite low, or in some cases nonexistent, and thus the water pumped may never be replaced. Consequently, the District has practiced the conjunctive use of surface and groundwater assets for many years. During the 1950's, the District used the Martin County Well Field only in the summer months when Odessa's water demands exceeded the transmission capacity from Lake Thomas. A parallel 33-inch (84-centimeter) line was laid from the Martin County Pump Station to Odessa for that purpose. During the 1960's, the District even "artificially recharged" the Martin County Well Field by injecting surplus water from Lake Thomas into the aquifer during the winter months, thereby increasing the quantity available for pumping the next summer.

When the Ward County Well Field came on line in the early 70's, the District continued its practice of conjunctive use. The City of Odessa typically uses water from that source only during the summer months to meet the increased demands. The well field is rested during the fall, winter, and spring months. In contrast, water from surface reservoirs is used at a mostly uniform rate throughout the year.

**District Water Quality Enhancement System.** As previously mentioned, the District has developed an extensive system of diversions, pipelines, and reservoirs in an effort to reduce the overall tonnage of chlorides and dissolved solids accumulating in the E. V. Spence Reservoir. These efforts began in 1969 with the construction of the diversion works and Barber Reservoir north of Colorado City. The current system includes five reservoirs, with a combined storage capacity of more than 100,000 acre-feet (123 million cubic meters), three diversion stations, and approximately 100 miles (161 kilometers) of water transmission line. In all, the District has spent more than $28 million on efforts to improve the water quality at the Spence Reservoir. Water taken from the diversion works is either sold to oil companies for use in oil field re-pressurization, or sent to the Barber, Red Draw, or Mitchell County reservoirs for evaporation.

Although the District's permits from the Texas Commission on Environmental Quality (TCEQ) authorize the use of up to 8,000 acre-feet (9.9 million cubic meters) of potable surface water annually for re-pressurization purposes, since 1969 the District's Board of Directors has elected to restrict the use of municipal quality surface or groundwater for that purpose.

Between 1969 and 1998, a total of 783,500 tons (796,100 metric tons) of chlorides were captured which would have otherwise traveled to, and accumulated within, the Spence Reservoir. Overall, these efforts have helped the District retain Spence as a valid municipal water supply source, which might not have been possible had the chlorides continued to gather within the reservoir and deteriorated its water quality.

**Strategic Water Releases.** Despite the District's diversion efforts, the water impounded in the Spence Reservoir has tended to be quite high in dissolved solids and chlorides. Prior to 1986, chloride levels rose to a high around 1000 ppm in 1980. Heavy rainfall that year dropped this level to 600 ppm, where it remained until the spill of saline water from the Natural Dam Lake in 1986-87. That spill resulted in the chlorides rising to the recent 1,000-1,200 ppm level. The municipal use of water containing such high concentrations of chlorides is marginal at best, even with extensive dilution by better quality waters from other sources.

Consequently, the District made a water release totaling 50,000 acre-feet (61.7 million cubic meters) during May and June of 1996. This release reduced the total impounded chlorides (tons) by one-third. This process was repeated when conditions again became favorable in 1998. That year the releases totaled 20,000 acre-feet of water, which reduced the impounded chlorides by 22,000 tons. Both of these releases were timed to be passed through the Ivie Reservoir downstream with minimal impact on that reservoir's water quality. The result of these releases will be dramatically better water quality once Spence receives significant inflow.

**Precipitation Enhancement.** In 1971, the District began a precipitation enhancement program (weather modification) in an attempt to increase the rainfall over the drainage areas of Lake Thomas and the Spence Reservoir. This program has operated almost every year since, and has been evaluated by the TCEQ, the U.S. Department of the Interior, and the Bureau of Reclamation. It is believed that an increase of 10 to 15 percent in rainfall has been achieved through these efforts. One indicator of this increase has been the rise in dry-land cotton production within the "target area" of the project. Although there is evidence that weather modification has increased precipitation, it is difficult, if not impossible, to determine what increase in runoff has occurred.

**Brush Management.** The rapid proliferation of saltcedar (*Tamarix* sp.) in all of riparian reaches of the upper Colorado River basin including the basins of E.V. Spence and O.H. Ivie Reservoirs is having a significant impact on all surface water resources. Saltcedar is an exotic, rapid invader of riparian waterways that consumes enormous quantities of water. One mature saltcedar tree may consume 200 gallons (0.76 cubic meters) of water in one day. Estimates indicate there may be as much as 25,000 acres (10,000 hectares) of saltcedar in the upper Colorado River basin upstream of the S.W. Freese Dam (Ivie Reservoir). Efforts to control saltcedar are underway by the Texas State Soil and Water Conservation Board (TSSWCB). Aerial application of the herbicide Arsenal (BASF) will be used to make the initial control of the saltcedar in the watershed above the Robert Lee Dam (E.V. Spence Reservoir). Treatment is scheduled to begin in September 2005 and be completed by September 2006. Using bio-control for follow-up maintenance, USDA-ARS researchers are releasing saltcedar leaf beetles in selected areas of the upper Colorado River basin. Prospects for long-term maintenance control with the leaf beetles appear hopeful.

**Drought Contingency Plan.** Droughts are quite common in West Texas. Fortunately, the Colorado River Municipal Water District has developed a very flexible water supply system, which uses multiple surface and groundwater sources, to reduce the impact a drought-affected source has on District deliveries.

This plan presents a guideline for District operations during a severe drought. The implementation of the plan will need to be done in the manner best suited to the drought conditions. The actions listed may need to be modified to best fit a given situation. This plan only focuses on the District's surface water system.

**The District's Surface Water Supply System.** As discussed above, the District's surface water system includes (1) Lake J. B. Thomas, (2) E. V. Spence Reservoir, and (3) O. H. Ivie Reservoir. However, only E.V. Spence and O.H. Ivie reservoirs are relevant to the conservation of the Concho water snake and these water sources are vulnerable in the following areas:

- Low water reserves.
- High dissolved solids and chloride levels.
- Short-term contamination from localized pollution.

It should be noted that surface water evaporation significantly depletes the District's water reserves each year. Throughout the service area, the average rainfall is only about 20 inches (51 centimeters) per year, while the average gross evaporation rate is about 82 inches (208 centimeters) per year. Subtracting these two numbers leaves a net evaporation of 62 inches (158 centimeters) per year. If the Ivie Reservoir remained at elevation 1,549.20, an elevation the reservoir has met or exceeded 50 percent of the time since impoundment, the evaporation would remove approximately 94,000 acre-feet (116 million cubic meters) per year. That figure is 40 percent greater than the 5-year combined annual peak use of all District customers.

The water supply system's problems, with the exception of a localized pollution problem, are relatively long term. The problems come relatively slowly, such as a drought depleting available water reserves, but can resolve themselves quickly when heavy rains come. Dealing with these problems happens on a monthly or yearly timeframe.

**Drought Management.** The following is the District’s drought contingency plan (Table 3).

Table 3. Drought trigger conditions (based on historical data).

| Trigger Condition | Mild | Moderate | Severe |
|---|---|---|---|
| Historical Percent | 80% | 90% | 95% |
| | | | |
| Spence-Elevation | 1,855.70 | 1,848.57 | 1,831.70 |
| Spence-Capacity (acre-feet) | 108,400 | 77,180 | 29,550 |
| Spence-Percent of Full | 22.18% | 15.79% | 6.05% |
| | | | |
| Ivie-Elevation | 1,541.41 | 1,514.95 | 1,508.90 |
| Ivie-Capacity (acre-feet) | 382,360 | 114,601 | 83,569 |
| Ivie-Percent of Full | 68.98% | 20.67% | 15.08% |
| | | | |
| Combined-Capacity | 490,760 | 191,781 | 113,119 |
| Combined-Percent of Full | 39.35% | 15.38% | 9.07% |

**Mild Conditions.** Upon reaching an above-listed trigger level, the District performs the following:

*E. V. Spence Reservoir:*

- Notify the Cities of Robert Lee and San Angelo that Spence Reservoir has reached this stage.
- May refrain from any large release from Spence Reservoir for water quality purposes.

*O. H. Ivie Reservoir:*

- No activity required.

*Combined Reservoirs:*

- Recommend all appropriate customers institute the "Mild Drought" conditions of their Plans.

**Moderate Conditions.** Upon reaching an above-listed trigger level, the District performs the following:

*E. V. Spence Reservoir:*

- Notify the Cities of Robert Lee and San Angelo that Spence Reservoir has reached this stage.
- Recommend San Angelo cease large-scale pumping operations.

*O. H. Ivie Reservoir:*

- Notify all appropriate customers that Ivie Reservoir has reached this stage.
- May refrain from any large release from Ivie Reservoir for water quality purposes.

*Combined Reservoirs:*

- Recommend all appropriate customers institute the "Moderate Drought" conditions of their Plans.

**Severe Conditions.** Upon reaching an above-listed trigger level, the District performs the following:

*E. V. Spence Reservoir:*

- Notify the Cities of Robert Lee and San Angelo that Spence Reservoir has reached this stage.
- May refrain from any transfers of Spence water to other reservoirs.

*O. H. Ivie Reservoir:*

- Notify all appropriate customers that Ivie Reservoir has reached this stage.
- Recommend San Angelo institutes the "Moderate Drought" conditions of their Plan.

*Combined Reservoirs:*

- Recommend all appropriate customers institute the "Severe Drought" conditions of their Plans.
- Ration water between the appropriate customers as required by conditions.

**System Emergency (Critical Condition).** A pipeline break, equipment failure, or system contamination can cause an extremely critical water problem within a short period of time. However, in most cases, the District is prepared to handle such situations without significant disruption of water deliveries. For example, as a general rule, the District operates with the combined capacity of our six water storage reservoirs being 50 percent or greater. That leaves about 150 million gallons (568,000 cubic meters) available for the Cities to use while system repairs are being made. As previously mentioned, the District's system includes multiple pipelines taking water from multiple sources. Thus, the District can still deliver water from more than one source even in the event of a failure on another system.

For example, consider water deliveries on the west-end (to Odessa, Midland, Big Spring, and Stanton) during the peak summer month with a breakdown on the Ivie System. The total peak month demand for those Cities is 72.8 million gallons per day (MGD) (276,000 cubic meters per day, CMD). Without Ivie, the delivery capability on the west end would be 47.1 MGD (178,000 CMD), leaving a shortfall of 25.7 MGD (98,000 CMD). With storage half-full, the District could ride 4-5 days during a repair. The loss of the Thomas, Spence, or Ward County systems would not be as critical.

The Cities of San Angelo and Midland have both expressed the ability and willingness to use their own water resources during such emergencies. San Angelo could provide their own needs during a system emergency between the Ivie Reservoir and their community. Midland could provide up to 25 MGD (95,000 CMD) for their own use, which would almost eliminate the shortfall listed above.

In the event of a System Emergency, the District's staff assesses the situation considering the system which failed, an estimated time for repairs, water demands of the cities, alternate sources of water which may be available, our current storage capacity, and each City's internal storage capacity. Each City which could be affected would then be briefed by telephone. Should the situation persist, and District's reservoir storage continues to be depleted, the affected cities may be asked to implement the restrictions listed under the "Emergency Condition" portion of their Drought Contingency Plans.

**1986 Biological Opinion.** The 1986 biological opinion from the Service required changes in operation of the District's system, which is listed in the Environmental Baseline section of this document.

**Proposed Future Operation.** The District will maintain flows in the Colorado River downstream of the E.V. Spence and O.H. Ivie reservoirs as follows:

<u>E.V. Spence Reservoir</u>.

To provide flow to support the aquatic ecosystem of the Concho water snake and to the extent there is inflow into Spence Reservoir, the District will maintain a minimum flow in the Colorado River below the Spence dam of not less than 4.0 cubic feet per second (cfs) (0.11 cubic meters per second, cms) during the months of April through September and 1.5 cfs (0.04 cms) during the months of October through March.

These flows will maintain the endemic invertebrate and fish species (Appendix A) in the range of the Concho water snake downstream from the E.V. Spence Reservoir. Appendix A provides an analysis of the snake's prey base including information on prey base sampling during the period of 1987 to 1996. In addition to maintaining the minimum flows in the Colorado River below the E.V. Spence dam, the District will periodically make additional discharges of varying flow rates from the E.V. Spence Reservoir as a part of its reservoir management activities and to manage water quality in the reservoir. Some of these discharges may be at high rates of flow coupled with flood runoff events. High discharges will function as channel maintenance flow to maintain suitable rock substrates and abate vegetation invasion of riffle habitat.

The District may periodically cause a total cessation of flow for necessary dam maintenance activities. Flow cessation periods will vary in length, however they will generally be infrequent and short-termed and will typically occur during the months of November through March.

During periods of extended hydrologic drought and to provide water for the health and human safety needs of its customers, the District will not be required to maintain flow in the Colorado

River below the Spence dam when the elevation of the E.V. Spence Reservoir is below elevation 1,843.5 feet (561.9 meters) MSL (mean sea level) (12.1 percent of the reservoir capacity).

O.H. Ivie Reservoir.

To provide flow to support the aquatic ecosystem of the Concho water snake and to the extent there is inflow into Ivie Reservoir, District will maintain a minimum flow in the Colorado River below the Ivie dam of not less than 8.0 cfs during the months of April through September and 2.5 cfs during the months of October through March.

These flows will maintain the endemic invertebrate and fish species (Appendix A) in the range of the Concho water snake downstream from the O.H. Ivie Reservoir. Appendix A provides an analysis of the snake's prey base including information on prey base sampling during the period of 1987 to 1996. In addition to maintaining the minimum flows in the Colorado River downstream of O.H. Ivie Reservoir, District will periodically make additional discharges of varying flow rates from the O.H. Ivie Reservoir as a part of its reservoir management activities and to manage water quality in the reservoir. Some of these discharges may be at high rates of flow coupled with flood runoff events. High discharges will function as channel maintenance flow to maintain suitable rock substrates and abate vegetation invasion of riffle habitat.

The District may periodically cause a total cessation of flow for necessary dam maintenance activities. Flow cessation periods will vary in length; however they will generally be infrequent and short-termed and will typically occur during the months of November through March.

During periods of extended hydrologic drought and to provide water for the health and human safety needs of its customers, the District will not be required to maintain flow in the Colorado River downstream of O.H. Ivie Reservoir when the elevation of the O.H. Ivie Reservoir is below elevation 1,504.5 feet (458.6 meters) MSL (11.9 percent of the reservoir capacity).

In addition to the above, the District will pursue additional watershed actions including:

1. The District will provide support for saltcedar control in the upper Colorado River watershed to include the Concho River as required. The District is cooperating in a saltcedar control project funded by the EPA through a Clean Water Act, Section 319(h) grant to the TSSWCB. The removal and control of saltcedar from the riparian reaches of the Colorado and Concho rivers will help to augment existing stream discharge and also reduce the buildup of dissolved solids (salts) in the soils of the riparian zone.

2. The District will support measures to improve and maintain water quality in the upper Colorado River basin. The District has participated in the Clean Rivers Program since 1991 and has a comprehensive surface water quality monitoring program in place. The District is working closely with the Texas Commission on Environmental Quality (TCEQ) on implementing the E.V. Spence Reservoir TMDL (total maximum daily load) completed in 2000. The District is also cooperating with the TCEQ on the formulation of the TMDL for the Colorado River between E.V. Spence Reservoir and the O.H. Ivie Reservoir.

3. The District will participate in a cooperative effort with the Corps, the Service, the U.S. Bureau of Reclamation, City of San Angelo, Upper Colorado River Authority, and the Tom Green County Water Improvement and Control District No. 1 to consider ways that will possibly augment instream flows in the Concho River downstream of San Angelo. In a June 14, 2004, information sheet the District indicated an interest in being the local sponsor for a watershed study and presented a list of potential partners.

4. As funds become available, including grants or other outside sources, the Corps and District will pursue studies to find the best means for rehabilitating/restoring riparian habitat following saltcedar spraying below Spence and Ivie reservoirs. When funds are available, the Corps and District would then implement the results of the studies which might include planting native riparian species and restoring natural hydrology.

## II. Listing of species and critical habitat.

**Listing.** The Concho water snake was federally listed as threatened on September 3, 1986 (51 FR 31412).

**Critical habitat.** Critical habitat was designated by the Service on June 29, 1989 (54 FR 27377), as follows:

1. Tom Green and Concho counties, Texas. Concho River: The mainstem river channel and river banks, up to a level on both banks that is 15 vertical feet (4.6 meters) above the water level at median discharge (but not extending more than ½ mile (0.8 kilometers) upstream on any tributary stream; extending from Mullin's Crossing northeast of the town of Veribest, downstream to the confluence of the Concho and Colorado Rivers.

2. Runnels, Concho, Coleman, and McCulloch counties, Colorado River: The mainstem river channel and river banks, up to a level on both banks that is 15 vertical feet (4.6 meters) above the water level at median discharge (but not extending more than ½ mile (0.8 kilometers) upstream on any tributary stream; extending from the Farm to Market Road (FM) 3115 bridge near the town of Maverick downstream to the confluence of the Colorado and Salt Creek, northeast of the town of Doole.

3. The entire O.H. Ivie (formerly Stacy) Reservoir basin up to the conservation pool level of 1,551.5 foot (472.9 meters) elevation MSL, including reservoir banks up to 15 vertical feet (4.6 meters) above the 1,551.5 foot (472.9 meters) elevation, and including tributary streams for not more than ½ mile (0.8 kilometers) upstream from the conservation pool level.

4. Constituent elements include shallow riffles and rapids with rocky cover, minimum stream flows, dirt banks, rocky shorelines, and woody riparian vegetation. Minimum flows include the following:

(a) A continuous, daily flow of 10.0 cfs (0.28 cms) in the Colorado River from E.V. Spence Reservoir to Ballinger, Texas.

(b) A flushing flow of 600 cfs (17.0 cms) from E.V. Spence Reservoir for a duration of 3 consecutive days (at any time during the months of November through February), at least every other year for channel maintenance.

(c) A continuous, daily minimum flow of 11.0 cfs (0.31 cms) in the Colorado River between Stacy [Freese] Dam and Pecan Bayou between April and September each year, and a minimum of 2.5 cfs (0.07 cms) between October and March of each year.

(d) Flushing flows of 2,500 cfs (71 cms) from Stacy [O.H. Ivie] Reservoir for 2 consecutive days at least once every 2 years for channel maintenance.

**Delisting petition.** In June 1998, the Service received a petition from the District to delist the Concho water snake. On August 2, 1999, the Service published a 90-day petition finding that the petitioner did not present substantial information indicating that delisting the species may be warranted (64 FR 41903).

## III. Status of the Concho water snake

**Description.** The Concho water snake (*Nerodia harteri paucimaculata*), along with the Brazos water snake (*Nerodia harteri harteri* ), are endemic residents of central Texas rivers and streams, occurring in and near both still and fast-moving water (Conant and Collins 1991, 1998). The species was first described in 1941 from the Brazos River drainage (Trapido 1941) and shortly thereafter a disjunct population was discovered in the Concho River drainage (Marr 1944). A review of the species was made by Tinkle and Conant (1961) and they separated the species into two subspecies, the Brazos water snake and the Concho water snake. Rose and Selcer (1989) concluded the two forms represent distinct species based on "…the fact that similar differences between other closely-related *Nerodia* populations have been deemed for specific status…" Sites and Densmore (1991) believed insufficient genetic markers existed to conclude the two snakes differ at the species level. However, Densmore et al. (1992), basing their conclusions on the evolutionary species concept, felt that the Concho water snake represented a distinct species based, in part, on its geographic isolation and fixed differences in genetic markers.

The Concho water snake is characterized by being somewhat smaller than most other *Nerodia* (Werler and Dixon 2000). At maturity (11-12 months), males average about 380 millimeters (15 inches) snout-vent length (SVL), and females average about 460 millimeters (18 inches) (Greene et al. 1999), with a maximum reported length of 1070 millimeters (42 inches) (Werler and Dixon 2000). The species has four rows of alternating dark-brown spots or blotches on its back, two rows on each side (Conant and Collins 1991, 1998; Werler and Dixon 2000). The dorsal (back) surface features 21 to 23 scale rows on a checkerboard of dark brown blotches on a gray, brown, or reddish-brown background. The ventral (belly) surface of the snake is typically light-colored, often centrally tinged with pink or light-orange in color, that is unmarked or has indistinct, laterally placed spots (Wright and Wright 1957; Conant and Collins 1991, 1998; Tennant 1984, 1985; Rose and Selcer 1989).

**Life-history.** Timing of reproduction in the Concho water snake is typical of *Nerodia*, with a spring mating period followed by late summer parturition (Fitch 1970). Males reach sexual maturity at about one year of age but females produce their first litter at 24 or 25 months old or 36 or 37 months of age, depending on their reproductive development (Werler and Dixon 2000). Whiting (1993) documented slower growth in reservoir habitats and females attained sexual maturity at about 3 years and live about one year longer than female Concho water snakes in riverine habitats.

The Concho water snake emerges from hibernation in mid-March to mid-April, and the main mating event occurs during April and early May, with a lesser event in October (Greene et al. 1999). Ovulation closely follows the mating period (Greene et al. 1999), and most births occur from late July through September (Dixon et al. 1988, 1989, 1990, 1991, 1992; Mueller 1990; Greene et al. 1999). Hibernation begins in late October to late November, depending upon weather and temperatures and the snakes generally emerge in March and April, again depending on weather and soil temperatures. Most adults probably hibernate in the tunnels of small burrowing animals, particularly crayfish, while hibernating juveniles may be more common in the crevices under rocks on gravel bars (Werler and Dixon 2000). After 3 to 3 ½ months of gestation, females produce litter sizes that range from 4 to 29, with a mean of about 11 neonate snakes—based on follicle counts from dissected snakes and embryos in palpated snakes as reported by Greene et al. (1999) and Tennant (1984). Females give birth to young in suitable habitat (probably most often under or near rocks or other cover) in streams, rivers, and reservoirs. The newly born snakes probably stay near the rocks for both cover and for seeking small fish as prey. In river habitat, the juvenile snakes are most often found on, or near, rocky riffles and were reported most common in shallow (4 to 12 inches water depth) riffles (Werler and Dixon 2000). As is true for most snakes, mortality is greatest during the first year and, probably depending on the severity of the winter, about 50 percent of the juveniles may expire during the first winter (Mueller 1990).

Sexual size dimorphism has been observed in Concho water snakes at birth, and females average 30 percent longer than males at maturity (Greene et al. 1999). Variability in growth rates and sexual maturation sizes has been observed between populations presumably based on prey availability (Dixon et al. 1991).

Concho water snakes feed almost exclusively on fish (Williams 1969; Dixon et al. 1988, 1989, 1990, 1992; Greene et al. 1994; Thornton 1990, 1992a; Rose 1989), and have been observed feeding both during the day and at night. Observed feeding behavior involves anchoring the body around rocks, usually in shallow water, and probing among the rocks, trapping fish prey in cracks and crevices. In riverine habitat and especially among neonates, minnows (Cyprinidae) are the primary food source. Prey item variety tends to increase with increasing snake body size (Greene 1993), and includes mosquitofish (*Gambusia affinis*), channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictus olivaris*), gizzard shad (*Dorosoma cepedianum*), and several species of sunfish (*Lepomis* spp.) (Dixon et al. 1991). Several other fish species have been found in Concho water snake stomachs, and the snake is thought to be an opportunistic predator on most small fish that may be found in shallow water habitat. Concho water snakes may also opportunistically feed on frogs (*Rana* and *Acris* spp.) (Greene 1993).

Stream and river habitat used by the Concho water snake is primarily associated with riffles, with young snakes using shallow parts of riffles and adult snakes using deeper parts of riffles to forage (Dixon et al. 1988; Rose 1989; Werler and Dixon 2003). Dixon et al. (1989) demonstrated that adult snakes used a variety of cover sites for resting including exposed bedrock, thick herbaceous vegetation, debris piles, and crayfish burrows. Riffles are believed to be the favored habitat for foraging.

In the reservoirs, habitat for the Concho water snake is thought to be shallow still water with rocks along the shoreline (Dixon et al. 1988). However, Concho water snakes have also been commonly observed around boat houses (O. Thornton, pers. comm., 2004). Unlike many other species of *Nerodia*, Concho water snakes do not seem to move far from water (Werler and Dixon 2000). Dixon has stated that the distance the snake will move from water is about 2 meters (6.6 feet) (J. Dixon, pers. comm., 2004).

Adult and maturing Concho water snakes use a wider range of habitats than do juveniles (Scott et al. 1989; Rose 1989; Werler and Dixon 2000). In reservoirs and lakes, juvenile Concho water snakes are generally found in low-gradient, loose-rock shoals adjacent to silt-free cobble and in streams and rivers, juveniles are found in gravel shallows or riffles (Rose 1989; Scott et al. 1989). This is the habitat where the neonate snakes are most likely to be born and thus, most likely to be encountered. It is likely that this habitat is also the best habitat for juvenile snakes to successfully prey on small fish The exposed rocky shoals act as thermal sinks and this may help keep the juvenile snakes warm. The rocky habitat likely also provides protection from a host of predators and the shallow water probably limits predation by large fish. Shallow water with flat rocks or boulder crevices, and habitat for small fish may provide the essential habitat needs for juvenile Concho water snakes.

As is true for most snakes, predation is considered a major source of mortality for Concho water snakes (Werler and Dixon 2000). Predators documented to prey on Concho water snakes (Dixon et al. 1990; Greene 1993) include kingsnakes (*Lampropeltis getula*), coachwhip snakes (*Masticophis flagellum*), racers (*Coluber constrictor*), raccoons (*Procyon lotor*), and great blue herons (*Ardea herodias*). Raptors such as hawks (*Buteo* spp.) and owls (*Strix* spp.) are also known to predate snakes (Ross 1989). Predatory fish include bass (*Micropterus* spp.) and channel catfish (*Ictaclurus punctatus* (Hamilton and Pollack 1955; McGrew 1963; Parmley and Mulford 1985; Dixon et al. 1988; and Mueller 1990).

Greene et al. (1999) found that the life span of adults only rarely exceeds five years. Since females do not reproduce until age two or three (Greene 1993), the number of reproductive opportunities is often limited to only two or three seasons (Greene et al. 1999). J. Dixon (pers. comm., 2004) noted that female Concho water snakes start breeding later and live longer in reservoir habitats, probably because growth is slower in reservoirs.

**Riverine habitats.** In rivers, the Concho water snake is mainly found in or near riffles (Dixon et al. 1988, Rose 1989) although recent drought conditions have shown that the snake has some flexibility in its habitat preferences (Dixon 2004). Scott et al. (1989) considered the density of riffles to be one of the major determinants of Concho water snake distribution. Riffles are a section of a river where due to an increase in channel gradient, the water depth is shallower, the water velocity is greater and the river bed is dominated by gravel, rocks and bedrock. Riffles begin when the upper pool overflows at a change in gradient and forms rapids. The stream flows over rock rubble or solid to terraced bedrock substrate through a chute channel that is usually narrower than the streambed. The riffle ends when the rapids enter the next downstream pool. The run of the riffle includes the area just below the upper pool (head of the riffle) where the water becomes noticeably faster and extends to a point (foot of the riffle) where the water becomes quiet again as it enters the lower pool. The streambed debris in a riffle often forms bars, shoals, or islands separated by flowing water. Parts of some riffles may be stabilized by vegetation or may be constricted by low-head dams, low water crossings, or other artificial structures across the channel bed. Artificial riffles have been created specifically for the Concho water snakes and in other situations, riffles were created as an unintended consequence downstream of the numerous low-head dams and low water crossings on the river.

In November of 2003 at the request of the Service, a subjective evaluation was made by O. Thornton to classify linear reaches of habitat in the Colorado and Concho rivers and also shoreline habitat within E.V. Spence and O.H. Ivie reservoirs. This evaluation of quantity and quality of riverine habitat suitable for the Concho water snake was summarized by the Service in Appendix B, and is based on personal experiences and observations over the last 15 years. Suitable riverine habitat is most common in the Upper Colorado (36 percent) and Lower Colorado (21 percent) river segments and most of the high quality habitat is also in these reaches of the river. The Concho River was estimated to contain 25 percent of the suitable snake habitat and 16 percent was high quality habitat (Appendix B).

Thornton (1992*b*) discussed the geologic setting, stream gradients, and channel configurations for reaches of the Colorado and Concho rivers supporting Concho water snakes. Shelves of limestone bedrock in and along the stream channel seemed to support the largest snake populations (Thornton and Dixon 1988; Thornton 1989, 1990, 1991, 1992*a*; Dixon et al. 1988, 1989). Shelf rock has numerous splits, crevices, and cracks; and flakes slough off to create a jumbled stream cobble that the Concho water snake uses for foraging and refuge. In the absence of shelf rock, other rock, such as limestone boulders, can provide adequate habitat.

Juvenile snakes are largely restricted to rocky riffles (Rose 1989, Scott et al. 1989, Werler and Dixon 2000). Neonates are generally found (in late summer and early fall) in gravel bars or shoreline settings where rock sizes range from small cobbles (64-128 mm or 2.5-5 in) to small boulders (256-512 mm or 10-20 in) using Lane's (1947) rock classification. However, some habitats with thriving populations (for example, Paint Rock, Concho County) lack this typical gravel bar setting. Here, the juvenile snakes may use boulders and shelf rock for cover. During their second year, snakes begin to use larger rocks, usually medium (51-102 cm or 20-40 in) to large boulders (102-204 cm or 40-80 in) (Scott et al. 1989).

Scott et al. (1989) and Rose (1989) reported that maturing/older individuals use a much wider range of habitats than juveniles. A radio telemetry study of Concho water snake movements found that adult snakes used a variety of available cover sites for resting including exposed bedrock, thick herbaceous vegetation, debris piles, and crayfish burrows (Dixon et al. 1989). Werler and Dixon (2000) reported that riverine Concho water snakes confined their foraging activities almost entirely to the riffles. Juveniles concentrated foraging chiefly on the shallow riffle margins, and adults hunted primarily in the deeper riffle parts of the stream (Werler and Dixon 2000). This conclusion was drawn from the findings of food contents of snakes which lacked fishes known to inhabit the deeper river pools. Gravid females occupied dense patches of vegetation and debris piles almost exclusively during the latter stages of gestation when they were inactive (Werler and Dixon 2000). Females give birth to young near riffles and neonates remained associated with the riffle where they were born, probably through the first hibernation season (Werler and Dixon 2000). Greene (1993) reported differences in micro-habitats used by different age classes (neonates, juveniles, and adults) and sexes of Concho water snakes and the diversity of micro-habitats used was further compounded by seasonality of use.

**Reservoir habitats.** In reservoir settings, the typical habitat element is broken rock along the shoreline (Dixon et al. 1988; Whiting 1993). Dixon (2004) characterized reservoir shoreline as prime habitat for the snake. Snakes are usually found in rocky areas near the habitats associated with schools of small fishes, such as shallow, silty areas with submersed vegetation (R. Pine, pers. comm., 2004). Although snakes seem to prefer the shallower areas, they are occasionally found on steeper shorelines where rock is available. Shoreline habitat evaluation by O. Thornton in December of 2003 estimated Spence Reservoir and Ivie Reservoir to contain 7 percent and 11 percent, respectively, of the range wide total of snake habitat (Appendix B). However, this evaluation was predicated on a different reservoir pool elevation than what was noted by Dixon, Thornton, Pine, and Allan during the survey of September 2004. This is important because both of these reservoirs experience nearly constant shifts in pool elevation and this results in ongoing changes in the snake's shoreline habitat. Dixon (2004) reported literally miles and miles of rocky shoreline in both reservoirs, but less in Spence with the reservoir only at seven percent capacity. Thus, both of these reservoirs have significant lengths of shoreline habitat available for the snake, but this linear length of habitat, as a percent of the total for the snake, is variable and not a constant. Differences among age classes in their use of different-sized rocks were similar to those in river settings. Juveniles and adults basked on dead shrubs and trees that had been killed by fluctuating lake levels. At Spence Reservoir, where there are virtually no dead trees or shrubs, snakes basked on the ground, generally among the protection of rocks (Whiting 1993).

Whiting (1993) described the distribution, movements, growth rates, habitat use, and age structure for the Concho water snake in E.V. Spence Reservoir, Ballinger Lake (Lake Moonen), and a Colorado River site. He found that Ballinger Lake had the largest population of all sites and the number of neonates born per year was frequently twice that of the other sites.

Whiting (1993) summarized the status of the populations in Spence Reservoir: "Growth rates were lower for Concho water snakes in a large reservoir [Spence] compared to a population on the Colorado River. Consequently, a lower proportion of females in the large reservoir bred in their second year compared with the Colorado River site. Based on life-table calculations, the two populations in the large reservoir were declining during the study period, while the river population was increasing." However, he also noted that during 1991 and 1992, a rising lake water elevation altered habitat availability in the reservoir. This is important because as the shoreline habitat changes when the lake elevation changes, the snake will move accordingly to seek preferred habitat.

Whiting et al. (1997) found rock structure along reservoir shorelines was a consistent distribution-wide correlate with Concho water snake densities. However, they found that rocky shorelines were not the sole predictor and that the rip-rap dam face of Spence Reservoir did not contain Concho water snakes, likely due to the presence of pea gravel substrates and also, possibly, due to water clarity, steeper gradient and higher wave actions. Whiting et al. (1997) also reported that elevation changes in Spence Reservoir, as little as one meter, altered habitat quality for the snakes. Lake fluctuations resulted in the loss of habitat in some areas (due to changing shoreline substrate structure) and the "creation" of habitat in other areas where rocks are exposed. It has not been quantified how overall habitat availability changes in the reservoirs with large changes in water elevation.

**Stream habitat.** A viable population is known from the "Elm Creek" site, about 3.2 miles (5.1 kilometers) north of Ballinger, Texas. This study site is a low-water crossing associated with about 500 meters (1,600 feet) of riffle and pool habitats. Several gravel and rock bars are present, each containing large flat rocks—a preferred refuge for Concho water snakes. Elm Creek has experienced a number of extended no flow periods over the five years prior to 2004 and then flooded in August 2004. In September 2004, Dixon (2004) noted Concho water snakes inhabited the site.

**Low-head dam habitat.** An example of a low-head dam habitat is the site known as "Egan Dairy Dam" on the Colorado River, about 5.3 miles (8.5 kilometers) north, northwest of Rowena, Texas. This site consistently produced captures of all life-stages on the Concho water snake and Dixon (2004) noted that this site changed little over the past 12 years and Concho water snakes continued to inhabit the site. The site was described as an intact low-head dam approximately one meter high, constructed of rocks and concrete. The many cracks and crevices in the dam provided shelter for the water snakes. Low-head dams may provide water for the fish and snakes during times of drought. Dixon (2004) noted that in both the Concho and Colorado river drainages, low-head dams form pools and these pools provide refuge for the snake and its prey base during times of drought.

**Hibernation sites.** Most of the information on adult hibernation sites has been from excavation of seven radio-tagged snakes from three sites (hibernacula) in the winter (Dixon et al. 1989). All three sites were within 5 m (16 ft) of water and contained moist substrates. Cloaca temperatures of the seven Concho water snakes ranged from 6.3 to 18.3 degrees C (43.3 to 64.9 degrees F). The adult snakes were using spaces beneath shelf rock and crayfish burrows as hibernacula. Young of the year were found using subterranean spaces within loose rock/soil aggregations during hibernation (Dixon et al. 1990).

**Vegetation.** Bank and shoreline vegetation plays an important role in providing cover and basking sites for Concho water snakes and also provides habitat for the small fish eaten by Concho water snakes. The type of vegetation does not appear to be important, but vegetation density and orientation may be important. Gravid females seek basking sites protected by thick, dense vegetation. Larger trees and shrubs, such as saltcedar (*Tamarix spp*.), pecan (*Carya illinoiensis*), cedar elm (*Ulmus crassifolia*), and willow (*Salix* sp.) that have limbs over the water, provide basking sites for all ages except neonates. Switchgrass (*Panicum virgatum*) and Mexican devil weed (*Aster spinosus*) are the most common herbaceous vegetation along the riverbanks and both provide cover and basking sites for all age classes. Thornton and Dixon (1988) report a dense variety of the non-native johnsongrass (*Sorghum halepense*) growing on gravel bars and along riverbanks apparently unaffected by high flows (greater than 500 cfs [14 cms]). Greene (1993) described riparian vegetation including: mesquite (*Prosopis juliflora* var. *glandulosa*), western soapberry (*Sapindus drummondi*), hackberry (*Celtis laevigata*), button-bush (*Cephalanthus occidentalis*), agarita (*Berberis trifoliolata*), Texas prickly pear (*Opuntia engelmanni*), slender stem cactus (*Opuntia leptocaulis*), greenbriar (*Smilax* sp.), and poison ivy (*Rhus radicans*).

**Movement.** Nine adult Concho water snakes with radio transmitters were monitored for 45 to 107 days. During this period, they moved from 693 to 2,244 feet (211 to 684 meters) (Werler and Dixon 2000). Marked juvenile snakes, recaptured as adults moved 4 to 12 miles (6.4 to 19.3 kilometers) along the same river system (Werler and Dixon 2000). However, most snakes showed a strong fidelity to one area and moved little. Juvenile snakes generally remained in the area of a riffle complex and movements increased as the snakes aged (Werler and Dixon 2000).

**Relative abundance.** O. Thornton (biologist for the District) and James Dixon (Professor Emeritus with Texas A&M University (TAMU)) have studied the Concho water snake for over a decade. They characterize the Concho water snake as the most common *Nerodia* in the Concho and Upper Colorado River watersheds (O. Thornton, J. Dixon, pers. comm., 2004).

As part of implementing the Corp's 1987 MOA, the District monitored the status of the Concho water snake in the upper Colorado River from 1987 to 1996. Thirteen stream monitoring sites were established on the Concho and Colorado rivers; plus one tributary site (Elm Creek) and one reservoir site at Ballinger Municipal Lake (Lake Moonen). Additional sites where historical riffles had been restored were added for monitoring in 1991. Additional snake captures were made in conjunction with numerous life-history, genetics, and distributional studies undertaken by or for the District. Over the 11-year period (includes a few 1997 collections), various surveys were conducted throughout the current and historic range, including tributaries and reservoirs.

In 1998, the District summarized the data that had been collected on snake populations, status and distribution (District 1998). The overall number of snakes collected (Table 4) varied over the 10 study years, with a high of 1,633 unique snakes caught in 1988 and a low of 448 unique snakes collected in 1995 (Figure 2). However, this data cannot be used for trend analysis as study effort varied among the years and data for study effort is generally lacking.

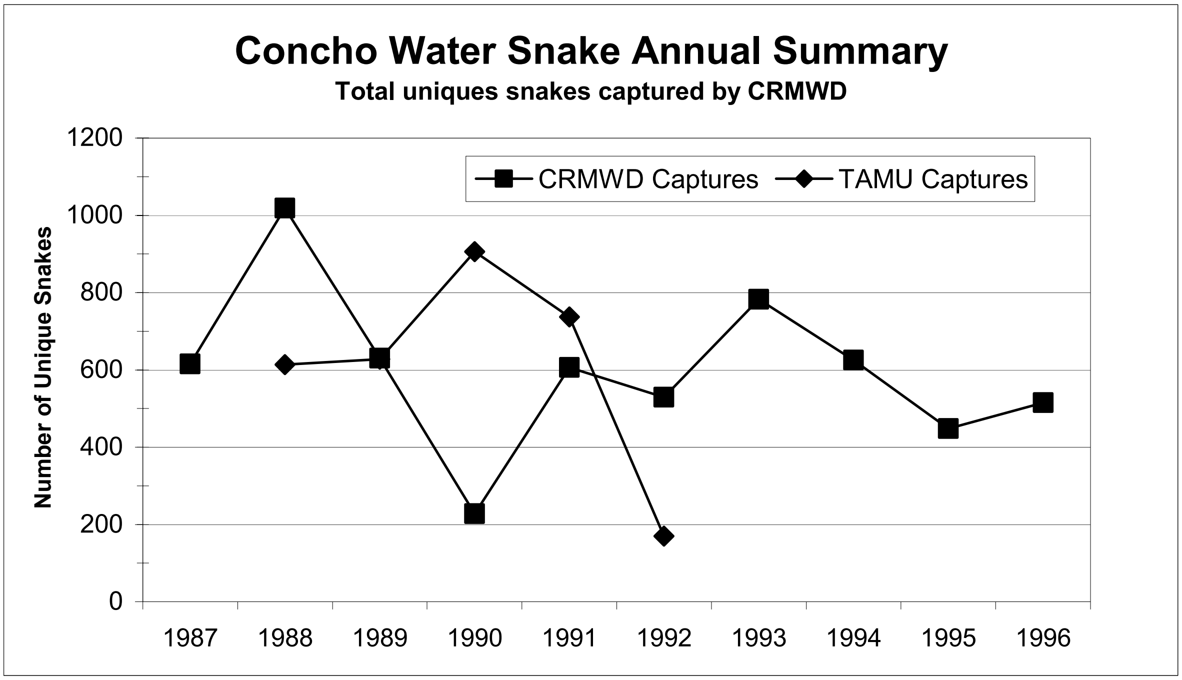



Figure 2. Total annual summary of District and TAMU captures of unique Concho water snakes (CRMWD 1998).

Table 4. Unique number of Concho water snakes captured annually (including all age classes) within each respective river reach, reservoir, or tributary, taken from District (1998, page 21)*.

| **River Reach / Reservoir / Tributary** | **1987** | **1988** | **1989** | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **11-year Total** | **% of total*** | **mean snakes/ annual**** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Colorado River | 305 | 894 | 905 | 661 | 807 | 446 | 530 | 352 | 319 | 353 | 14 | **5586** | 61.6% | 558.6 |
| Concho River | 90 | 435 | 249 | 181 | 110 | 97 | 104 | 95 | 62 | 94 | 0 | **1517** | 16.7% | 151.7 |
| Ivie Reservoir | | | | | 88 | 42 | 84 | 85 | 30 | 32 | | **361** | 4.0% | 60.2 |
| Lake Spence | 39 | 45 | | 126 | 153 | 11 | | | | | | **374** | 4.1% | 74.8 |
| Lake Moonen | 97 | 140 | 67 | 137 | 166 | 71 | 52 | 51 | 14 | 5 | | **800** | 8.8% | 80.0 |
| LB Chute | | | | | | | | | 4 | 12 | | **16** | 0.2% | - |
| Elm Creek | 79 | 91 | 37 | 29 | 19 | 30 | 13 | 42 | 19 | 18 | | **377** | 4.2% | 37.7 |
| Coyote Creek | | 26 | | | | 1 | | | | 1 | | **28** | 0.3% | - |
| Bluff Creek | 4 | 2 | | | | 1 | | | | | | **7** | 0.1% | - |
| Dry Hollow | | | | | | | | | | | 1 | **1** | 0.0% | - |
| Kickapoo Creek | | | | | | | | | | | 1 | **1** | 0.0% | - |
| Grape Creek | 1 | | | | | | | | | | | **1** | 0.0% | - |
| **TOTAL** | **615** | **1633** | **1258** | **1134** | **1343** | **699** | **783** | **625** | **448** | **515** | **16** | **9069** | | |
| | | | | | | | | | | | | | | |
| TAMU | | 614 | 628 | 906 | 737 | 170 | | | | | | **3055** | 33.7% | |
| District | 615 | 1019 | 630 | 228 | 606 | 529 | 783 | 625 | 448 | 515 | 16 | **6014** | 66.3% | 601.4 |
| TOTAL TRIBS | 84 | 119 | 37 | 29 | 19 | 32 | 13 | 42 | 19 | 19 | 2 | **415** | 4.6% | 41.5 |
| TOTAL RESERVOIRS | 136 | 185 | 67 | 263 | 407 | 124 | 136 | 136 | 44 | 37 | 0 | **1535** | 16.9% | 153.5 |
| TOTAL TRIBS + RIVERS* | 479 | 1448 | 1191 | 871 | 936 | 575 | 647 | 489 | 404 | 478 | 16 | **7534** | 83.1% | 753.4 |

Note: * these fields not calculated in original table by District (1998).
** calculated for 1987-1996 for rivers and Moonen; for years with snakes for other reservoirs.

There are at least three methods that could be used to assess the relative abundance, and trend, of Concho water snakes: mark and recapture, “rock flipping,” and trapping. Both rock flipping and trapping would result in measures of catch per unit effort (CPUE).

As of 1997, a total of 9,069 Concho water snakes, not counting recaptures, had been captured, including 1,535 in reservoir habitat (Table 4). A large number of Concho water snakes have been marked, generally with pit-tags. Mark and recapture studies have been used for many purposes, including estimating abundance, longevity, movements, and viability of the Concho water snake.

However, for a number of reasons, primarily insufficient sampling effort at any single study site and a host of variables, especially environmental variability within a site and among sites, study results have not been robust enough to allow either population or trend estimates with satisfactory precision. Whiting (1993) used mark and recapture techniques to study Concho water snakes in three artificial habitats (two lakes and a created riffle habitat). However, Whiting noted that sample sizes were insufficient to allow use of the more robust analytical tools and high rates of migration, along with the effects of mortality, limited analytical options for the Ballinger Lake study site. Whiting generated population estimates for four cohorts at each of the three sites and population estimates ranged from about 20 to 70 snakes with great variability among cohorts at each site. Standard errors of the estimates varied greatly from about 7 percent to 26 percent of the population estimate and variability was as great within cohorts at a study site as it was by year among study sites. This probably means that too many variables are affecting the mark and recapture results to allow reliable trend analysis unless sampling effort were drastically increased.

Researchers also collected Concho water snakes by searching hiding places (especially under rocks) and by trapping the snakes in funnel minnow traps. Results from both of these methods could be used in “catch per unit effort” analyses and used to monitor trend.

During the fall months, the water snakes, especially the newborn snakes, can be found under flat rocks. Newborn, or neonate, Concho water snakes should be good indicators of the health of the population as they measure both the adult population and are indicators of healthy populations. Early in the studies, data were collected for the number of search hours spent flipping rocks and the sizes and number of Concho water snakes collected (Table 5). However, in subsequent years data were not collected that allowed estimation of search hours. The early data does indicate that the method could be useful for measuring population trend of the Concho water snake.

Table 5. Comparison of Concho River, Colorado River, and Reservoir sites for capture rates of juvenile Concho water snakes. All data was from 1987 and 1988 and data was not segregated by year. All data was from mid-August to early October. Means represent juvenile Concho River water snakes caught per search hour but the standard error reflects variability among search days. The capture probabilities of juvenile snakes are probably not independent events per site per search event, therefore the mean statistic is a measure of relative abundance and many assumptions would have to be made before catch rates could be compared among sites.

| Site | # of Sample Events | Mean juvenile snakes/search hour | Standard error of mean per search event |
|---|---|---|---|
| Colo. R. 5 mi SE Bronte | 4 | 0.76 | 0.28 |
| Lake Spence | 7 | 0.13 | 0.07 |
| Colo. R. 3.5 mi SW Rockwood | 6 | 1.67 | 0.4 |
| Colo. R. 5 mi SSE Rockwood | 6 | 1.32 | 0.24 |
| Colo. R. 9 mi S Gouldbusk | 4 | 1.42 | 0.64 |
| Colo. R Turkey Bend | 13 | 1.94 | 0.63 |
| Concho R. LWC | 5 | 1.7 | 0.78 |
| Concho R. Tickle LWC | 7 | 1.14 | 0.61 |
| Colo R. 5.8 mi ENE Doole | 5 | 1.0 | 0.34 |
| Colo R 5.3 mi NNW Rowena | 7 | 2.82 | 0.77 |
| Colo. R 6 mi SE Ballinger | 5 | 1.86 | 0.17 |
| Colo. R 6 mi SE Maverick | 6 | 1.3 | 0.31 |
| Colo R Hwy 83 | 7 | 2.67 | 0.73 |
| Elm Creek 3.2 N Ballinger | 11 | 2.2 | 0.48 |
| 1987 Lake Moonen shoreline NW of Dam | 8 | 1.33 | 0.36 |
| 1988 Lake Moonen shoreline NW of Dam | 9 | 0.68 | 0.25 |

Another method of capturing Concho water snakes uses regular funnel type minnow traps. The minnow traps are set in shallow water judged to be Concho water snake habitat, usually around rocks and riffles. The traps are checked daily and numbers (including size classes and sexes) of Concho water snakes can be equated to snakes per trap-day. Results from both the rock flipping and the minnow trap methods are subject to many variables, including fluctuations in the environment and searcher or trapper expertise. J. Dixon (pers comm., 2004) provided the following summary for 1990-1992 (Table 6).

Table 6. Catch per unit effort results for Concho water snakes captured in funnel minnow traps in 1991 and 1992. Data are courtesy of J. Dixon, pers. comm., 2004. As with the "rock-flipping" method, many assumptions would have to be accepted before catch rates could be compared among sites or between years at a site.

| Trapping Event | # of Trap Days | # of Concho Water Snakes Captured | Concho Water Snakes/Trap-Day |
|---|---|---|---|
| April 1991 | 99 | 11 | 0.11 |
| May 1991 | 842 | 91 | 0.11 |
| June 1991 | 1806 | 196 | 0.11 |
| July 1991 | 2059 | 164 | 0.08 |
| August 1991 | 744 | 56 | 0.08 |
| September 1991 | 178 | 31 | 0.17 |
| October 1991 | 172 | 24 | 0.14 |
| April 1992 | 244 | 32 | 0.13 |
| May 1992 | 2048 | 244 | 0.12 |
| June 1992 | 1157 | 136 | 0.12 |

The results of these data are fairly consistent among months and between years, suggesting that trapping Concho water snakes could be a good method of assessing trends in abundance, but trapping effort would have to be sufficient. Data provided by the District allowed a more in-depth examination of catch per unit effort for two specific areas, a section of the Colorado River 6 miles SE of Ballinger, Texas and an area known as "below Freese Dam" on the Colorado River (Table 7).

Table 7. Catch per unit effort results for Concho water snakes captured in funnel minnow traps at two locations in 1991 and 1992 (data courtesy of the District). Basic statistics are the results of program MINITAB. As before, many assumptions would have to be accepted before catch rates could be compared among sites or between years at a site.

| Location | Time Period | Number of Days Trapping | Mean Captures per Trap Day | Standard Deviation of the Mean | Standard Error of the Mean | Minimum Captures per Trap Day | Maximum Captures per Trap Day |
|---|---|---|---|---|---|---|---|
| 6 SE Ballinger | All 1991 | 50 | 0.09 | 0.06 | 0.009 | 0 | 0.28 |
| 6 SE Ballinger | 5/27-6/3/91 | 6 | 0.094 | 0.037 | 0.015 | 0.042 | 0.15 |
| 6 SE Ballinger | 6/17 – 7/30/91 | 40 | 0.098 | 0.062 | 0.010 | 0 | 0.21 |
| 6 SE Ballinger | 8/15 – 8/21/91 | 4 | 0.096 | 0.044 | 0.022 | 0.029 | 0.12 |
| 6 SE Ballinger | All 1992 | 42 | 0.09 | 0.063 | 0.010 | 0 | 0.31 |
| 6 SE Ballinger | 4/12 – 5/24/92 | 31 | 0.105 | 0.065 | 0.012 | 0.016 | 0.31 |
| 6 SE Ballinger | 6/17 – 6/27/92 | 11 | 0.05 | 0.036 | 0.011 | 0 | 0.13 |
| Freese Dam | All 1991 | 88 | 0.08 | 0.059 | 0.006 | 0 | 0.23 |
| Freese Dam | 5/12 – 6/16/91 | 20 | 0.104 | 0.056 | 0.012 | 0 | 0.19 |
| Freese Dam | 6/17 – 8/9/91 | 48 | 0.068 | 0.048 | 0.007 | 0 | 0.19 |
| Freese Dam | 8/11 – 10/11/91 | 20 | 0.10 | 0.072 | 0.016 | 0 | 0.23 |
| Freese Dam | All 1992 | 30 | 0.167 | 0.082 | 0.015 | 0.025 | 0.31 |
| Freese Dam | 5/3 – 5/24/92 | 20 | 0.151 | 0.092 | 0.021 | 0.025 | 0.31 |
| Freese Dam | 6/17 – 6/27/92 | 10 | 0.20 | 0.048 | 0.015 | 0.093 | 0.26 |

Generally, researchers set 20-65 minnow traps per day of trapping at each site. Results were remarkably consistent among sites, between sites, and among seasons and days. Generally, for the greater sampling efforts, catch per unit effort ranged from about 0.07 to 0.1 snakes per trap-day (about one snake captured for every 10 to 14 traps set per day). In part, this may be attributed to the propensity for snakes to be recaptured. However, when traps were increased at a site, the catch rate remained more or less constant, which may suggest that in suitable habitat, a somewhat constant density of Concho water snakes may be expected. In future monitoring efforts, trapping may be the best and most efficient method of determining presence or absence but comparison through time would be difficult because of the large sampling effort that would be required for meaningful results and the great fluctuation in environmental variables that could occur.

In August and September, O. Thornton and J. Dixon revisited many of the former study sites. For J. Dixon, this was about 12 years after his previous work and 2004 was about the 12th year of ongoing drought in the watersheds. The purpose of the 2004 study was to (1) gain the observations and impressions of the two people most experienced with the snake and its habitats, and (2) attempt to document the presence of the species at former study sites. The 2004 study effort was much less than the effort spent during the 1987-1996 studies. Table 8 summarizes the observations made by Dixon (2004) compared to selected previous reports.

Table 8. Evaluations of Concho water snake captures and habitat evaluation at specific sites.

| Site | Dixon (2004) | Selected Previous Reports |
|---|---|---|
| Ivie Reservoir | Reservoir at about 30 percent capacity. Survey by rock flipping only. Two neonates and recent evidence (shed) of a 1-year old Concho water snake (CWS) were found. Rocky shoreline habitat present in significant quantity throughout the reservoir. | CRMWD (1993): 1993 was first year the reservoir maintained a full level.<br>CRMWD (1994): Snakes were generally found throughout the reservoir. There are locations that have yielded snakes annually since 1991. |
| Spence Reservoir | Reservoir at about 7 percent capacity. 30 traps were set for 3 days. One juvenile and 2 adult CWS were captured. Other CWS were observed on 3 occasions. | Whiting (1993): Two sites were studied in this 24 year-old reservoir. Although CWS have been found at numerous sites, Pump Station (1988-91 cohorts n = about 200 CWS) and Pecan Creek (same cohorts, n = about 149 CWS) were the only two established populations.<br>CRMWD (1992): In 1991, 4,734 trap days resulted in capture of 307 CWS (0.065 CWS/trap day) and 128 unique CWS (0.027 unique CWS/trap day). |
| Lake Ballinger (same as Lake Moonen) | Virtually dry, water depth of about 2 feet (covering about 200 acres, O. Thornton, pers. comm. 2004). No CWS observed. Foot survey only, no trapping for snakes. | Whiting (1993): Had the largest population of the 3 areas he studied. Number of neonates born per year was frequently twice that of other sites.<br>CRMWD (1994): Little change in CWS numbers from 1993. |
| Concho River: Vinson Dam | Rate of flow estimated at less than 0.3 cfs. Eight traps were set for 1 day. Rocks were turned. No CWS were observed or captured. | CRMWD (1994): CWS observed abundance reached a peak in 1993 with more than 40 CWS observed. 1994 observed abundance was similar to 1992, which was greater than observed abundance of 1987 through 1991. |

| **Site** | **Dixon (2004)** | **Selected Previous Reports** |
|---|---|---|
| Concho River: Glasscock Site | Has large deep pools that probably act as a refuge during times of drought. Two juvenile CWS observed foraging. 20 traps set for 1 day and 1 neonate CWS captured. | CRMWD (1994): Multiple pool-riffle complexes. Number of observed CWS peaked in 1988 with more than 50 CWS counted. Numbers observed since 1988 were steady to slightly declining, with a total of 10 CWS captured in 1994. |
| Colorado River: Cervenka Dam | Greatly changed over past 12 years and drought has caused establishment of vegetation and reduced flow. One juvenile and one adult CWS were observed. | Whiting (1993): Stretch of riffles less than 100 m. Based on data collected through 1992, Whiting made a point estimate of 167 CWS for the 1988-91 cohorts. |
| Colorado River: Egan Dam Site | Had not changed appreciably over past 12 years. Flow estimated to be 8 to 10 cfs. Two CWS were observed and 6 traps set for 1 day resulted in 1 adult male CWS. | CRMWD (1994): Number of CWS observed peaked in 1988 with about 80 CWS. 15 CWS were observed in 1994, down from more than 40 observed in 1993. |
| Elm Creek Site | Dry for 3 years prior to August 2004. Not trapped because humans were using the site. Riffles and rocks were searched and 6 neonates and 1 subadult CWS were quickly captured. | CRMWD (1994): Each year the creek experiences flood events with a very high discharge. 45 CWS observed in 1994, which was more than any year since 1988 when more than 80 were observed. |
| Colorado River: Highway 83 | Riffles were searched and 10 traps were set for 1 day. No CWS were observed. | CRMWD (1994): Saltcedar present along one bank. 66 CWS were observed in 1994, with an upward trend since 1990, when about 20 CWS were observed. |
| Colorado River: Freese Dam | Site has been altered more than any other site over past 12 years. Beavers have created several ponds and changed downstream flows. Site had no vegetation in 1992 but now completely vegetated. 29 traps were set for 1 day and one juvenile female CWS was captured. | CRMWD (1994): Original riffle configuration was altered by construction of Freese Dam. Rapid proliferation of channel vegetation thoughout the site. 40 CWS observed in 1994, with a steady decline in observed CWS since the more than 200 observed in 1991. |
| Colorado River: Riverbend Ranch | Riffle has changed slightly from O. Thornton's 1996 visit. Grass is denser and riffle has become altered by grass and shrubs. Riffle needs a flushing flow. No traps were set. Quick search (about 15 minutes) by flipping rocks resulted in one juvenile CWS captured. | CRMWD (1994): During low flow periods, water flows along the south side of the island. 28 CWS were observed in 1994, with a steady increase in observed CWS since the low of about 10 observed in 1991. About 55 were observed in 1988. |

Despite the relatively brief study period and reduced trapping effort, Dixon (2004) was able to document the continued presence of Concho water snakes in both reservoirs and in both the Concho and Colorado rivers. The 2004 survey was undertaken in about the 12th year of an extensive drought and flows were generally reduced and vegetation had encroached into many of the study sites. The greatest change was in Lake Moonen (Ballinger Lake) that at one time had a robust Concho water snake population (Whiting 1993). The lake was virtually dry in September 2004 and no water snakes were observed. The results at the Elm Creek site were particularly noteworthy. The creek had experienced a number of extended no flow periods over the five years prior to 2004. During his 2004 surveys, J. Dixon found both new-born young and a subadult Concho water snake. J. Dixon was able to confirm the continued presence of Concho water snakes at 8 of 11 sites searched.

**Population Viability.** Mark and recapture data has also been used to examine the viability of Concho water snake populations. J. Dixon (pers. comm., 2004) believes the large dams associated with reservoirs probably effectively limit interchange between snakes up and downstream of the dams. Jeff Hatfield and James Hines (unpublished manuscript, 2004) attempted to estimate the annual survival ($\lambda$) and finite rate of increase for the Concho water snake based on the mark and recapture data. Their analyses suffered from problems with assumptions and sample sizes. Basically, their results failed to demonstrate that any of the sites studied had viable populations but they pointed out that these results do not necessarily mean that the populations are not viable, but it does mean that the data used in the analysis and the estimates produced did not support conclusions of viability. They also noted that because the models do not account for immigration, rates of increase are usually biased to being too small. Also they did not assume stochasticity or infinite carrying capacity, which would make the estimated $\lambda$ smaller in a population viability analysis. Finally, they attempted to estimate the average finite rate of increase for both sexes of adult Concho water snakes and using the 10 years of data, excluding the reservoir study sites. In this case, the point estimate was 1.26, which would suggest overall viability for the Concho water snake. However, the standard error (0.18) would result in a 95 percent confidence interval that would include point estimates of $\lambda$ less than 1.0.

**Range.** The Concho water snake has one of the smallest distributions of any snake in the U.S. It (including the Brazos water snake combined ranges) is one of only two snakes endemic to Texas, with the Trans-Pecos black-headed snake (*Tantilla cucullata*) being the other (Werler and Dixon 2000). The Concho water snake occurs over approximately 238 miles of the Colorado and Concho rivers in central Texas and more than 40 miles of artificial shoreline habitat on E.V. Spence Reservoir, Ivie Reservoir, and Ballinger Municipal Lake (also known as Moonen Lake). Counties of known occurrence include Brown, Coke, Coleman, Concho, Lampasas, McCulloch, Mills, Runnels, San Saba, and Tom Green counties. The range can be segmented into 5 subpopulations. The Concho River segment is from San Angelo to the confluence with the Colorado River. Spence Reservoir is the shoreline distance of the lake. The Upper Colorado River segment is from the outflow of Spence Reservoir to the inflow of Ivie Reservoir. Ivie Reservoir is the shoreline distance of the lake. The Lower Colorado River segment is from the outflow of Ivie Reservoir to Bend State Park.

This historic distribution of the Concho water snake was based on reports beginning with the species description in 1944 (Brnovak 1975; Marr 1944; Flury and Maxwell 1981; Scott and Fitzgerald 1985; Tinkle and Conant 1961; and Williams 1969). These studies reported the snake has been extirpated from the tributaries above the City of San Angelo (South Concho River, Dove Creek, and Spring Creek). Prior to 1987, the area where the snake was believed to be most concentrated was in the vicinity of the Stacy Dam site near the confluence of the Concho and Colorado rivers. Outside of this area, the snake had been found only in isolated occurrences indicating a disjunct, fragmented distribution. The snake had not been collected in the Colorado River reservoirs or in the degraded riverine habitat below the E.V. Spence Reservoir. It also had not been found in perennial tributaries with the possible exception of Elm Creek near Ballinger.

One of the keys to finding snakes was seasonal timing of searches and the use of minnow traps (District 1998). The Concho water snake has a much higher level of activity during April, May, September, and October, compared to June, July, and August, when they reduce their activity. Spring and fall surveys therefore are more likely to encounter snakes than are mid-summer surveys. Searches by District field biologists beginning in 1987 found the snake within E.V. Spence Reservoir, downstream of Spence Reservoir in the artificial riffles, Ballinger Municipal Lake, and in the old Ballinger Lake and the connecting channel between the two reservoirs. The snake was also found in multiple locations on Elm Creek plus two of its tributaries, Bluff Creek and Coyote Creek. Searches on the main stem rivers (Colorado and Concho) indicated the snake was occupying numerous riffle sites plus was occasionally found in the pools between riffles. The snake was also documented to occur in Kickapoo Creek and Dry Hollow, two tributaries of the Concho River with single specimens found in 1997. Searches above E.V. Spence Reservoir found the snake at several locations on the Colorado River in Mitchell County.

**Colorado River.** The snake has been found in the Colorado River above E.V. Spence Reservoir and downstream to Sulphur Springs. The river reach immediately below E.V. Spence Reservoir was thought to have been extirpated of Concho water snakes within five years after the dam was completed (Brnovak 1975). District biologists also failed to find snakes in this reach during foot searches until artificial riffles were constructed in 1989. Subsequent trapping at these sites in the fall of 1991 found the snake to still be present, albeit in much reduced numbers. This capture of snakes is significant because it indicates they were present in degraded habitat. The placement of the rocks in the river (artificial riffles) facilitated capture of the snakes. Had minnow traps been used at these historic riffles prior to the construction of the artificial riffles, snakes likely would have been captured (O. Thornton, pers. comm., August 2004).

Locations in the Lower Colorado River near the towns of Regency, Harmony Ridge, Adams, and Bend had riffles where Concho water snakes were found. These localities were presumed to be disjunct, isolated meta-populations that were assumed to be not in contact with the upstream population. Although isolated searches have been conducted between Regency and Bend without finding snakes, a comprehensive and thorough search (with traps) of this reach has never been accomplished.

During the study period from 1987-1996, the Colorado River reach consistently produced the greatest number of Concho water snakes. A total of 5,586 unique snakes were found in the Colorado River and this represented 62 percent of the total snakes captured (9,069) and an average of 559 snakes per year (Table 4).

**Concho River.** During the monitoring period, snakes were found in the entire reach of the river from the Bell Street dam (San Angelo) to the confluence with the Colorado River and in fairly good numbers with a total of 1,517 unique snakes captured, which was 17 percent of the total snakes captured (9,069) and an average of 152 snakes per year (Table 4).

**Reservoirs.** Surveys of reservoirs began in earnest in 1987 after snakes were found in E.V. Spence Reservoir and Lake Moonen near Ballinger. A monitoring site was established at Lake Moonen on a stretch of shoreline in the emergency spillway. Spence Reservoir and Lake Moonen were studied intensively in 1990 and 1991 by researchers from TAMU. Additional studies by students from TAMU during 1990 and 1991 involved a more comprehensive investigation of Concho water snake movements and population demographics in a lacustrine environment (Whiting 1993). This study also pointed out the fact that reservoir shoreline habitat was typically in a state of flux and never constant, another indication of the snake's ability to adapt to shifting environments. Because of TAMU intensive studies, District biologists refrained from working these reservoirs in 1990 resulting in the low number of captures shown in Table 4. Over the five years of studies (1987, 1988, 1990-92) a total of 374 unique snakes were captured at Spence, representing 4 percent of the total snakes captured and an average of 75 snakes per year (Table 4).

After inundation of the Ivie Reservoir basin began in 1990, annual searches were performed on the shoreline throughout the lake in areas having rocky substrates that mimicked Concho water snake habitat. These searches were successful with the snake being found each year in a multitude of localities around the reservoirs shoreline. Over the six years of studies (1991-1996) a total of 361 unique snakes were captured at Ivie Reservoir, representing 4 percent of the total snakes captured and an average of 60 snakes per year (Table 4).

Surveys of the Ballinger Municipal Lake (Lake Moonen) became a routine monitoring activity after a large number of neonates were discovered in the emergency spillway area in August of 1987. Besides the spillway area (which was established as one of the upper Colorado River monitoring sites), the shoreline northeast of the dam and part of the west shoreline north of the spillway were also periodically searched during the ten year monitoring period. Over the ten years of studies (1987-1996) a total of 800 unique snakes were captured at Moonen, representing 9 percent of the total snakes captured and an average of 80 snakes per year (Table 4). Foot surveys of this lake in August 2004 found only a small pool of water (approximately 200 acres), no inflow to the lake, and no snakes were found to be present (Dixon 2004).

By the end of the 10-year monitoring program, a total of 1,535 Concho water snakes had been captured from the three reservoirs representing 17 percent of the total snakes captured and an average of 154 snakes per year. All three age classes (adults, juveniles, and neonates) had been found in these reservoirs indicating the presence of reproducing populations.

**Tributaries.** Very few tributaries of the Colorado and Concho rivers sustain viable populations of Concho water snakes. The Elm Creek watershed in Runnels County was significant because the snake was well established in it and two of its tributaries, Coyote and Bluff creeks. A monitoring site was established on Elm Creek and it too was used as a study site by the TAMU researchers. A high number of snakes (mainly newborn of the year) were documented in 1987 and 1988, however, captures dropped significantly in 1989. This was probably caused by the loss of several mature females in 1988 during radio-telemetry studies. The two snakes found on Dry Hollow and Kickapoo Creek in 1997 were inadvertently discovered during water quality surveys (Table 4). Other tributaries (some substantial streams), such Beals Creek, Jim Ned Creek, Pecan Bayou, Brady Creek, San Saba River, and Llano River, were surveyed in the past and Concho water snakes have never been collected from these streams (Scott et al. 1989).

South Concho River and Dove Creek, tributaries to the Concho River upstream of San Angelo, historically had Concho water snakes (Marr 1944; Tinkle and Conant 1961; Scott et al. 1989). Surveys since 1979 upstream of San Angelo have only resulted in the collection in 1985 of 2 specimens in Spring Creek, a tributary to Twin Buttes Reservoir (Scott et al. 1989). The total geographic extent of the habitat available at the site was estimated at 2 kilometers (1.2 miles) long. No recent information is available on this site and the populations upstream of San Angelo are presumed extirpated.

**Summary.** The Concho water snake inhabits the Colorado and Concho rivers from Bend State Park upstream to the City of San Angelo on the Concho River and upstream to above E.V. Spence Reservoir to the confluence of Beals Creek on the Colorado River. Depending on drought stage, this is about 451 kilometers (280 miles) of river habitat and about 64 kilometers (40 miles) of reservoir habitat. Prior to pre-European settlement, the natural habitat for the Concho water snake was stream and river habitat. The Concho water snake presently also survives in lakes, reservoirs, and small impoundments created by manmade low-head dams.

In this area of Texas, the Concho water snake is the most common water snake (*Nerodia*). The Concho water snake is closely tied to water and is seldom found more than a few meters from water. Rocks are important for refuge and gravid females are most often encountered in debris piles. Overhanging vegetation provides basking sites. The snake is known to over-winter in crayfish burrows and other holes in the river-banks and reservoir shorelines, and the species also shelters from winter weather under rocks. Although over a period of years, Concho water snakes may move long distances (up to 19 kilometers (12 miles) has been documented), during the course of a season, most snakes probably only move a few hundred meters, if at all (Werler and Dixon 2004). The large dams associated with the reservoirs probably effectively halt interchange between snakes above and below these dams.

Concho water snakes almost exclusively eat small fish. Therefore, habitat (water, cover, and prey) for the small fish is important for the Concho water snake. Female Concho water snakes bear young at 2 to 3 years of age and probably few snakes live longer than 5 years. Young are live-borne and litters range from about 4 to 24 neonates, with an average of about 11 per litter. Without doubt, mortality from predators is great. There are no reliable estimates of Concho water snake densities and observations of relative abundance must be viewed in the context of the many variables, especially environmental variability, that affect perceived abundance. Observed numbers of Concho water snakes varied considerably at the monitoring sites among years and among monitoring sites. With the exception of Whiting (1993), the studies were not designed to estimate abundance or density and no inference can be made about trends in abundance or density. In 2004, Dixon (2004) briefly surveyed 11 sites that had been extensively surveyed from 1988 to 1992. He was able to document the continued presence of Concho water snakes at 8 of the 11 sites. Snakes may have occurred at two additional sites but the survey effort was too brief to produce results. Lake Moonen, which at one time had a robust population of Concho water snakes, was virtually dry and the snake is probably extirpated, at least temporarily, from the lake. Elm Creek had experienced a number of extended no flow periods over the five years prior to 2004 but Concho water snakes had once again occupied the creek by the September 2004 surveys and newborn young were observed.

## IV. Environmental Baseline

The Environmental Baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and ecosystem, within the action area.

### a. Status of the species within the action area

The action area encompasses the entire range of the species and includes District operations as defined in the Project Description.

### b. Factors affecting species environment within the action area

Much of the county water information in this section comes from the Regional Water Plan for Region F (Regional Water Plan 2001).

The Concho water snake is dependent on a habitat containing water and its prey species, fish. The snake has evolved in an area where drought is a common circumstance. This area is part of the Texas Water Development Board's Region F. Most of Region F is in the upper portion of the Colorado Basin and in the Pecos portion of the Rio Grande Basin. A small part of the region is in the Brazos Basin. Region F is characterized by low precipitation, 7-27 inches (17.8-68.6 cm)/year, low runoff, 0.1-0.46 inches (0.25-1.17 cm)/ year, and high reservoir evaporation, 67.8-74.5 in (172-189 cm)/year. Precipitation increases from west to east from slightly more than 10 inches (25.4 cm) per year in western Reeves County to more than 28 inches (71.1 cm) per year in Brown County. The rate of reservoir evaporation exceeds rainfall throughout Region F. The major aquifers are: Edwards-Trinity Plateau, Ogallala, Cenozoic Pecos Alluvium and a small portion of the Trinity. Minor aquifers include: Dockum, Hickory, Lipan, Ellenburger-San Saba, Marble Falls, Rustler, and the Capitan Reef Complex. Counties in Region F include: Borden, Scurry, Andrews, Martin, Howard, Mitchell, Loving, Winkler, Ector, Midland, Glasscock, Sterling, Coke, Runnels, Coleman, Brown, Reeves, Ward, Crane, Upton, Reagan, Irion, Tom Green, Concho, McCulloch, Pecos, Crockett, Schleicher, Menard, Sutton, Kimble, and Mason. The population has increased from 81,985 in 1900 to an estimated 590,618 in 1998, a compounded rate of 1.3 percent per year.

The current water supply in Region F consists of ground water, surface water from in-region reservoirs, local supplies and wastewater reuse. There is a small amount of ground water that comes from Regions G and E. Based on the assessment of currently available supplies, ground water is the largest source of water in Region F, accounting for 66 percent of the total supply. Reservoirs are the second largest source of water, with 21 percent of the supply, and local supplies of wastewater reuse generally provide the remainder of the region's supply. The total currently available water supply for Region F is estimated at approximately 713,000 acre-feet (879 million cubic meters). The water demand in Region F in 2000 was 881,500 acre-feet (1,087 million cubic meters).

Total demands for Region F are projected to increase from 881,500 acre-feet (1,087 million cubic meters) per year in 2000 to 900,200 acre-feet (1,110 million cubic meters) per year in 2050. The largest demand category is irrigation, which accounts for nearly 75 percent of the total demand in this Region, while most surface waterin the action area is used for municipal supplies. Regional demands exceed the available supply by over 170,000 acre-feet (210 million cubic meters) per year in 2000, increasing to 200,000 acre-feet (247 million cubic meters) per year by 2050.

**Action Area.** Counties in the action area include: Coke, Runnels, Tom Green, Coleman, Concho, McCulloch, Brown, Mills, San Saba, and Lampasas. Mills, San Saba, and Lampasas counties are in the action area, but not in Region F. These Region F project area counties have the following major reservoirs, capacity, ownership and 1996 usage (acre-feet): Oak Creek Reservoir (Coke County - 39,360, City of Sweetwater - 5,160), Lake Coleman (Coleman County - 40,000, City of Coleman - 1,610), Spence Reservoir (Coke County - 488,800, District - 1,932), Lake Winters (Runnels County - 8,374, City of Winters - 792), Lake Brownwood (Brown County - 131,430, Brown County WID - 10,157), Hords Creek Lake (Coleman County - 8,110, Corps), Lake Ballinger/Lake Moonen - 6,850, City of Ballinger), Ivie Reservoir (Coleman, Concho, and Runnels counties - 554,300, District), OC Fisher Lake (Tom Green County - 115,700, Corps), Twin Buttes Reservoir (Tom Green County - 186,200, Bureau of Reclamation), Lake Nasworthy (Tom Green County - 10,108, City of San Angelo), Brady Creek Reservoir (McCulloch County - 30,430, City of Brady), and Mountain Creek Reservoir (Coke County - 949, Upper Colorado River Authority). The Twin Buttes Reservoir and dam was built by the Bureau of Reclamation and is currently operated by the City of San Angelo, and is approximately 6 miles (9.7 kilometers) upstream of the City.

Total firm yield (acre-feet) for the District's Thomas, Spence, and Ivie reservoirs for 1997 and projected 2050 are 151,800 and 138,262, respectively. Firm yield is the annual amount of water that could reliably be obtained during a repeat of the worst historical drought experienced in the period of available hydrologic record leaving no reserves.

Water use in 1996 and projected 2050 water demand for the Region F counties in the project area are (acre-feet/year): Coke – 2,788 and 3,041; Runnels – 11,427 and 11,192; Tom Green – 79,299 and 163,384; Coleman – 5,085 and 4,512; Concho – 6,168 and 8,701; McCulloch – 6,021 and 8,000; and Brown – 23,121 and 20,692. However, most of the water in the action area is stored and diverted out of the area for use in urban areas such as Midland, Odessa, Big Spring, Snyder, San Angelo and Abilene.

The following aquifers are in these counties with associated 5-year (1993-1997) average historical use (acre-feet): Trinity (2,243), Lipan (56,505), and Hickory (3,782). The Trinity

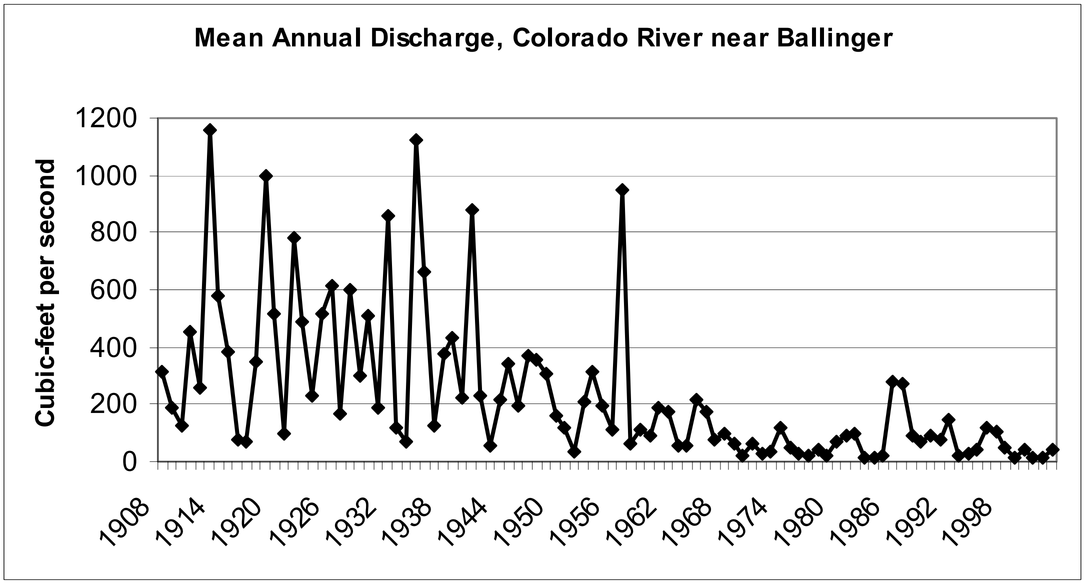
Aquifer has a retrievable storage of 38,500 acre-feet in Brown County. The Lipan Aquifer has a retrievable storage (acre-feet) for the following counties: Concho – 70,500; Runnels – 56,250; Tom Green – 838,000. Hickory Aquifer pumping has been constrained by the presence of radionucliides. These radioactive decay products are derived from the breakdown of the feldspar minerals in the Hickory sands and gravels. Ground water pumping for 1997 was the following in the project area counties (acre-feet): Coke – 708, Runnels – 2,716, Tom Green – 75,687, Coleman – 116, Concho – 2,518, McCulloch – 5,920, and Brown – 2,543. Ground water pumping is highest in Tom Green County.

District total water sales in 1997 were the following (acre-feet): Odessa – 20,890, Big Spring – 6,844, Snyder – 3,016, Midland – 21,804, Stanton – 346, San Angelo – 9, Robert Lee – 124, Grandfalls – 258, Pyote/West Texas State School – 215. The City of San Angelo receives water from six sources: Lake Nasworthy, Twin Buttes Reservoir, O.C. Fisher Reservoir, the Concho River, Ivie Reservoir, and Lake Spence. The City of Sweetwater, Region G, has rights to 5,328 acre-feet of water from Oak Creek Reservoir in Coke County. The City of Abilene, Region G, may receive up to 15,000 acre-feet of water from the District.

Rivers that have been identified on a draft list by the Texas Parks and Wildlife Department (TPWD) as ecologically unique river and stream segments and include the Concho water snake as an element are: Colorado River from Brown/San Saba/Mills County line upstream to S.W. Freese Dam in Coleman/Concho County and the Concho River from a point 1.2 miles (1.9 kilometers) above the confluence of Fuzzy Creek in Concho County upstream to San Angelo Dam on the North Concho River in Tom Green County and to Nasworthy Dam on the South Concho River in Tom Green County.

**Stream Flows.** Stream flows throughout the range of the Concho water snake have declined considerably over time due to changes in the watershed and impoundments and withdrawals of water for human uses, mainly for municipal and agriculture purposes. The resulting long term declines in riverine stream flow are demonstrated by the annual runoff totals of the Colorado River at Ballinger (Figure 3). Throughout the system, mean and median flows have declined substantially as a result of flow regulation and diversion (Table 9).

In recent years, low discharges in the rivers have been exacerbated by low annual rainfall totals throughout the watershed. An analysis by the District of the annual rainfall totals at 10 rain gages from 1993 to 2003 found that rainfall was below the long-term average at over half the gages for every year. As a result of stream regulation and drought, stream flows during 1999 to 2003 have been appreciably lower than the period of record for seven stream gages analyzed on the Colorado and Concho rivers (Table 9). Recent flows on the Concho River have been particularly low. Pre-regulation, median annual flow on the Concho River at San Angelo and Paint Rock gages have declined from 32 and 26 cfs, respectively, to 0.2 and 0.1 cfs during the drought of 1999 to 2003 (Table 9). Declines in discharges on the Colorado River have been lessened to some extent by the required minimum flows for the snake since 1987. However, median annual discharge at the Stacy gage has declined from 71 cfs pre-regulation, to 9 cfs during 1999 to 2003 (Table 9).



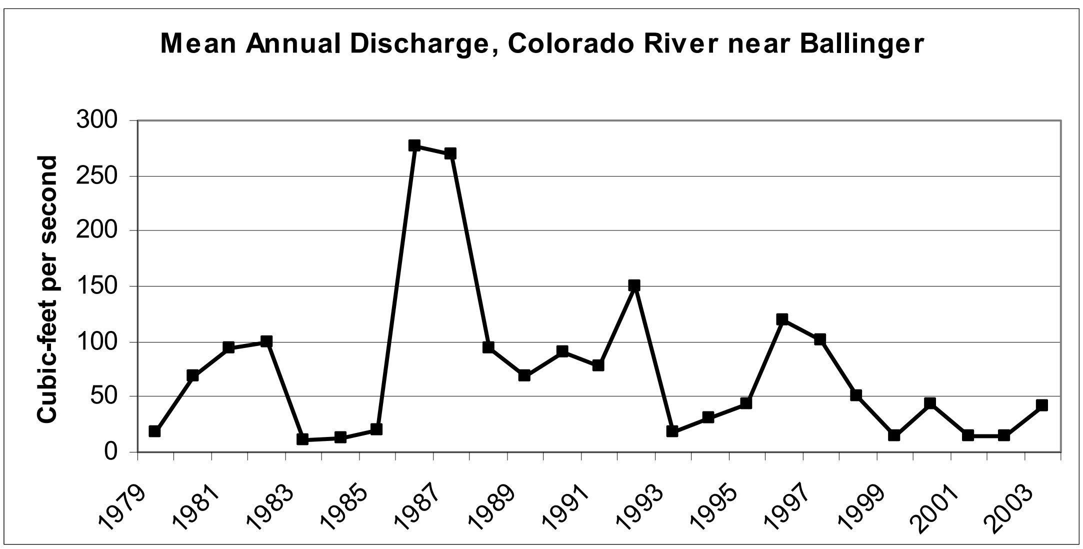




Figure 3. Mean annual discharge of the Colorado River at Ballinger during the period of record, 1908 to 2003 (top graph), and from 1979 to 2003 (bottom graph).

Table 9. Analysis of USGS gages on Concho and Colorado rivers within the range of the Concho water snake.

| Analysis | Period (# years) | Concho River - USGS gages | | Colorado River - USGS gages | | | | |
|---|---|---|---|---|---|---|---|---|
| | | at San Angelo | at Paint Rock | above Silver | at Robert Lee | near Ballinger | near Stacy | at Winchell |
| Years Records Evaluated | Period of Record | 1916-2003 (88) | 1916-2003 (88) | 1968-2003 (36) | 1924-27, 1939-55, 1969-2003 (46) | 1908-2003 (96) | 1968-2003 (36) | 1924-2003 (80) |
| | Pre-Regulation | 1916-30 (15) | 1916-1960 (45) | NA | 1924-27,1939-55 (21) | 1908-68 (61) | 1968-1989 (22) | 1924-1989 (66) |
| | Post-Regulation | 1931-2003 (73) | 1961-2003 (43) | NA | 1969-2003 (25) | 1969-2003 (75) | 1990-2003 (14) | 1990-2003 (14) |
| | District Monitoring | 1987-1996 (10 years) | | | | | | |
| | Recent Drought | 1999-2003 (5 years) | | | | | | |
| | NOTES | Outflow of three reservoirs | Concho River downstream flows | Inflow to Spence Reservoir | Outflow of Spence Reservoir | 55 mi. downstream of Spence Res. | Outflow of Ivie Reservoir | 55 mi. downstream of Ivie Res. |
| Mean Annual Discharge (cfs) | Period of Record | 93.8 | 140.3 | 71.5 | 89.5 | 237.8 | 165.9 | 459.4 |
| | Pre-Regulation | 148.5 | 217.6 | NA | 206.3 | 334.8 | 222.9 | 506.7 |
| | Post-Regulation | 82.6 | 58.8 | NA | 18.9 | 65.8 | 77.2 | 159.4 |
| | District Monitoring | 21.2 | 87.4 | 66.4 | 37.6 | 96.3 | 175.9 | 327.8 |
| | Recent Drought | 7.0 | 15.3 | 45.0 | 13.4 | 24.8 | 13.4 | 68.1 |
| Median Annual Discharge (cfs) | Period of Record | 8.2 | 24.0 | 7.6 | 2.4 | 16.0 | 37.0 | 59.0 |
| | Pre-Regulation | 32.0 | 26.0 | NA | 7.0 | 20.0 | 71.0 | 70.0 |
| | Post-Regulation | 6.4 | 24.0 | NA | 1.2 | 12.0 | 13.0 | 15.0 |
| | District Monitoring | 7.9 | 43.0 | 13 | 4.0 | 21.0 | 32.0 | 65.0 |
| | Recent Drought | 0.1 | 0.2 | 8 | 10.0 | 8.3 | 9.0 | 8.4 |

Table 9. Cont'd.

| Analysis | Period | Concho River - USGS gages | | Colorado River - USGS gages | | | | |
|---|---|---|---|---|---|---|---|---|
| | | at San Angelo | at Paint Rock | above Silver | at Robert Lee | near Ballinger | near Stacy | at Winchell |
| Frequency (% of days) <= 10 cfs | Period of Record | 54.3% | 35.1% | 57.4% | 70.6% | 40.3% | 22.0% | 18.9% |
| | Pre-Regulation | 29.9% | 35.7% | NA | 54.6% | 37.3% | 10.6% | 15.4% |
| | Post-Regulation | 59.4% | 83.4% | NA | 79.9% | 45.4% | 39.7% | 41.1% |
| | District Monitoring | 60.0% | 9.3% | 44.2% | 78.2% | 27.2% | 18.1% | 2.5% |
| | Recent Drought | 90.8% | 86.1% | 81.7% | 51.9% | 66.0% | 56.8% | 61.6% |
| Frequency (% of days) <= 1.0 cfs | Period of Record | 21.6% | 18.4% | 18.6% | 41.0% | 13.2% | 2.9% | 6.4% |
| | Pre-Regulation | 1.6% | 20.1% | NA | 28.4% | 15.1% | 4.8% | 6.4% |
| | Post-Regulation | 24.4% | 16.6% | NA | 48.7% | 9.8% | 0.0% | 6.8% |
| | District Monitoring | 3.6% | 2.9% | 7.1% | 18.0% | 0.8% | 0.0% | 0.0% |
| | Recent Drought | 68.4% | 58.8% | 40.2% | 3.1% | 11.5% | 0.0% | 12.1% |

**Water right permits.** We were provided data by the TCEQ for all surface water permits in the following 8 counties: Coke, Runnels, Tom Green, Coleman, Concho, McCulloch, Brown, Mills, San Saba, and Lampasas. We removed permits for the Brazos River Basin and the San Saba River. Records included both diversion and impoundment permits. This does not include all surface water diversions that affect stream flows in the habitat of Concho water snake because there are many more withdrawals from farther upstream that ultimately reduce the available water for downstream flows. However, this analysis does include those permits that are the closest in proximity to the snake's habitat.

Most water right permits in this area are for irrigation uses (87 percent), while the majority of water quantities permitted for diversion is for municipal and industrial use (75 percent) (Table 10). Of the ten counties included in this summary, the number of permits ranged from 22 (Lampasas County) to 194 (Tom Green County) and the amount of water permitted (acre-feet) for annual diversions ranged from 2,110 (Lampasas County) to 156,962 (Tom Green County).

Table 10. Summary of surface water rights permits in Concho and Colorado River in Concho water snake habitat. Permit records provided by TCEQ.

| **ALL RECORDS** | **Number of Permits** | |
|---|---|---|
| Total permits | 679 | |
| Total amount permitted for diversion (AF/YR) | 429,277 | |
| Total amount permitted for impoundment (AF) | 1,595,834 | |
| | | |
| **SUMMED BY USE** | **Number of Permits** | **% of total** |
| | | |
| MUNICIPAL OR INDUSTRIAL USE | | |
| Total permits | 49 | 7% |
| Total amount permitted for diversion (AF/YR) | 322,705 | 75% |
| Total amount permitted for impoundment (AF) | 1,547,095 | 97% |
| | | |
| IRRIGATION USE | | |
| Total permits | 592 | 87% |
| Total amount permitted for diversion (AF/YR) | 96,020 | 22% |
| Total amount permitted for impoundment (AF) | 12,377 | 1% |
| | | |
| OTHER USES (Mining, Recreation, Domestic and Livestock, Other) | | |
| Total permits | 38 | 6% |
| Total amount permitted for diversion (AF/YR) | 10,552 | 2% |
| Total amount permitted for impoundment (AF) | 36,362 | 2% |
| | | |

Table 10. Cont'd.

| **SUMMED BY COUNTY (% of total)** | **Number of Permits** | **% of total** |
|---|---|---|
| COKE COUNTY(all Colorado River) | | |
| Total permits | 25 | 4% |
| Total amount permitted for diversion (AF/YR) | 61,368 | 14% |
| Total amount permitted for impoundment (AF) | 549,664 | 34% |
| TOM GREEN COUNTY (all Concho River) | | |
| Total permits | 194 | 29% |
| Total amount permitted for diversion (AF/YR) | 156,962 | 37% |
| Total amount permitted for impoundment (AF) | 269,734 | 17% |
| RUNNELS COUNTY (mostly Colorado River) | | |
| Total permits | 129 | 19% |
| Total amount permitted for diversion (AF/YR) | 10,232 | 2% |
| Total amount permitted for impoundment (AF) | 17,017 | 1% |
| CONCHO COUNTY (mostly Concho River) | | |
| Total permits | 25 | 4% |
| Total amount permitted for diversion (AF/YR) | 2,562 | 1% |
| Total amount permitted for impoundment (AF) | 1,164 | 0% |
| COLEMAN COUNTY(all Colorado River) | | |
| Total permits | 65 | 10% |
| Total amount permitted for diversion (AF/YR) | 131,684 | 31% |
| Total amount permitted for impoundment (AF) | 606,815 | 38% |
| McCULLOCH COUNTY(all Colorado River) | | |
| Total permits | 31 | 5% |
| Total amount permitted for diversion (AF/YR) | 7,745 | 2% |
| Total amount permitted for impoundment (AF) | 30,962 | 2% |
| BROWN COUNTY(all Colorado River) | | |
| Total permits | 56 | 8% |
| Total amount permitted for diversion (AF/YR) | 39,087 | 9% |
| Total amount permitted for impoundment (AF) | 117,258 | 7% |
| SAN SABA COUNTY(all Colorado River) | | |
| Total permits | 68 | 10% |
| Total amount permitted for diversion (AF/YR) | 8,188 | 2% |
| Total amount permitted for impoundment (AF) | 364 | 0% |

Table 10. Cont'd.

| | | |
|---|---|---|
| MILLS COUNTY(all Colorado River) | | |
| Total permits | 65 | 10% |
| Total amount permitted for diversion (AF/YR) | 11,449 | 3% |
| Total amount permitted for impoundment (AF) | 2,857 | 0% |
| LAMPASSAS COUNTY(all Colorado River) | | |
| Total permits | 22 | 3% |
| Total amount permitted for diversion (AF/YR) | 2,110 | 0% |
| Total amount permitted for impoundment (AF) | 555 | 0% |

**Saltcedar**. Saltcedar was introduced into the United States in the 1800's. Saltcedar is reported by Hart (2004) to have four main impacts on the local environment once it is established: (1) increased soil salinity, (2) increased water consumption, (3) increased wildfire frequency, and (4) increased frequency and intensity of flooding. Once established, the plants tend to dominate flood plains.

Saltcedar evapotranspiration losses in Region F are estimated at 27.3 to 234 inches/year/plant (69.3 to 594.4 cm/year/plant) or 2.28 to 19.52 acre-feet/acre/year (2,812 to 24,078 cubic meters/acre/year). Initial results indicate that some areas within the Region may benefit from successful and long-range brush control. A review of vegetative cover extent, type of brush, and watershed hydrology indicates that Ivie Reservoir, Lake Spence, and Twin Buttes Reservoir may be likely candidates for brush control. There are currently on-going studies in the North and Middle Concho and the Upper Colorado rivers. There are three ways that brush control can be implemented: physical removal, controlled burns, and chemical kills. Physical removal is labor intensive and so burning or chemicals are typically used.

Saltcedar is currently found in the project area in Spence, Ivie, and Twin Buttes reservoirs. Smaller infestations can be found within almost every waterway in the project area. The total infestation in the project area can be measured in the thousands of acres. More than 25 percent of once perennial streams in the Concho and Colorado basins stopped flowing after the drought of the 1950's when brush such as mesquite, juniper, and saltcedar infested the areas (UCRA 2000). As a result, every 10 acres (4 hectares) of moderate to heavy brush infestation takes one acre-foot of water annually. With the drought of the late 1990's, additionally perennial streams and major river segments and tributaries have either slowed their flows or ceased flowing.

In 1999, the 76$^{th}$ Legislature initiated the North Concho River Brush Control Project to enhance the amount of water flowing from the North Concho River Watershed into O.C. Fisher Reservoir (TSSWCB 2003). Estimates indicate that this project will enhance more than 267,000 acre-feet of water in the North Concho River Watershed over the 10-year life of the project. As of December 2003, almost 59 percent, or 207,537 acres (83,987 hectares), of the 351,689 acres (142,323 hectares) had been treated (TSSWCB 2003). The following effects have been observed thus far: (1) areas where brush control work has been concentrated (Chalk Creek, Grape Creek, Sterling Creek, and Walnut Creek) exhibit more frequent runoff events of greater intensity and duration than other tributaries along the North Concho River; flow responses to rainfall are more frequent and pools hold water for longer periods of time following rainfall events; following aerial treatment, a pronounced increase in soil moisture and decrease in evapotranspiration has been observed.

In a computer simulation for Ivie Reservoir, values used for average annual rainfall for the Main Concho River Watershed varies from 22.2 inches (56.4 centimeters) in the western portion of the watershed to 25.5 inches (64.8 centimeters) in the eastern portion (UCRA 2000). Average annual evapotranspiration is 22.04 inches (56.0 centimeters) for the brush condition and 20.89 inches (53.1 centimeters) for the no-brush condition yielding 22,527 gallons (85 cubic meters) of water per acre (0.4 hectares) of brush removed per year. Variations in the amount of increased water yield are influenced by brush type, brush density, soil type, and average rainfall. With brush management, the projected average annual flow to Ivie Reservoir increased by 37,636 acre-feet (46 million cubic meters).

**Reasonable and prudent alternatives from 1986 Biological Opinion.**

Reasonable and prudent alternatives were developed in the December 1986 biological opinion with the Corps on construction and operation of the Stacy Dam, Reservoir, and pump station on the Colorado River in Coleman, Concho, and Runnels counties. These alternatives were to eliminate jeopardy. There was no critical habitat designated at that time so there was no adverse modification. The principal objective of these alternatives was habitat creation within the snake's historic range. Based on the Physical Habitat Simulation Program (PHABSIM), Stacy Dam was expected to result in the loss of 1,738,033 $ft^2$ weighted useable area (WUA) of juvenile water snake habitat and the creation of up to 2,629,449 $ft^2$ (WUA) of new habitat. Occupation of the new habitat by Concho water snakes was to be carefully monitored to assure long-term success. Flexibility to test methods of creating the necessary water snake habitat will be provided for in a cooperative agreement.

Each of the 1986 Reasonable and Prudent Alternatives are listed below and the results from the District's actions are provided in brackets [].

I. Monitoring. District was to monitor three times a year in each of the three river reaches isolated by Stacy Reservoir (upper Colorado River, lower Colorado River, and Concho River). Five specific juvenile habitat areas supporting healthy populations of Concho water snakes were to be selected in each reach and used as permanent monitoring sites. Annual reports were to be submitted for ten years. [This activity was completed by the District in 1996. Annual reports were submitted to the Corps and also provided to the Service in 1998 as a part of the petition to delist the snake. The stream channel monitoring requirement was amended in the Service letter dated March 7, 1989. Stream channel sites were established and monitored through 1996. Data was gathered as specified in the March 7, 1989 amendment. Stream channel monitoring results were included in the annual monitoring report submitted to the Corps.]

II. Studies

A. Life history study, including age, growth, reproduction, hibernation, food and feeding, behavior, predation, competition, habitat descriptions and utilization, thermoregulation and movement. [Life history completed by the Texas A&M Research Foundation (principal investigator J. Dixon). Final annual report submitted to the Corps in 1992. Completed studies resulted in two MS theses and one doctoral dissertation (copies provided to the Service). Growth and thermoregulatory studies completed by N. Scott in 1993 and submitted to the Corps and Service.]

B. Genetic viability of the existing population and the isolated subpopulations. [Completed in 1991 by J. Sites and L. Densmore. Final report submitted to the Service.]

C. Physical habitat studies, including stream channel stability, sediment source and deposition, vegetation encroachment and water chemistry. [Completed by O. Thornton and submitted to the Corps and Service in 1992.]

D. Information on availability and distribution of food items. [Completed annually as a part of monitoring studies by O. Thornton and submitted to the Corps in annual reports. J. Dixon and students also collected information on food distribution and availability which was included in annual reports.]

E. Energy budget and growth of all three water snake species (blotched water snake, *N. erythrogaster*, and diamondback water snake, *N. rhombifer*) at different life stages under natural and controlled conditions. [Completed by N. Scott in 1993 and submitted to the Corps and the Service.]

F. Evaluation of the various proposed management alternatives within this opinion, with recommendations for improvements. [O. Thornton submitted annual (1987-1996) evaluations of prudent alternatives and suggested improvements in annual reports to the Corps and Service.]

III . Upper Colorado River Management. The objectives of this alternative are to reconstruct Concho water snake habitat in the Colorado River from Robert Lee Dam to Maverick and to stop the continued downstream encroachment of silt and vegetation on juvenile foraging areas below Maverick. The following items were required for the rehabilitation.

A. Flow releases from E.V. Spence Reservoir:

1. Minimum Flow. District will release water from E.V. Spence Reservoir at flows sufficient to maintain at least 10 cfs (0.28 cms) throughout the reach of the Colorado River from Robert Lee to the USGS flow gauge at Ballinger. This flow will not be dependent upon presence or absence of flow into the reservoir, is in addition to releases for downstream water rights and shall not be depleted below the 10 cfs (0.28 cms) level by any water user.

2. Channel Maintenance Flow.

A. To maintain a stable channel morphology, a high flow is needed for flushing of sediments. Although the flow that originally formed the Colorado River channel in this area is no longer possible [15,907 cfs (450 cms) (0.98 days/year)], it is expected that 600 cfs (17.0 cms) released from E.V. Spence Reservoir for a period of 3 consecutive days once every 2 years should be sufficient to maintain a channel of reduced size. This flow must be released during the winter (November through February) to avoid adverse effects on juvenile and hatching Concho water snakes. If insufficient head exists to release 600 cfs (17.0 cms) during the first year of a two year cycle, maximum flows available will be released the second year for the same duration (3 days). District will not be required to release water (as described in this section) during periods of extended drought or conditions that may call for water rationing by the municipalities serviced by District.

B. Channel and habitat rehabilitation: [March 7, 1989 amendment to BO specified six prototype artificial riffles to be constructed. Artificial riffles were completed in August of 1989. Concho water snakes were captured in all six riffles in 1991 and annually thereafter through 1996.]

1. Vegetation and Silt Removal. In order to recreate appropriate juvenile Concho water snake habitat in the upper Colorado River from Robert Lee to near Maverick (30 miles [48 kilometers]), it will be necessary to remove the existing encroaching silt and vegetation from the riffle areas. The requested channel maintenance flow releases are not expected to effectively remove already established vegetation. Mechanical removal is suggested. District should submit a plan for this effort by May 1987 for Corps and FWS review and approval.

2. Addition of Rock. It was deemed necessary to reconstruct rock substrate, from medium gravels to large boulders, by placing rocks laterally and across channel to form bars and riffle areas. The new habitat areas must have shallow water associated with the rock, and a general slope of 10 percent or less. New habitat will be monitored for success and replaced or modified as necessary to ensure long-term success in Concho water snake survival and reproduction.

C. Concho water snake reintroduction. It was not believed that adequate numbers of Concho water snakes would effectively colonize all of the newly created habitat. It would be necessary to move snakes upstream to the restored habitats. Such transplants are to come from the area on the Colorado River to be inundated by Stacy Reservoir and will consist of approximately equal numbers of males and females. This alternative was delayed, due to ongoing genetics studies, with a November 28, 1989, amendment to the biological opinion. [This requirement was not necessary to fulfill because Concho water snakes were found occupying all six artificial riffles.]

D. Protection of rehabilitated habitat and existing, minimum, and dominant flows. For long-term maintenance of the rehabilitated habitats and flows, it will be necessary to protect the newly created habitat areas from water and gravel harvesting, low-head dam construction, road and bridge construction and any other channel modification or development that might be proposed. District was to use its legal authorities to prevent water development within the Colorado River channel, and elsewhere in the watershed when such development will impound over 200 acre-feet (247,000 cubic meters). The District also was to discourage water development within the watershed under the 200 acre feet category.

IV. Lower Colorado River Management. Concho water snake habitat in this reach was good from between Stacy Dam and Winchell, fair between Winchell and the Highway 45 Bridge, and unoccupied below Highway 45. The goal of this alternative was to protect the good habitats and to upgrade the fair and unoccupied reaches to good habitats and also to protect proposed critical habitat constituent elements below Stacy Dam.

A. Flow releases from Stacy Reservoir:

1. Minimum Flow. There were to be flows released from Stacy Dam sufficient to maintain 11.0 cfs (0.31 cms) in the Colorado River between April and September, and 2.5 cfs (0.07 cms) between October and March of each year, from Stacy to Pecan Bayou. These flows were not to depend on the presence or absence of water flowing into Stacy Reservoir, and were to be protected from legal and illegal water diversion.

2. Channel Maintenance. District was to assure that the Colorado River below Stacy Dam remains suitable habitat for the Concho water snake by releasing 2,500 cfs (71 cms) under the same criteria for channel maintenance flows that were released from Spence Reservoir (see III A.2). If 2,500 cfs (71 cms) did not flush sediments below Stacy Dam, District would be responsible for mechanical removal.

3. Temperature. Release of waters from Stacy Dam significantly colder than the ambient water temperature of the Colorado River will result in the death of many water snakes and most of the forage fish for many miles downstream. Release of deep cold waters from Stacy Reservoir during the summer months when ambient river water temperatures could be 80°F (27°C ) must not occur. When the reservoir is stratified, all releases will come only from the warmer, epilimnetic surface waters.

B. Habitat Improvement

1. Stacy Dam to Winchell. Changes in water flows after construction of Stacy Dam were expected to reduce Concho water snake habitat in this reach by 186,758 $ft^2$ weighted useable area (WUA). However, the river was not expected to aggrade as happened below Spence Reservoir because of differences in soil type and land management practices below Stacy. Snakes are expected to remain in this reach of the river at reduced numbers corresponding to the reduced habitat.

2. Winchell to Pecan Bayou. From Winchell to Pecan Bayou, the Colorado River changes its bedrock strata and enters an area of extensive sandstone. Snakes and riffle habitats were found in the first 24 miles (38.6 kilometers) of this formation at a reduced rate. Numerous low head dams or gabions were to be constructed, to create new riffles. Reaches of the Colorado River below Pecan Bayou were not recommended for improvement because sustained maintenance of riffle habitats might be physically impossible due to floods and siltation. [This alternative was eliminated in the March 7, 1989, amendment to the BO.]

V. Concho River Management. In 1986 there were 19 low head dams (some exceeding 6 feet in height) on the Concho River below San Angelo. These dams interrupt gravel transport downstream, inundate long stretches of river, and may hinder snake movement. The District was to determine the feasibility of removal of each of these low head dams. [An investigation of the ownership and status of all 19 low-head dams was completed by O. Thornton in 1987. A report was submitted to the Corps and the Service. Removal of these dams was not recommended pending further study.]

VI. New Reservoir Habitats, Stacy Reservoir Management. In order to replace habitat lost due to Stacy Reservoir, habitat along the new reservoir shore must be made more suitable for Concho water snakes by constructing 45 new reservoir habitats. [This alternative was deleted by a March 7, 1989, biological opinion amendment because the Concho water snake colonies were found in Lake Spence and Lake Moonen. Additional basking areas were to be provided within the reservoir by allowing the larger trees to stand rather than removing them.]

VII. Tributary Stream Habitats. While loss of prime water snake habitat and proposed critical habitat in the Colorado and Concho Rivers was partially offset by habitat improvements above and below Stacy Reservoir, additional secure habitat was needed. Several of the smaller tributaries of the Colorado and Concho Rivers were known or believed to support Concho water snakes. [District personnel captured 5 Concho water snakes in Elm Creek and its tributary, Coyote Creek in 1986. Kickapoo Creek, Spring Creek, and perhaps Lipan Creek may still support a few Concho water snakes. The District was to negotiate with private land owners for protection of Elm Creek and its tributary in the area of suitable water snake habitat, about 7 miles (11 kilometers).]

VIII. Maintenance of Genetic Heterogenity. It was surmised that the isolation of Concho water snake populations by Stacy Reservoir could result in a loss of genetic diversity so it appeared necessary to move snakes from one population to another. At least five female Concho water snakes were to be transferred to each of the 3 isolated populations from its nearest neighboring population once each year during mid summer.

IX. Employment of a Full-Time Biologist. District was to hire a full-time biologist for ten years to oversee the implementation of the alternatives. [Completed with hiring of O. Thornton in 1987.]

X. Cooperative Agreement. An agreement was to be signed by the principal parties to assure that all phases of the biological opinion would be carried out before and after construction of Stacy Dam. It was believed that if habitat creation and improvement measures set forth by the Reasonable and Prudent Alternatives were successfully completed and occupied by Concho water snakes, a maximum total of 2,629,449 $ft^2$ WUA of juvenile foraging habitat will be created. The total gain represented a recovery of 161 percent over the total losses of 1,637,308 $ft^2$ WUA to the Stacy project, and will increase existing habitat from current 6,311,788 $ft^2$ WUA to 7,203,204 $ft^2$ WUA.

**1986 Reasonable and Prudent Measures.** The 1986 biological opinion also contained a reasonable and prudent measure to reduce take: a District employee was to be on hand at times when take was likely to occur, to salvage snakes. Terms and conditions of incidental take were: (1) that the District notifies the Service prior to any activity likely to result in take; (2) that any snakes salvaged be immediately reported to the Service or placed as per prior agreement with Service; and (3) any Concho water snake mortalities be reported to the Service.

## IV. Effects of the Action

**Introduction.** As mentioned previously, the Action that is the subject of this consultation is an emergency situation affecting human health and safety. The District (September 2004 letter to the Service), using their expert judgment, believes the conditions that caused this emergency will end when both Spence and Ivie reservoirs are at 50 percent of capacity.

The intent of this biological opinion is to add the latest scientific information to the analysis of effects both on the species and its critical habitat, as it was originally designated, and to use this new information to analyze effects and to draw conclusions on the effects of the action.

### a. Factors to be considered

**Threats.** Both the Brazos and Concho water snakes have a historic range of the upper reaches of large central Texas rivers. The hypothesis is that an ancestor water snake of the *Nerodia fasciata* lineage evolved to occupy a niche in these prairie rivers and an environmental change caused the Brazos and Concho forms to be isolated from one another. The Concho water snake occupies a restricted geographic range in the Concho and Colorado River Basins in central Texas and is completely contained within the proposed action area. Optimal habitat is believed to be free-flowing streams over rocky substrates periodically scoured by floods (which provide relatively sediment free rock rubble and open banks), abundant rock debris and crevices for shelter, and the shallow riffles where juveniles are most commonly found. All size classes of the species forage almost exclusively on small fish, so habitat for the prey species is also important.

When the Concho water snake was listed in September 1986, the primary threats were believed to be destruction, modification, or curtailment of its range. The final rule noted that habitat was affected by four large mainstream reservoirs on the Concho and Colorado rivers. The rule stated that above dams the Concho water snake habitat was inundated and below dams the normal run-of-the-river was curtailed and scouring of the river bed by flood flows was prevented. Without the scouring flows, the streambed captures silt and vegetation, including saltcedar that becomes established, burying the rocky streambed.

In December 1986 the Service provided a biological opinion to the Corps for a permit to the District that would facilitate the construction and operation of the S.W. Freese Dam (Stacy Dam) and reservoir (O.H. Ivie Reservoir). The Service concluded that the proposed action was likely to jeopardize the continued existence of the Concho water snake and proposed reasonable and prudent alternatives. Habitat related requirements included:

- Maintain a continuous daily flow of at least 10 cfs (0.28 cms) in the Colorado River from Spence Reservoir to Ballinger,
- Provide a flushing flow of at least 600 cfs (17 cms) from Spence Reservoir for a duration of 3 consecutive days sometime between November 1 and February 28,
- Maintain a continuous daily flow of 11 cfs (0.31 cms) in the Colorado River between Freese Dam and Pecan Bayou between April and September,
- Maintain a continuous daily flow of 2.5 cfs (0.07 cms) in the Colorado River between Freese Dam and Pecan Bayou between October and March, and
- Provide flushing flows of 2,500 cfs (71 cms) from Ivie Reservoir for 2 consecutive days at least once every 2 years.

In June 1989, the Service designated critical habitat for the threatened Concho water snake. Included were a portion of the Concho River below San Angelo and portions of the Colorado River above and below Ivie Reservoir. The Colorado River above and below Spence Reservoir, and Spence Reservoir, were not included. A long stretch of Colorado River above Lake Buchanan was not included. The Service included the Ivie Reservoir basin because "the potential for the snake to inhabit Ivie Reservoir appears significantly greater than previously thought." The Service also included one-half mile (0.8 kilometers) of the streams and other tributaries upstream from their confluences with the Concho and Colorado rivers or Ivie Reservoir. Within the boundaries of the designated critical habitat, the Service recognized the following primary constituent elements:

- Shallow riffles and rapids with rocky cover,
- Minimum stream flows,
  - Continuous daily flow of 10 cfs (0.28 cms) in the Colorado River from E.V. Spence Reservoir to Ballinger, Texas
  - Flushing flow of 600 cfs (17 cms) from E.V. Spence Reservoir for a duration of 3 consecutive days at any time during the months of November through February, at least every other year
  - Continuous daily minimum flow of 11.0 (0.31 cms) cfs in the Colorado River

    between Freese Dam and Pecan Bayou between April and September each year, and a minimum of 2.5 cfs (0.07 cms) between October and March of each year, and
  - Flushing lows of 2,500 cfs (71 cms) from Ivie Reservoir for 2 consecutive days at least once every 2 years for channel maintenance.
- Dirt banks,
- Rocky shorelines, and
- Woody riparian vegetation.

A final recovery plan for the Concho Water Snake was completed in 1993 (USFWS 1993). The recognized threats to the Concho water snake included: (1) habitat loss and degradation resulting from: (a) reservoir inundation and (b) modifications to flow regimes related to water diversion and/or impoundment; (2) pollution or degradation of water quality in the Concho and Colorado rivers or tributaries; (3) fragmentation and isolation of populations following habitat disturbances; (4) loss of adequate instream flow due to natural and/or man-made conditions; and (5) sediment loading and deposition coupled with vegetation encroachment of rocky/bedrock riffle habitats used by Concho water snakes.

However, subsequent to the finalization of this recovery plan, new information has indicated that some of these threats have decreased in significance (Dixon 2004), and that a new threat exists, reduction of snake habitat by saltcedar (Thornton, pers. comm., 2004).

**Recovery strategy.** The 1993 recovery strategy relied on maintenance of adequate instream flows to maintain both the quantity and quality of Concho water snake habitat so that occupied habitat would continue to support viable populations of the Concho water snake. Actions were designed to insure that a combination of natural and/or man-made factors did not result in inadequate instream flows, which it was believed could have adverse effects on the Concho water snake, its habitat, and prey base. Additionally, time was needed to evaluate changes such as sedimentation and the adequacy of current flushing flows (related in part to reservoir development) on Concho water snake habitat. Recovery plans are guidance documents and are based on an adaptive management strategy. As new and better information becomes available, recovery plans are amended. New information on the habitat needs of the Concho water snake is now available (Dixon 2004) and has altered our understanding of the recovery needs of the Concho water snake. Reservoir habitat and habitat provided by low-head dams have been shown to provide important buffers during extended drought.

**b. Analyses for Effects of the Action**

The effects of the proposed action are primarily a result of direct effects (the immediate effects of the project on the species or its habitat) that will be ongoing for the life of the project and some time after and encompass the entire range of the Concho water snake. The primary negative effects to the Concho water snake and its designated critical habitat are related to the changes in reservoir operations and the resulting releases to the Colorado River downstream.

**Reservoir inundation.** Concho water snakes have been shown to maintain reproducing populations in reservoir environments by using rocky shorelines that are similar in substrate structure, water depth, and availability of fishes for prey. During the District's 10-year monitoring effort, snakes were regularly found in Spence, Ivie, and Moonen reservoirs. Surveys in 2004 have confirmed that snakes persist in Spence and Ivie reservoirs, although lack of inflow to Lake Moonen may have resulted in their extirpation there (Dixon 2004). As a result of the Service designating Ivie Reservoir as critical habitat for the species and the fact that the snake has continued to reproduce and persist in lake and reservoir habitat, the threats from reservoir inundation are no longer considered significant to the conservation of the snake. District estimates suggest that 18 percent of the total available habitat to the snake range-wide is provided in these two reservoirs (see discussion in Sec. III, Status of the Concho water snake, page 4 and Appendix B).

Changes in the water surface elevation of the reservoirs (Spence and Ivie) do affect the availability of shoreline habitat for the snake (Whiting 1993). There is not a quantified relationship of snake habitat to reservoir levels. It appears that shallow, rocky shoreline habitat, inhabited by prey fishes, are available throughout the range of potential reservoir stages (Dixon 2004). Reservoir habitats may be altered due to the proposed action; however, the overall available snake habitat should not be measurably affected. Reservoir levels may increase as a result of decreasing minimum flow releases, which would provide more shoreline miles of potential habitat.

**Stream flows.** The impact to stream flows as a result of the proposed action is not a range-wide phenomenon that will affect the Concho water snake throughout its present distribution. The proposed action will have no effect on instream flows in the river segment above E.V. Spence Reservoir. Nor will this action have an effect on the Concho River segment between San Angelo and O.H. Ivie Reservoir. Only the Colorado River segments between Spence Reservoir and Ivie Reservoir and below Ivie Reservoir will be affected because of the proposed action. It should be noted that although there will be an effect, the impact from the effect will be ameliorated to some degree by the nature of the intervening watersheds that drain each of these stream segments.

The upper Colorado River basin is characterized as being xeric in nature, replenished by flood events, and supplemented by numerous tributaries, some of which are perennial but most being intermittent. Both the Colorado River and Concho River are "gaining" streams, i.e., as you progress downstream, these rivers "gather" water. This "gathering" of water is exhibited not only by tributary inflow but also as bank discharge from spring flow that occurs where shallow aquifers interface with the stream. This "gaining" stream phenomenon is greatly controlled by ambient weather conditions. During periods of long-term drought, the tributaries and springs will cease flowing. During normal rainfall periods, these sources of water help to restore and maintain a more stable instream flow.

O. Thornton (pers. comm., October 2004) believes some instream flows will return once the long-term drought is over. Based upon his experience in the upper basin, the stream segment between Spence and Ivie will see flows augmented by intermittent discharge from Messbox Creek (near Robert Lee), Oak Creek, Valley Creek, Elm Creek, and Mustang Creek. Post-drought conditions may exhibit continual discharge from the confluence of Oak Creek with the

Colorado River downstream. The Elm Creek watershed is a significant tributary and it is now providing a constant inflow into the Colorado River at Ballinger.

The Concho River has five noteworthy tributaries that will augment flows after drought conditions have been relieved. These streams are the Lipan Creek, Dry Hollow, and the Kickapoo Creek, all of which drain into the river above Paint Rock.

The downstream segment of the Colorado River below the Freese Dam will experience nearly constant flow beginning roughly at the mouth of Panther Creek. This is nearly 2 miles downstream of the FM 503 crossing and approximately 14 miles downstream of the Freese Dam. Mustang Creek (Concho County) drains into this segment approximately 3 miles below Freese Dam and its watershed has periodically provided significant inflows into the Colorado River. Below the mouth of Panther Creek, and above US 377 (Winchell), Salt Creek, and Home Creek, are two significant tributaries that will also provide augmenting flows to the Colorado River. Below Winchell significant instream flows are received from Pecan Bayou, the San Saba River, and Cherokee Creek, plus numerous other minor tributaries.

A flow simulation was conducted to evaluate the potential changes in downstream flows in the Colorado River from Spence Reservoir as a result of the proposed action to decrease the magnitude and frequency of releases from the dam. This simulation used the recorded 1999 to 2004 stream discharges, published by the USGS, to predict the downstream discharge based on the District's proposed operations (Appendix C). The simulation is preliminary and may be revised prior to finalization of this biological opinion. This time period was used because it represents a period of extreme drought coupled with the possible effects of the action on Concho water snakes. The results indicate flows under the proposed action would decline compared to the actual data under previous minimum flow releases. For example, the median annual flow at Ballinger from 1999 to 2003 was 8.6 cfs. Under the proposed action the median flow would have been 0.8 cfs. The percent of no flow days at Ballinger would increase from 0 with the actual data to 50 percent under the proposed action. This would affect the riverine sections of the habitat below Spence and Ivie reservoirs downstream to where flows would be naturally augmented by intervening watershed inflows (see discussion above).

The proposed actions would decrease flows often during the mid to late summer (July-August) at the time when female Concho water snakes would be gestating and bearing young. However, historical USGS records indicate the river flow during this time of the year (July through August) is characterized by periods of low to no discharge. This is typical of the arid region the upper Colorado River drains. Although this decrease in flow will likely reduce the amount of available shallow, rocky habitats in much of the river, it is our belief that the Concho water snake has evolved and adapted to this environment over the past several million years and is well equipped to endure and survive these conditions. The extent of the habitat degradation, in river area and duration, is largely dependent upon the climatic conditions. In severe drought, as the region has experienced during much of the previous decade, the linear extent of dewatered riverine habitats could be large and the length of time without adequate flows could extend for several months or more. This was recently noted by Dixon (2004) in his observation that Elm Creek had experienced no flow conditions for a period of three years and yet Concho water snakes were found shortly after a flood event restored stream flow in the creek.

Dixon (2004) theorizes that Concho water snakes will utilize remaining pools, particularly upstream of low-head dams, during low flow times. So long as there is some water and fish available for prey, snakes are likely to survive under such conditions for some time period (Dixon 2004).

**Population fragmentation.** Past actions to construct large reservoirs (Ivie, Spence, O.C. Fisher and Twin Buttes reservoirs) have likely resulted in the segmenting of populations of Concho water snakes. J. Dixon (pers. comm., August 2004) does not believe Concho water snakes travel overland to circumvent the barriers caused by the large dams. Therefore, based on the best information currently available, the large dams probably fragment the species' genetic interchange. The proposed action is limited to the operation and maintenance of District facilities and should not result in further fragmentation or isolation of snake populations.

The genetic variability of the Concho water snake was investigated and documented by Sites and Evans (1990) and Sites and Densmore (1991). The results of these and other studies (Lawson 1987; Rose and Selcer 1989) indicated the Concho water snake (and other species of *Nerodia*) is characterized by very low levels of protein polymorphism. Furthermore, the relatively high diversity of mtDNA haplotypes they found within the subspecies, both within and between metapopulations sampled from a major part of the total range, suggests that population densities are generally high and that, while metapopulations are structured, gene flow among them is sufficient to maintain at least some common haplotypes throughout most or all of the range even with the reservoir barriers. Estimates by Sites and Densmore (1991) further indicated a minimum amount of genetic diversity could be lost from the total Concho water snake gene pool with the filling of Ivie Reservoir, and they concluded that the potential genetic loss resulting from the completion of the reservoir project (Freese Dam) would be inconsequential. Regardless of these conclusions, the Service believes that the transfer of five male Concho water snakes above and below both the Robert Lee and Freese dams once every three years would be sufficient to maintain genetic heterogeneity between these separated metapopulations. However, it would not be necessary to transfer snakes between the Concho River and the upper reach of the Colorado River above Ivie Reservoir.

**Water quality / pollution.** Impacts from water quality degradation and pollution remain a potential threat; however, no impacts have been observed or documented as a result of water quality conditions during the past 12 years of an extreme, long-term drought. The likelihood of impacts to the snake and small fish from chronic water quality degradation or the introduction of contaminants does increase with the proposed action as the riverine reaches decline in flows, the ability to dilute or transport pollutants decreases. However, it should be noted that the District has a very comprehensive water quality monitoring program in the upper Colorado River basin that includes the distribution of the Concho water snake above the Freese Dam. The Lower Colorado River Authority (LCRA) has the responsibility for water quality monitoring below the Freese Dam. Both of these entities have participated in the Clean Rivers Program since 1991 and have provided a proactive responsibility for ensuring a high level of surface water quality in the Colorado River and its mainstem reservoirs. These programs are ongoing and designed to ensure the water quality integrity for all aquatic resources in the upper basin. As water quality problems are detected, swift responses by the District and the LCRA to effect corrective actions through State of Texas regulatory agencies (TCEQ and the Texas Railroad Commission) are completed.

**Sedimentation.** As a result of regulated flows and lack of large rainfall events, and the increase in saltcedar, the Colorado and Concho rivers have seen increases in the amount of sedimentation in riffle areas that serve as Concho water snake habitats, particularly for neonates. This is a long-term, ongoing alteration in the geomorphology of the river and will likely continue under the proposed action. Without significant rainfall events in unregulated watersheds, flushing flows will not be available to transport sediments and scour riffle areas of encroaching vegetation. Dixon (2004) suggests that the Concho River needs a flow in excess of 15,000 cfs to reset the river channel and restore former riffle areas. It is unknown if the river habitat will be returned to pre-drought conditions, without sediment, grass, and shrubs replacing the rocky substrate. District annual monitoring reports noted that in many cases, intense use by cattle helped maintain the riffle habitat. However, this activity is a "double-edged sword" in the riparian areas of the river basin. O. Thornton (pers. comm., October 2004) has observed in his experience over the past 15 to 20 years that livestock use of the river, though beneficial in helping to control riffle vegetation, has aggravated channel sedimentation by creating barren pathways (i.e., cattle, sheep, and goat trails) that contribute to erosion and sediment load during intense rain and runoff events.

**Critical habitat.** The original primary constituent elements related to stream habitats and minimum flows will likely be impacted by the proposed action. However, our understanding of habitat utilization by the Concho water snake has been substantially changed. It is now known that the snake uses areas upstream and downstream of low-head dams, and is not solely dependent on riffles for foraging (Dixon 2004).

Lower than the original required flows are expected to occur in both reaches of the Colorado River. The amount of available shallow, rocky, riffle habitats is likely to be reduced as a result of the proposed action. Reservoir habitats will be affected by the proposed action, but the net change in functionality of the reservoirs is not expected to be great.

**c. Species' Response to Proposed Action**

**Snake populations.** Because we do not have any data on snake populations to formulate trends or current status, it is difficult to quantify the future impacts on the snake of the proposed action. Certainly decreased or loss of flows in the Colorado River will have some affect on the Concho water snakes by limiting their prey species and habitats. Beneficial actions proposed by the District including saltcedar removal and riparian rehabilitation/restoration should counter balance these negative effects.

Additionally, when drought conditions subside, increases in precipitation will provide benefits to the species. Likewise, as the reservoirs increase in stored volume, the miles of potential shoreline habitat for the snake will increase and the flooding of vegetated shoreline will have short-term benefits by providing an abundance of habitat and forage for small fish. It is difficult to predict when these benefits will occur.

**Critical habitat.** The 1986 biological opinion required continuous daily flows of 10.0 cfs in the

Colorado River from E.V. Spence Reservoir to Ballinger, Texas, and continuous daily minimum flows of 11.0 cfs in the Colorado River between Freese Dam and Pecan Bayou between April and September each year. The 1989 designation of critical habitat reiterated these flows as primary constituent elements of critical habitat.

At the times the 1986 biological opinion and the 1989 designation of critical habitat were finalized, our knowledge of the habitat needs of the Concho water snake was incomplete. Subsequent work, especially the many studies done in the early 1990's, has greatly added to our knowledge. It is now known that the Concho water snake is more of a habitat opportunist than originally believed (Dixon 2004). In addition to reservoir and riverine habitat, the snake is known to use areas above and below low head dams, pools created by the dams, man-made lakes, naturally occurring pools in the river, and tributaries, as Concho water snake has been found in Elm Creek and two of its tributaries. Without doubt the riverine habitat is an important type of habitat but the need for continuous flows of 10.0 cfs or greater cannot be substantiated.

The amount of reservoir critical habitat will increase as the water level in the reservoirs increase because the amount of shoreline habitat will increase. However, the rocky substrate preferred by the Concho water snake is sporadically distributed and it is uncertain whether a linear relationship between reservoir level and Concho water snake habitat exists. Reservoirs will continue to provide important habitat for the about 18 percent of the snake population that occurs there, especially during times of drought and will likely provide a source of snakes for translocation purposes. Critical reservoir habitat could be better defined as the shallow water areas sheltered from intense wave action, where rocky habitat, especially flat slab rock, is present and vegetation is present as habitat for small fish.

<u>Beneficial Actions.</u>

A new, albeit indirect, threat to the snake, not identified at the time of listing or critical habitat designation, has been the invasion of saltcedar. The 1986 final rule that listed the Concho water snake as a threatened species mentioned saltcedar as one of the species that became established but did not recognize saltcedar specifically as a threat. We now know that saltcedar has multiple negative effects. Saltcedar consumes great quantities of water and thus reduces the water available to the river and its tributaries. Saltcedar produces quantities of salt and can degrade water quality thus possibly affecting snake prey items. Saltcedar forms dense monotypic stands of vegetation that out competes and replaces native species, thus altering key functions of the ecosystem.

**Saltcedar control**. Computer modeling has shown that the entire Colorado and Concho river basins could gain 249,584 acre-feet (308 million cubic meters) of annual groundwater recharge and surface water flow into existing reservoirs (UCRA 2000). Two reservoir basins, Ivie and Twin Buttes, could realize almost 155,000 acre-feet (191 million cubic meters) of water annually in groundwater recharge and surface flow through brush control (UCRA 2000). In this computer simulation for Ivie Reservoir, values used for average annual rainfall for the Main Concho River Watershed vary from 22.2 inches (56 centimeters) in the western portion of the watershed to 25.5 inches (65 centimeters) in the eastern portion (UCRA 2000). Average annual evapotranspiration is 22.04 inches (56 centimeters) for the brush condition and 20.89 inches (53 centimeters) for the no-brush condition yielding 22,527 gallons (85 cubic meters) of water per acre (0.4 hectares) of brush removed per year. Variations in the amount of increased water yield are influenced by brush type, brush density, soil type, and average rainfall. With brush management, the projected average annual flow to Ivie Reservoir increased by 37,636 acre-feet (46 million cubic meters).

As of 2004, it is estimated that roughly 16,000 acres (6,500 hectares) of District lake basins are infested with saltcedar (Okla Thornton, District, pers. comm., 2004). The Colorado River and its main tributaries are estimated to have an additional 6,000 to 8,000 acres (2,400 to 3,200 hectares). The impact of saltcedar to water resources has been well documented. A single, mature tree can consume up to 200 gallons (0.8 cubic meters) of water per day (McGinty et. al. 2004). Several studies have demonstrated that one acre (0.4 hectares) of moderate size saltcedar trees (6 to 10 feet [2 to 3 meters] tall) can transpire anywhere from 2 to 12 acre-feet (2,500 to 15,000 cubic meters) of water in an annual growing season (April to October) (Okla Thornton, District, pers. comm., 2004). Considering the number of acres of saltcedar in the upper Colorado River basin, this translates into an incredible amount of water that can be recovered with a saltcedar control program. As part of the proposed project, the District will provide support for saltcedar control in the upper Colorado River watershed, including the Concho River. The District is cooperating in a saltcedar control project funded by the EPA through a Clean Water Act, Section 319(h) grant to the TSSWCB.

An actual test of saltcedar removal and commensurate water production was done on the Pecos River and reported in 2001 (Hays 2003). During the first year, estimated annual water use by saltcedar and associated vegetation (using a specific yield of 10 percent) varied from a low of 2.3 acre-feet/year (2,800 cubic meters/year) to a high of 7.0 acre-feet/year (8,600 cubic meters/year), averaging 4.9 acre-feet/year (6,000 cubic meters/year). Based on a value of 4.9 acre-feet/year (6,000 cubic meters/year), control of saltcedar on the Pecos River site (2,774 acres) resulted in an annual water savings of 13,593 acre-feet (17 million cubic meters) (assuming 100 percent control of the vegetation and no water use by replacement vegetation).

The removal and control of saltcedar from the riparian reaches of the Colorado and Concho Rivers will help to augment existing stream discharge and also reduce the buildup of dissolved solids (salts) in the soils of the riparian zone. A test project to evaluate the use of fixed wing and rotary wing aircraft to aerially treat saltcedar within the upper Colorado River Basin was done in 2003 (McGinty et al. 2004). During September 2003, both aircraft types were used to apply various herbicides at various speeds and volumes to saltcedar within the Lake Spence basin. In a draft report, McGinty et al. reported that one-year following application, excellent control (97 percent) was achieved with Arsenal (1 pound/acre) when applied by fixed wing aircraft. Control with Cimarron Max (Rate 3) was much less (22 percent).

As a result, aerial application of the herbicide Arsenal (BASF) will be used to make the initial control of the saltcedar in the watershed above the Robert Lee Dam (E.V. Spence Reservoir). Treatment had been scheduled to begin in September 2004, but early senescence of saltcedar trees (possibly because of cool temperatures) prevented this initial treatment. The next scheduled treatment is in September 2005. This Arsenal treatment at 0.5 gallons/acre applied by helicopter will be from the Lake Thomas Dam to the Spence lake basin and will include Beals Creek, totaling approximately 2,800 acres (1,100 hectares) (pers. comm., Tuffy Wood, 2004). The treatment will include two segments. Segment one will be approximately 75 miles (120 kilometers) by 150 feet (46 meters) in the Colorado River and will include Bull, Bluff, Deep, Willow, Champion, and Morgan creeks for a total of 1,544 acres (625 hectares). Segment two will be 64 miles (100 kilometers) by 100 feet (30 meters) on Beals Creek; 25 miles (40 kilometers) by 150 feet (46 meters) on the Colorado River; and from the confluence of Beals Creek to the mouth of Lake Spence, for a total of 1,231 acres (500 hectares). In 2006, the Lake Spence basin will be treated by the same method for a total 7,000 acres (2,800 hectares). There is an estimated 7,000 acres (2,800 hectares) of saltcedar within the Lake Spence basin and 9,000 acres (3,600 hectares) within the Ivie Reservoir basin. If the Pecos River results are applicable, that would mean saving 83,300 acre-feet (102 million cubic meters) of water per year. It is anticipated that this would recharge the river basin thus providing additional instream flows.

Bio-control is planned to be used for follow-up maintenance control. The U.S. Department of Agriculture – Agricultural Research Service is releasing saltcedar leaf beetles in selected areas of the upper Colorado River basin. Prospects for long-term maintenance control with the Asian leaf beetles appear hopeful.

**Summary**. Although decreased flows during the human health and safety emergency period are affecting riverine habitat used by the Concho water snake, increased flows once the drought has ended, along with water savings and replenishment that will result from large-scale saltcedar control and riparian habitat rehabilitation/restoration should combine to help restore the riverine habitat and sustain the snake.

A method of restoring the degraded riffle habitat may be needed. The most natural method would be to use scouring flows, that is, flows of great volume but short duration that would wash the sediments and vegetation off of the rocks. However, it is not known if stored water volumes and natural rain events will ever allow scouring flows of the magnitude needed. It has been suggested that a natural flood flow in excess of 10,000 cfs (283 cms) would more than likely be required (Thornton, pers. comm. August 2004). However, Thornton recalled a flood event on the Concho River in 1989 with a measured (USGS) discharge of greater than 10,000 cfs (283 cms) that failed to significantly remove vegetation and sediment in the river at the Concho low water crossing.

## V. Cumulative Effects

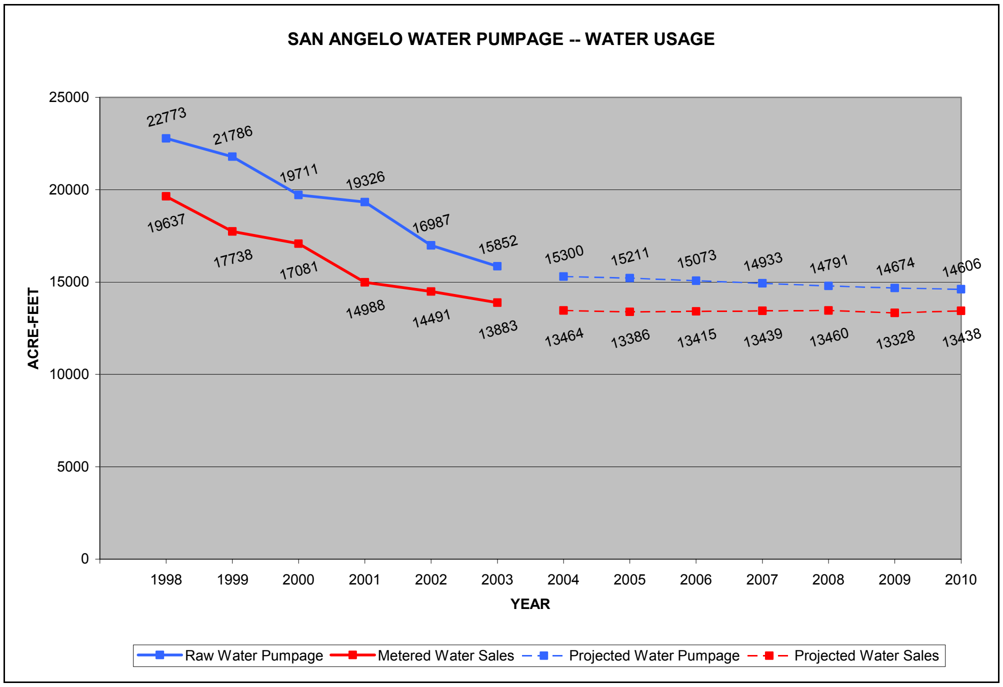
Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Water use and availability for humans and for the environment will be the driving factors of the cumulative effects. The 33 county Region F water planning area experienced a 1.3 percent annual growth rate, going from 81,985 in 1900 to 590,618 in 1998. The total water supply for the Region F area is 713,000 acre-feet, and in 2000 the demand was 881,500 acre-feet. Total demands for Region F are projected to increase from 881,500 acre-feet in 2000 to 900,200 acre-feet per year in 2050. The largest demand category is irrigation, which accounts for nearly 75 percent of the total demand. The demand exceeds the available supply by over 170,000 acre-feet per year in 2000, increasing to 200,000 acre-feet per year by 2050.

Water use in 1996 and projected 2050 water demand for the Region F counties in the project area are (acre-feet/year): Coke – 2,788 and 3,041; Runnels – 11,427 and 11,192; Tom Green – 79,299 and 163,384; Coleman – 5,085 and 4,512; Concho – 6,168 and 8,701; McCulloch – 6,021 and 8,000; and Brown – 23,121 and 20,692. Total firm yield (acre-feet) for the District's Thomas, Spence, and Ivie reservoirs for 1997 and projected 2050 are 151,800 and 138,262, respectively. Firm yield is the annual amount of water that could reliably be obtained during a repeat of the worst historical drought experienced in the period of available hydrologic record leaving no reserves.

The City of San Angelo receives municipal water supply from Twin Buttes and O.C. Fisher reservoirs, as well as supplemental water from the District. The City can provide water to the Concho River through waste water discharges. Figure 4 shows the projected future water pumpage and usage for the City of San Angelo.

Figure 4. San Angelo water pumpage and usage, 1998 to 2003, and projected through 2010.




## VI. Conclusion

After reviewing the current status of the Concho water snake and it's designated critical habitat, the effects of the proposed operation and maintenance of the District's water supply system, and the cumulative effects, it is the Service's biological opinion that the proposed action, is not likely to jeopardize the continued existence of the Concho water snake, and is not likely to destroy or adversely modify designated critical habitat.

## INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any grant or permit issued to the District, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require the District to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the District must report the progress of the action and its impact on the species to the Service and the Corps as specified in the incidental take statement. [50 CFR §402.14(i)(3)]

### Amount or Extent of Take Anticipated

The Service anticipates incidental take of Concho water snakes may occur in the form of (1) harm to the species by habitat alteration that may impair sheltering, breeding and feeding behaviors and (2) harm to the species by limited genetic exchange due to the high dams preventing the species' upstream movement. It will be difficult to detect the take of individual snakes for the following reasons: the species is wide-ranging; finding a dead or impaired specimen is unlikely; losses may be masked by seasonal fluctuations in numbers or other causes; the species occurs in aquatic habitats that make detection of individuals unrealistic; and the harm may be in the form of reduced reproduction and recruitment which would require a long-term intensive study to detect. However, the following level of take of this species can be anticipated by estimating the loss of essential habitat elements, such as stream flows and silting of rocky riffle areas that affect acres of riverine habitat.

The proposed action may result in the take of acres of riverine habitats downstream of the Robert Lee Dam (Spence Reservoir) to the confluence with the Concho River ("below Spence Colorado River") and approximately 14 miles (23 kilometers) downstream of Ivie Reservoir to the mouth of Panther Creek ("below Ivie, Colorado River"). In order to quantify this habitat area, we used the estimates of available Concho water snake habitat in these reaches, as provided by the District (Appendix B) and multiplied the linear distances by a standard width of river derived from an average of cross-sectional data (Thornton 1996). The width was determined by averaging the wetted perimeter data from 5 sites measured annually over 8 years (1989-1996) in each reach (data used from Appendix III, Thornton 1996) and then added 12 feet (3.7 meters) to the width to allow for the river banks used by the snake. The same calculations were completed for quantifying habitat in the Concho River (Table 11), but Concho River habitat is not affected by the actions reviewed in this opinion.

Table 11. Estimate of Concho water snake habitat available, in acres, in Spence and Ivie Reservoirs and four river reaches of the Concho and Colorado rivers. Areas considered for incidental take are shaded.

| | **Subpopulation (Reservoir / River Segment)** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Habitat Quality** | **Spence Res.** | **Ivie Res.** | **Concho River** | **Below Spence, Co. River** | **Below Ivie, Co. River** | **Lower Co. River (Panther Ck to Bend SP)** | **Total** |
| High | 62.9 | 85.2 | 301.5 | 890.2 | 195.7 | 406.0 | **1,941.5** |
| Medium | 30.0 | 115.4 | 363.7 | 153.4 | 0 | 246.8 | **909.3** |
| Low | 48.2 | 12.4 | 240.2 | 396.9 | 0 | 53.9 | **751.6** |
| **Total** | **141.1** | **213.0** | **905.4** | **1,440.5** | **195.7** | **706.8** | **3,602.5** |
| **Percent of Total Habitat** | **3.9%** | **5.9%** | **25.1%** | **40.0%** | **5.4%** | **19.6%** | |

The incidental take that may occur in the Colorado River reach downstream of the Spence Reservoir is estimated to occur within a total of 1,440.5 acres (583 hectares) (40 percent) of Concho water snake habitat (Table 11). This take may occur from periodic habitat alteration because of decreased instream flows. During some time periods of low reservoir inflows, downstream releases may be suspended from Spence Reservoir and may result in little to no flow in this reach for up to 50 percent of days in a given year (Appendix C). In addition, these no flow events are likely to occur during late summer and early fall when snakes are bearing young and neonates are present. Declines in instream flow below Spence will be lessened downstream of the mouth of Elm Creek, a tributary that provides water to the Colorado River. Riffles, where neonates take shelter and where all age classes forage, may be dewatered for extended periods. Decreases in instream flows and periodic dewatering of the river may also affect fish population densities, which serve as the prey base for the snake.

The incidental take that may occur in the Colorado River reach downstream of the Ivie Reservoir is estimated to occur on 195.7 acres (79 hectares). This represents 5.4 percent of the total amount of Concho water snake habitat (Table 11). This take may occur from periodic habitat alteration because of decreased instream flows downstream to the mouth of Panther Creek, where tributary inflows are expected to provide stream flows in the Colorado River. During time periods of low to no reservoir inflows, downstream releases may be suspended from Ivie Reservoir. This may result in low to no flow in this reach downstream to the mouth of Panther Creek which is approximately 14 miles (23 kilometers) downstream of Freese Dam. Because of river channel gains and other release requirements, this reach will likely not be impacted to the same extent as anticipated below Spence Reservoir. The habitat that may be taken as a function of low (or no) stream flow is a portion of the area designated as critical habitat for the Concho water snake.

The presence of the high dams that created Spence and Ivie reservoirs is another source of incidental take as upstream snake movement is blocked thus preventing genetic continuity of the Concho water snake at those locations within its range. This may result in reduced genetic heterogeneity through time.

**Effect of the take**

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measure(s) are necessary and appropriate to minimize impacts of incidental take of the Concho water snake:

(1) The District, in coordination with the Corps and Service, shall minimize the effects of habitat alteration.

(2) The District, in coordination with the Corps and Service, shall minimize the effects of reduced Concho water snake genetic continuity.

**Terms and conditions**

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures, described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

The Service believes that all of the Concho water snakes in the 1,440.5 acres (583 hectares) below Spence Reservoir and in the 195.7 acres (79 hectares) below Ivie Reservoir may be incidentally taken through harm as a result of habitat alterations caused by the proposed action. Additionally, the Concho water snake population may be harmed because of limited upstream movement and the resulting lack of genetic exchange.. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information, and reinitiation of consultation will be required to re-evaluate the efficacy of the reasonable and prudent measures provided. The Federal agency must provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

Pursuant to section 7(b)(4) of the Act, the following terms and conditions are necessary and appropriate to minimize take:

(1) Term and condition that implements RPM #1 – The Corps and the District shall seek funds to study a methodology for riparian rehabilitation/restoration following saltcedar spraying and then seek funds and subsequently utilize these funds (if acquired) to implement the recommendations of the study.

(2) Term and condition that implements RPM #2 – In the springtime, the District, in coordination with the Corps and Service, should move 5 male snakes from below Spence and Freese dams to above these dams, once every 3 years. Since males likely couple with multiple females, moving males will have a greater chance of maintaining genetic flow.

**Reporting Requirements**

(1) The District shall report to the Service within 60 days of completion of the results of any riparian rehabilitation or restoration studies, or work implemented under RPM #1 of the Terms and Conditions above.

(2) The District shall report to the Service within 60 days of completion of any movement of snakes under RPM #2 above.

**Conservation Recommendations**

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

(1) The Corps/District should participate in meetings where efforts to recover/delist the Concho water snake are discussed.

(2) The Corps/District should seek partnerships that will aid in the recovery/delisting of the Concho water snake.

(3) The Corps/District should consider future genetic studies to validate this estimate of snakes needed to move above dams to maintain genetic diversity.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification by the Corps of the implementation of any conservation recommendations.

**Reinitiation Notice**

This concludes formal consultation on the actions outlined in the reinitiation request. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

Sincerely,

*/s/ Robert T. Pine 12/3/04*

Robert T. Pine
Supervisor

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## Appendix A

## CONCHO WATER SNAKE PREY BASE

Instream flows for the upper Colorado River basin should be predicated on maintaining the aquatic and riparian habitat at a level necessary to ensure long-term sustainability and viability of the Concho water snake, *Nerodia harteri paucimaculata*. The key to determining flow regimes for the snake will be based upon providing an instream flow that mimics natural, historical flow conditions and also satisfies the flow requirements of the suite of fish species presently occurring within the range of the snake.

Long-term prey-base studies conducted during the 10-year monitoring period for the Concho water snake indicate this species is an opportunistic, piscivorous predator. This conclusion is drawn by comparing prey items (Table A1) taken from Concho water snakes with the fish species collected (Table A2) at monitoring sites and riffles in the upper basin over the course of the above mentioned 10 year project.

Table A1. Concho water snake prey items (1987-1996).

| Species | # of Items | Percent |
|---|---|---|
| *Cyprinella lutrensis* | 409 | 33.4 |
| *Pimephales vigilax* | 400 | 32.6 |
| *Menidia beryllina* | 79 | 6.4 |
| *Gambusia affinis* | 71 | 5.8 |
| *Pylodictis olivaris* | 38 | 3.1 |
| *Ictalurus punctatus* | 33 | 2.7 |
| *Percina macrolepida* | 29 | 2.4 |
| *Cyprinodon rubrofluviatilis* | 28 | 2.3 |
| *Lepomis cyanellus* | 13 | 1.1 |
| Balance of prey items (>10 species) | 126 | 10.4 |
| **Total** | **1,226** | **100** |

Table 2. Monitoring site and upper basin seine samples (1987-1996).

| Species | # of Fish | Percent |
|---|---|---|
| *Cyprinella lutrensis* | 89,001 | 68.7 |
| *Gambusia affinis* | 18,864 | 14.6 |
| *Pimephales vigilax* | 13,246 | 10.2 |
| *Menidia beryllina* | 6,917 | 5.3 |
| Balance of fish collected | 1,522 | 1.2 |
| **Total** | **129,550** | **100** |

*Cyprinella lutrensis*, because of its abundance in the riffle habitat of the snake, was, by a narrow margin, the most commonly palpated food item of the snake. *Pimephales vigilax*, as a food item, was found essentially at the same frequency as *C lutrensis*. Being a species that prefers to hide under rocks on the stream bottom (Parker 1964. Southwest. Nat. 8:228-35) rather than occupying the upper water column, resulted in its high incidence in the diet of the snake. The Concho water snake's feeding habit typically involves searching and probing in and around rocks within a riffle. Consequently, the snake will frequently capture prey species occupying those places (i.e., *Pimephales vigilax*). The flow regimes necessary to maintain these prey species will vary depending upon season and climatic perturbations. Typically, the upper Colorado River basin is characterized by drought and the resident fish fauna has evolved and adapted to an ephemeral and intermittent stream system. It is not uncommon for stream flows to cease during the summer months (July and August) and return abruptly as a torrential flood. However, in the arid climate of the upper Colorado River basin, rainfall with a subsequent runoff that restores discharge to the stream is highly variable and unpredictable.

## Appendix B

## ESTIMATE OF QUANTITY AND QUALITY OF CONCHO WATER SNAKE HABITAT

At the request of the U.S. Fish and Wildlife Service (Service), Okla Thornton, biologist with the Colorado Municipal Water District used his best judgment and highlighted on a map all areas of Concho water snake habitat, throughout its range. For each highlighted area, Mr. Thornton, estimated the quality of the habitat from 10 (best quality habitat) to 1 (least quality habitat). The Service digitized this information using GIS program and quantified the length (in river meters or shoreline meters for reservoirs) of each habitat area designated by Mr. Thornton. There were no habitats scored as a 1. This habitat assessment was irrespective of discharge in the river or elevation of the reservoirs.

The resulting data were summarized by quality and river reach (Table B1). The Concho River segment is from San Angelo to the confluence with the Colorado River. Spence Reservoir is the shoreline distance of the lake. The Upper Colorado River segment is from the outflow of Spence Reservoir to the inflow of Ivie Reservoir. Ivie Reservoir is the shoreline distance of the lake. The Lower Colorado River segment is from the outflow of Ivie Reservoir to Bend State Park

Table B1. Summary of Concho water snake habitat availability.

| | **Estimated linear amount of Concho water snake habitat (meters of stream length or shoreline length)** | | | | | |
|---|---|---|---|---|---|---|
| | **Subpopulation (River Segment or Reservoir)** | | | | | |
| **Habitat Quality** | **Concho River** | **Spence Res.** | **Upper Co River** | **Ivie Res.** | **Lower Co. River** | **Total** |
| 10 | 15504.0 | 0.0 | 35878.5 | 0.0 | 15641.4 | **67023.9** |
| 9 | 0.0 | 0.0 | 1121.4 | 0.0 | 1412.3 | **2533.7** |
| 8 | 0.0 | 6044.8 | 3408.4 | 8186.1 | 8497.2 | **26136.5** |
| 7 | 8390.3 | 0.0 | 2548.5 | 7491.2 | 4875.4 | **23305.4** |
| 6 | 2856.0 | 0.0 | 1183.2 | 2906.2 | 2746.2 | **9691.6** |
| 5 | 7451.6 | 2883.6 | 3233.2 | 689.5 | 2860.7 | **17118.6** |
| 4 | 1748.5 | 1324.8 | 11761.2 | 487.6 | 611.4 | **15933.5** |
| 3 | 2135.7 | 1393.4 | 3642.4 | 698.9 | 1679.6 | **9550.0** |
| 2 | 8465.0 | 1911.4 | 2614.0 | 0.0 | 0.0 | **12990.4** |
| **Total** | **46551.1** | **13558.0** | **65390.8** | **20459.5** | **38324.2** | **184283.6** |

The results were then grouped into high (scores 8-10), medium (scores 5-7), and low (scores 2-4) to compare the amount of habitat quality in each river segment or reservoir. Overall, the Upper Colorado River segment had the most habitat and the most high quality habitats, and Spence Reservoir had the least overall habitat available (Figure B1).

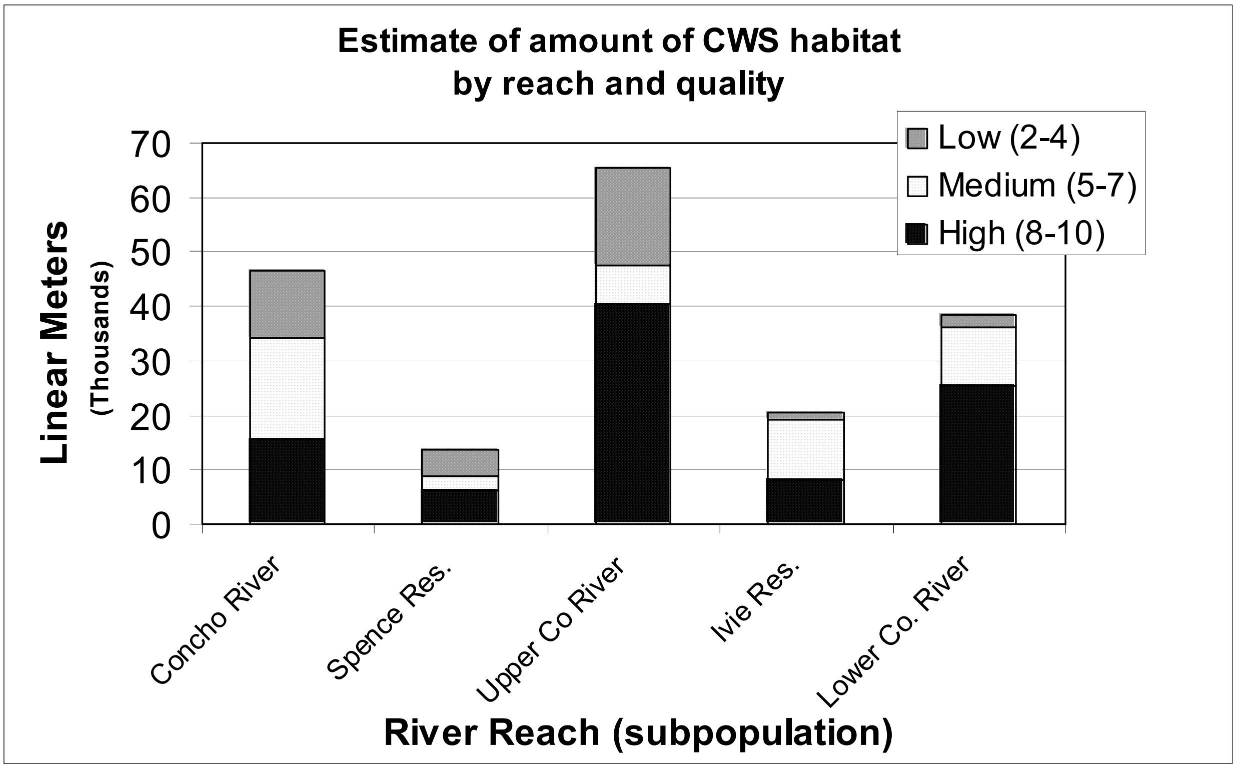



Figure B1. Comparison of Concho water snake habitat available by river segment or reservoir and by quality of habitat.

As a percent of total Concho water snake habitat available, the river segments contain 82 percent of all habitats and the two reservoirs contain 18 percent of all habitats, based on this analysis (Figure B2). The largest percent of high quality habitat was found in the Upper and Lower Colorado River segments (42 percent and 27 percent, respectively) and the reservoirs combined contain 15 percent of available high quality habitats.

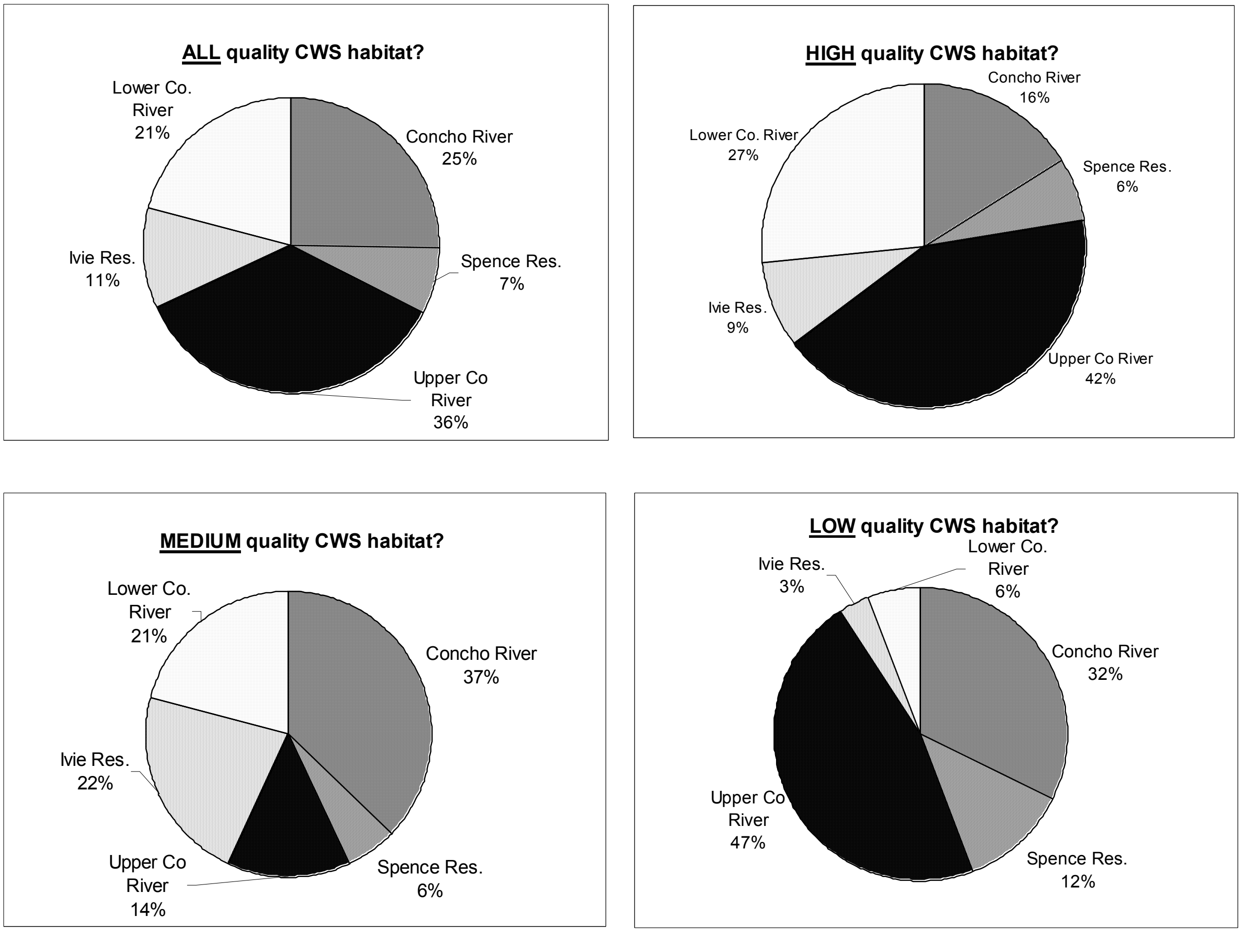



Figure B2. Percent of available Concho water snake habitat by quality and river reach.

## Appendix C

## MINIMUM FLOW SIMULATIONS OF COLORADO RIVER FLOWS ABOVE AND BELOW SPENCE RESERVOIR BASED ON 1999 - 2004 FLOW CONDITIONS

### I. Analysis Objective

Predict the downstream flows in the Colorado River at Ballinger of proposed reservoir releases from Spence Reservoir, based on District proposed operations and using the actual flow conditions from January 1, 1999, to August 15, 2004.

### II. Current Operational Requirement

1986 Biological Opinion and 1987 MOA requires continuous daily flow of 10 cfs at the Ballinger gage.

### III. Proposed Spence Reservoir Operations

District has proposed that Spence ouflows be 4.0 cfs in summer (Apr - Sept) and 1.5 cfs in winter (Oct - Mar), when inflows (as measured at Silver gage) are at least this level. No flows will be released if inflows are not equal to or greater than the minimum proposed.

### IV. Definitions of Abbreviations

| | |
|---|---|
| $S_m$ | = USGS measured flow, Colorado River above Silver gage, inflow to Spence Reservoir |
| $RL_m$ | = USGS measured flow, Colorado River near Robert Lee gage, outflow from Spence Reservoir |
| $B_m$ | = USGS measured flow, Colorado River at Ballinger gage, downstream flows |
| $S_p$ | = Predicted flow at Silver gage based on District proposed flows |
| $RL_p$ | = Predicted flow at Silver gage based on District proposed flows |
| $B_p$ | = Predicted flow at Silver gage based on District proposed flows |

WINTER = October 1 to March 31

SUMMER = April 1 to September 30

### V. Rules for simulating flows

1. If the measured Silver inflow is less than 1.5 cfs in winter or 4.0 cfs in summer, then the predicted Robert Lee outflow = 0 cfs.

WINTER: If $S_m < 1.5$ cfs, then $RL_p = 0$ cfs.

SUMMER: If $S_m < 4.0$ cfs, then $RL_p = 0$ cfs.

2. If the measured Silver inflow is equal to or greater than 1.5 cfs in winter or 4.0 cfs in summer, then the predicted Robert Lee outflow = 1.5 cfs in summer and 4.0 cfs in winter.

WINTER: If $S_m$ => 1.5 cfs, then $RL_p = 1.5$ cfs.

SUMMER: If $S_m$ => 4.0 cfs, then $RL_p = 4.0$ cfs.

3. If the measured Ballinger discharge is greater than measured Robert Lee discharge, then the predicted Ballinger discharge is the measured Ballinger discharge less the measured Robert Lee discharge plus the predicted Robert Lee outflow.

If $B_m > RL_m$, then $B_p = (B_m - RL_m) + RL_p$

4. If the measured Ballinger discharge is less than the measured Robert Lee discharge, and the difference in the measured discharge at Robert Lee and the measured discharge at Ballinger is less than 1.5 cfs in winter (4.0 cfs in summer), then the predicted Ballinger discharge is the predicted discharge at Robert Lee less the difference in Robert Lee and Ballinger measured discharges.

WINTER: If $B_m < RL_m$, and $RL_m - B_m < 1.5$ cfs, then $B_p = RL_p - (RL_m - B_m)$

SUMMER: If $B_m < RL_m$, and $RL_m - B_m < 4.0$ cfs, then $B_p = RL_p - (RL_m - B_m)$

5. If the measured Ballinger discharge is less than the measured Robert Lee discharge, and the difference in the flow measured at Robert Lee and the measured discharge at Ballinger is greater than 1.5 cfs in winter (4.0 cfs in summer), then the predicted Ballinger flow is 0.

WINTER: If $B_m < RL_m$, and $RL_m - B_m > 1.5$ cfs, then $B_p = 0$ cfs

SUMMER: If $B_m < RL_m$, and $RL_m - B_m > 4.0$ cfs, then $B_p = 0$ cfs

6. The resulting spreadsheet formulas are in Table 1.

Table C1. Sample calculations used in Colorado River flow simulations.

| CELL | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|
| | USGS Mean Daily Discharge CFS | | | | | | | |
| | Colorado River / Spence Reservoir Analysis | | | | | | | |
| | | | | | | | | |
| 5 | Winter: Oct - Mar | 1.5 | | | | | | |
| 6 | Summer: Apr - Sept | 4 | | | | | | |
| 7 | | | | | | | | |
| 8 | | **Measured** | **Measured** | **Measured** | **Simulated** | **Simulated** | **Adjusted** | **Adjusted** |
| 9 | **Date** | **Silver** | **Robert Lee** | **Ballinger** | **Robert Lee** | **Ballinger** | **Robert Lee (simulated)** | **Ballinger (simulated)** |
| 10 | 1999-01-01 | 1.4 | 11 | 15 | 0 | 4 | 0.01 | 4 |
| 11 | 1999-01-01 | 1.4 | 11 | 15 | =IF(C13<$C$6,0,$C$6) | =IF(E13>D13,E13-D13+F13,(IF(D13-E13<$C$6,F13-(D13-E13),0))) | =IF(F13>0,F13,0.01) | =IF(G13>0,G13,0.01) |
| 12 | | | | | | | | |
| 13 | 1999-04-01 | 7.4 | 8.8 | 19 | 1.5 | 11.7 | 1.5 | 11.7 |
| 14 | 1999-04-01 | 7.4 | 8.8 | 19 | =IF(C16<$C$7,0,$C$7) | =IF(E16>D16,E16-D16+F16,(IF(D16-E16<$C$7,F16-(D16-E16),0))) | =IF(F16>0,F16,0.01) | =IF(G16>0,G16,0.01) |

VI. Results

| | % frequency of days, CR at Ballinger | | |
|---|---|---|---|
| | Actual (1999-2004) | Simulated Flows | |
| Total Days, < 10 cfs | 57.5% | 89.0% | |
| Total Days, = 0 cfs | 0.0% | 50.0% | |
| | | | |
| Winter, = 0 cfs | 0.0% | 36.3% | |
| Summer, = 0 cfs | 0.0% | 62.3% | |
| | | | |
| Winter, =< 1.5 cfs | 5.4% | 51.0% | |
| Summer, =< 1.5 cfs | 17.3% | 67.2% | |
| | | | |
| Winter, < 10 cfs | 49.4% | 92.1% | |
| Summer, < 10 cfs | 64.5% | 85.3% | |
| | | | |
| Total Days, N = | 2054 | 2054 | |
| Winter Days, n = | 1002 | 1002 | |
| Summer Days, n = | 1052 | 1052 | |
| | | | |
| All, Mean Annual Flow | 24.8 | 17.2 | |
| All, Median Annual Flow | 8.6 | 0.8 | |
| | | | |
| | % frequency of days, CR at Robert Lee | | |
| All, = 0 cfs | 0 | 50.1% | |
| All, =< 1.5 cfs | 4.2% | 29.1% | |
| All, =< 4.0 cfs | 6.1% | 20.7% | = 4 cfs |
| All, =< 10 cfs | 53.9% | 100.0% | |
| All, >10 cfs | 46.1% | 0.0% | |

VII. Notes

1. The time period under analysis, January 1, 1999 to August 15, 2004, is a very dry period for overall river flows.
2. Discharge records from October 1, 2003, to August 15, 2004, are preliminary and not final by USGS.
3. All discharges = 0, or predicted negative numbers, were converted to 0.01 for logarithmic graph plots.

# APPENDIX B

# ECO-REGIONS OF TEXAS

# Ecoregions of Texas

**23 Arizona/New Mexico Mountains**
- 23a Chihuahuan Desert Slopes
- 23b Montane Woodlands

**24 Chihuahuan Deserts**
- 24a Chihuahuan Basins and Playas
- 24b Chihuahuan Desert Grasslands
- 24c Low Mountains and Bajadas
- 24d Chihuahuan Montane Woodlands
- 24e Stockton Plateau

**25 High Plains**
- 25b Rolling Sand Plains
- 25e Canadian/Cimarron High Plains
- 25i Llano Estacado
- 25j Shinnery Sands
- 25k Arid Llano Estacado

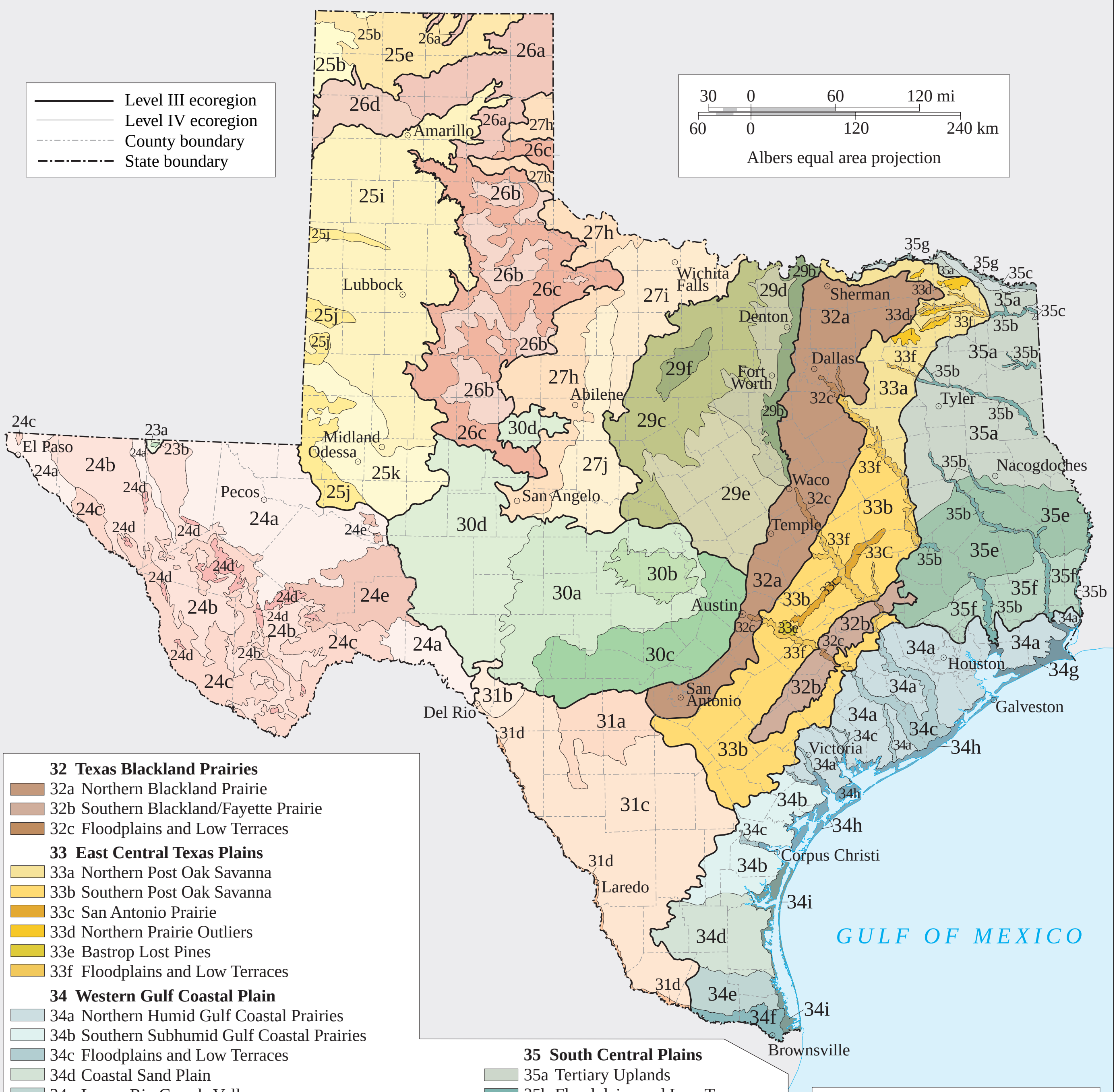
**26 Southwestern Tablelands**
- 26a Canadian/Cimarron Breaks
- 26b Flat Tablelands and Valleys
- 26c Caprock Canyons, Badlands, and Breaks
- 26d Semiarid Canadian Breaks

**27 Central Great Plains**
- 27h Red Prairie
- 27i Broken Red Plains
- 27j Limestone Plains

**29 Cross Timbers**
- 29b Eastern Cross Timbers
- 29c Western Cross Timbers
- 29d Grand Prairie
- 29e Limestone Cut Plain
- 29f Carbonate Cross Timbers

**30 Edwards Plateau**
- 30a Edwards Plateau Woodland
- 30b Llano Uplift
- 30c Balcones Canyonlands
- 30d Semiarid Edwards Plateau

**31 Southern Texas Plains**
- 31a Northern Nueces Alluvial Plains
- 31b Semiarid Edwards Bajada
- 31c Texas-Tamaulipan Thornscrub
- 31d Rio Grande Floodplain and Terraces




**32 Texas Blackland Prairies**
- 32a Northern Blackland Prairie
- 32b Southern Blackland/Fayette Prairie
- 32c Floodplains and Low Terraces

**33 East Central Texas Plains**
- 33a Northern Post Oak Savanna
- 33b Southern Post Oak Savanna
- 33c San Antonio Prairie
- 33d Northern Prairie Outliers
- 33e Bastrop Lost Pines
- 33f Floodplains and Low Terraces

**34 Western Gulf Coastal Plain**
- 34a Northern Humid Gulf Coastal Prairies
- 34b Southern Subhumid Gulf Coastal Prairies
- 34c Floodplains and Low Terraces
- 34d Coastal Sand Plain
- 34e Lower Rio Grande Valley
- 34f Lower Rio Grande Alluvial Floodplain
- 34g Texas-Louisiana Coastal Marshes
- 34h Mid-Coast Barrier Islands and Coastal Marshes
- 34i Laguna Madre Barrier Islands and Coastal Marshes

**35 South Central Plains**
- 35a Tertiary Uplands
- 35b Floodplains and Low Terraces
- 35c Pleistocene Fluvial Terraces
- 35e Southern Tertiary Uplands
- 35f Flatwoods
- 35g Red River Bottomlands

Griffith, G.E., Bryce, S.A., Omernik, J.M., Comstock, J.A., Rogers, A.C., Harrison, B., Hatch, S.L., and Bezanson, D., 2004, Ecoregions of Texas, U.S. Environmental Protection Agency, Corvallis, OR.

**APPENDIX C**

**O.C. FISHER LAKE ECOSYSTEM RESTORATION PROJECT**

# DETAILED PROJECT REPORT
# AND
# INTEGRATED ENVIRONMENTAL ASSESSMENT

FOR

# O.C. FISHER LAKE ECOSYSTEM RESTORATION PROJECT
# SAN ANGELO, TEXAS

June 2005

Prepared for
City of San Angelo

by the

US Army Corps of Engineers
Fort Worth District
P.O. Box 17300
Fort Worth, TX 76102-0300

# EXECUTIVE SUMMARY

The Detailed Project Report (DPR) presents the results of the feasibility study for construction of the O.C. Fisher Lake Ecosystem Restoration Project under the authority of Section 1135 of the Water Resources Development Act of 1986, as amended (33 USC 2201). The purpose of the study was to identify the environmental degradation created by construction and operation of O.C. Fisher Lake and to develop and evaluate restoration measures to restore the biological integrity and diversity of the ecosystem to a more natural and sustainable condition. The U.S. Army Corps of Engineers, Fort Worth District (USACE) conducted the study through cooperative efforts with U.S. Fish and Wildlife Service (USFWS), Natural Resource Conservation Service (NRCS), Texas Parks and Wildlife Department (TPWD), Texas Agricultural Extension Service (TAES), Upper Colorado River Authority (UCRA), Texas State Soil and Water Conservation Board (TSSWCB) and Angelo State University (ASU).

The study area is located in northwest Tom Green County of west central Texas adjacent to the city limits of San Angelo. It is located on the North Concho River, 6.3 miles above the river's confluence with the South Concho River of the Colorado River watershed. All lands, with exception of the dam and uncontrolled spillway operated by USACE, are operated and maintained through license agreements with USACE. ASU operates and maintains the land north of the North Concho River for fish and wildlife management, biological research, education, and plant conservation. TPWD operates lands south of the river for multiple recreational purposes.

Environmental degradation began in 1952 during construction of the reservoir. Approximately 253 acres of prime riparian habitat and a total of 7,524 acres of woody vegetation were lost. Large acreages of native prairie were also lost. Environmental degradation continued from operation of the project upon completion of the reservoir. Livestock were allowed to graze upon the lands and naturally occurring wildfires were suppressed. Overgrazing and removal of fire, coupled with drought conditions and subsequent drop in lake level, allowed invasive brushy species the opportunity to dominate the habitat and negatively impact the hydrology of the ecosystem. Each year, invasive brushy species continue to expand their range, further depleting the hydrological regime of the ecosystem through high rates of evapotranspiration.

Invasive brushy species include exotic saltcedar, mesquite and willow baccharis. All of which detrimentally alter the historical habitat conditions due to their prolific growth and high moisture consumption. Only 4.6 percent of the riverine habitat contains surface water and the current lake level is in the reserve pool, some 53 feet below conservation pool. Prickly pear is another vegetative species that has become invasive within the ecosystem.

Water quality is reduced within the study area as a result of invasive vegetative species. O.C. Fisher Lake is included in the draft 2002 List of Impaired Waters (June 13, 2002), as required by Section 303(d) of the Clean Water Act, for high levels of chloride and total dissolved solids. Saltcedar leaves exude salt creating high salinity soil conditions which presumably contribute to high levels of chloride within surface water. Surface run-off during heavy rain events carries sediments into waterways because native groundcover vegetation is displaced by large stands of invasive vegetative species creating exposed bare soil.

As surface water continues to be lost within the ecosystem, degradation and loss of native historical habitat soon follows. Currently, native vegetation exists in conditions similar to historical conditions in only 35.8 percent (89.4 acres) of riparian woodland habitat and 4.5 percent (139.1 acres) of transitional habitat. As native vegetation is degraded from its historical condition, the carrying capacity for fish and wildlife species dependent upon the habitat is subsequently reduced. Currently, the study area supports approximately half of its potential carrying capacity in terrestrial habitats due to habitat degradation and approximately two percent of its potential carrying capacity in aquatic habitats.

The recommended plan will result in significant benefits to the ecosystem. Habitat value will increase 200 percent over existing conditions and increase nearly 600 percent over future conditions without restoration. With full implementation of the recommended plan, perennial surface water would increase from 453.6 acres to 3,840.9 acres. The progressive loss of riparian woodland habitat would halt, conserving the existing 89.4 acres of remnant woodland, and an additional 160.4 acres of remnant woodland would be restored towards historical condition. The recommended plan would also restore 8,666.9 acres of habitat to a more natural, historic and sustainable condition which is critical to the hydrological regime of the ecosystem. The total estimated cost of the recommended plan is $3,863,920 and the local sponsor’s share is $965,980.

The proposed restoration project is extremely significant for many reasons. Aquatic habitats and associated riparian woodland habitats within west central Texas are scarce, and ever declining, as invasive vegetative species continue to dominate native vegetation and alter ecosystems. The North Concho River Brush Control Project conducted by the state above the study area offers a unique opportunity to combine contiguous benefits of both projects for a greater benefit than could be derived individually. The recommended plan will significantly restore biodiversity and may benefit some threatened and endangered wildlife species and contribute to a lake level rise improving the water supply for San Angelo and creating recreational and economic benefits to the area.

City of San Angelo is identified as the non-Federal sponsor and has been presented with the findings of this report. The city offers support for the plan, including cost sharing, and agreed to assume responsibilities for all operation and maintenance cost upon completion of the restoration project. The first year’s estimated operation and maintenance cost is $56,900 and the estimated average annual operation and maintenance cost is $25,372. A review of the information provided by the City of San Angelo regarding its financial capability to meet the cost sharing requirements indicates that the city has the statute authority and the financial capability to provide the required non-Federal items of local cooperation.

Extensive coordination and input was obtained from the USFWS and TPWD during the development of the recommended plan and both agencies are supportive of the project. The recommended plan is consistent with state and federal government initiatives to improve water quality and conserve/improve native habitats. It is also consistent with the North American Waterfowl Management Plan to preserve and increase North America’s waterfowl population.

An Environmental Assessment (EA) was integrated into the DPR to assess potential impacts that may occur through full implementation of the recommended plan. Items marked with an asterisk (*), both in the index and throughout the body of the report, indicate information required to fulfill National Environmental Policy Act requirements. A public notice was released on XXXXXXXX, disclosing the availability of the EA.

XX comment letters were received during the public review period, which closed on XXXXX. XX of the letters were from resource agencies and expressed general support of the ecosystem restoration project. Based upon findings of potential impacts resulting from the actions as proposed in this DPR, the actions are anticipated to result in no significant adverse impacts on the natural or man-made environment, as long as implementation of the actions adheres to applicable regulations, policies, coordination requirements, standards, and guidelines. Based upon this assumption, a Finding of No Significant Impact was executed on XXXXXXX.

For more information, please contact Ernest C. Eberle, Jr. in writing or by telephone at:

U.S. Army Corps of Engineers, Fort Worth District
CESWF-PER-PF, ATTN: Marcia R. Hackett
819 Taylor Street, Fort Worth, Texas 76102-0300

# DETAILED PROJECT REPORT and
# INTEGRATED ENVIRONMENTAL ASSESSMENT
# O.C. Fisher Lake Ecosystem Restoration Project
# San Angelo, Texas

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*** National Environmental Policy Act Requirement**

# INTRODUCTION

**Study Authority.** The study is authorized under the continuing authority provided to the Chief of Engineers by Section 1135 (b) of the Water Resources Development Act of 1986, as amended (33 USC 2201). The intent of the Section 1135 Program dictates that a project initiated under this authority must either modify an existing USACE project to improve the environment or restore the environment in an area where an existing USACE project has contributed to the degradation of the quality of the habitat. USACE is the lead agency for this study. In a letter dated May 14, 2002, City of San Angelo expressed their desire to participate in an ecosystem restoration study comprising all federal lands associated with O.C. Fisher Lake.

*** Study Purpose, Area and Scope.** The purpose of the study is to conduct investigations into the feasibility of implementing an ecosystem restoration project on the lands surrounding O.C. Fisher Lake and recommend an ecosystem restoration project for implementation. The study area includes all 15,860 acres of government-owned property, including riparian and riverine habitats that have been degraded as a result of the construction, operation, and maintenance of the lake, and lacustrine habitats degraded by the subsequent encroachment of invasive phreatophytic vegetation. Successful ecosystem restoration within the study area requires reestablishment of the hydrological regime, which would significantly benefit the aquatic, riparian, and transitional habitats of the study area. The study investigated the benefits to the hydrologic regime, and thus the aquatic habitats and associated riparian habitats, of removing the invasive vegetation and reestablishing appropriate vegetation to support a more natural and sustainable state within the riparian and transitional areas.

**Study Participants.** The O.C. Fisher Lake Ecosystem Restoration Project Study was initiated at the request of the City of San Angelo. In addition to USACE and City of San Angelo, the study has been a multi-disciplinary effort among a wide range of participants including the United States Fish and Wildlife Service (USFWS), United States Natural Resources Conservation Service (NRCS), TPWD, ASU, Texas Agricultural Extension Service (TAES), UCRA, and TSSWCB.

*** Location.** O.C. Fisher Lake is located in west central Texas on the North Concho River, 6.3 miles above the river's confluence with the South Concho River and approximately 65 miles above its confluence with the Colorado River. The lake is adjacent to the city limits of San Angelo in the northwest corner of Tom Green County, Texas. Figure 1 shows the location of the study area.

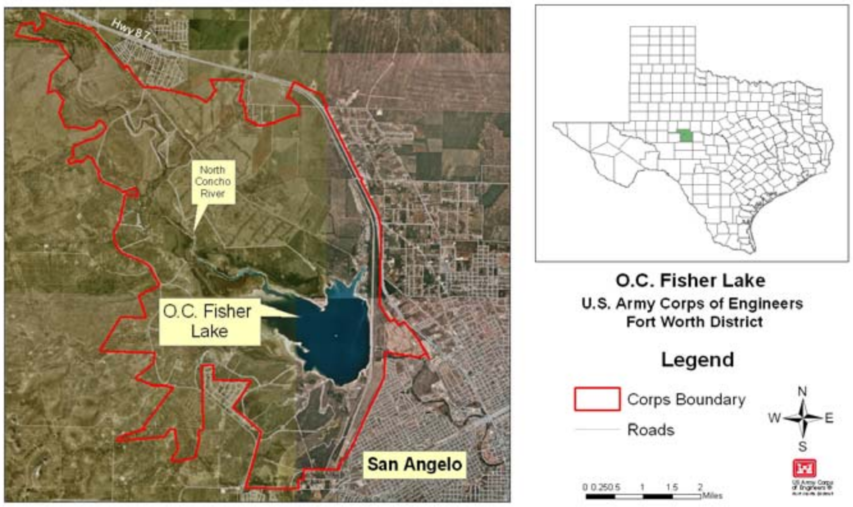


**FIGURE 1.** O.C. Fisher Lake Ecosystem Restoration Project Location.

**O.C. Fisher Lake.** O.C. Fisher Lake is a multipurpose reservoir operated by the US Army Corps of Engineers (USACE) and authorized primarily for flood control purposes. Other missions of the reservoir include water supply for the City of San Angelo, recreation, and wildlife habitat. Construction of the reservoir began in May 1947 and was completed in February 1952.

The conservation pool is 5,440 surface acres at 1908 feet Mean Sea Level (MSL), and its flood pool is 12,700 surface acres at 1938 feet MSL. All lands are owned by USACE and USACE operates and maintains the dam and uncontrolled spillway. The remaining lands are operated and maintained through license agreements with USACE. Angelo State University (ASU) operates and maintains the land north of the North Concho River for fish and wildlife management, biological research, education, and plant conservation. Texas Parks and Wildlife Department (TPWD) operates lands south of the river for multiple recreational purposes.

**Ongoing/Previous Studies, Projects and Reports.** No studies or projects are currently being conducted within the study area. The Texas State Soil and Water Conservation Board (TSSWCB) is implementing a major project, the North Concho River Pilot Brush Control Project, along the North Concho River, the major tributary of O.C. Fisher Lake. The project is in its sixth year and its purpose is to enhance the amount of water flowing from the North Concho River watershed through brush control on 432,000 acres, approximately half of the entire river's watershed. Currently, 295,510 acres of brush have been treated and treatment is continuing with additional state funding. The Upper Colorado River Authority (UCRA) reports that springs are beginning to flow and perennial characteristics within the main stem of the river are observed (UCRA 2004).

# * EXISTING CONDITIONS

**Climate.** The climate in Tom Green County is generally mild with hot summers. Average annual temperature is 64.9°F, with an average high of 78.1°F and an average low of 51.6°F. Highest temperatures occur in July with an average high of 92.7°F and an average low of 69.1°F. Lowest temperatures occur in January with an average high of 56.8°F and an average low of 30.6°F. The area averages 251 days of sunshine (sunny or partly cloudy). Snow and sleet are not common, but may occur once or twice each year (National Weather Service 2004).

San Angelo received an average annual rainfall of 20.91 inches since 1977 with most of the rain occurring in the spring and fall. May and September received the most rainfall since 1977, averaging 3.09 inches and 2.95 inches respectively (National Weather Service 2004). Rainfall during the spring and fall generally falls during short duration, high intensity thunderstorms. Rainfall data recorded at the USACE weather station and ASU weather station, both located within the study area, averaged 21.2 inches per year from 1954-2001.

**Topography.** Elevations within the study area range from 1846 feet MSL at the lake's current level to 1991 feet MSL located on the northwest portion of the study area. The North Concho River traverses the study area from the northwest to the southeast and flows into O.C. Fisher Lake. The study area north of the river is alluvial plains with gentle slopes rising from river bank and lakeshore. The study area south of the river contains the most animated terrain consisting of high hills, steep bluffs and the North Concho River deeply etched into its alluvial plains. Moving southward from the river, the study area changes to a broad low gradually sloping plain with high bluff interruptions cut by tributaries that cross the study area flowing from the west in the North Concho River.

**Soils.** Soils within the study area are predominately contained within three soil series; Angelo series, Kimbrough series and Tulia series. Angelo series is described as nearly level to gently sloping soils on smooth outwash plains. Angelo soils are well-drained, have slow surface runoff, moderately slow permeability, and are well suited to crops or to range. The Kimbrough series is described as gently sloping to sloping and undulating soils on outwash plains. Kimbrough soils are well-drained, surface run-off medium, moderate permeability and are mostly used as range and wildlife habitat. The Tulia series is described as nearly level to gently sloping soils on outward plains. It is well-drained, surface runoff medium, moderate permeability and suitable for crops, range and wildlife habitat (Soil Conservation Service 1976).

**Land Use.** The land within the study area is owned and managed by USACE. The entire study area is operated and maintained through separate license agreements with ASU for lands north of the North Concho River and TPWD for lands south of the North Concho River. ASU operates its lands for fish and wildlife management, biological research, education, and plant conservation and TPWD operates its lands for fish and wildlife management and recreation. Grazing and prescribed burning occurs within large tracts of the leased lands as a component of natural resource management. Vegetative condition is monitored to ensure proper management. Approximately 611 acres within ASU's lease are cultivated or research lands.

**Air Quality.** Tom Green County meets or exceeds the primary standard for air quality established by the U.S. Environmental Protection Agency (EPA) and is therefore classified as an attainment area. The primary standard considers pollutant levels of carbon monoxide, nitrogen dioxide, sulfur dioxide, ozone, particulate matter and lead. The closest air monitoring station is located in Odessa of Ector, County, 132 miles north-northwest of San Angelo. Since 1998, the air monitoring station recorded only 2 days in 2001 when the air quality index reached unhealthy levels of air pollutants (EPA 2004).

**Socioeconomic Conditions.** Tom Green County encompasses 1,522 square miles with a population of 103,528 in 2003 (US Census Bureau 2004). Economy of the county is derived predominately from agriculture and ranching (Texas State Historical Association 1996). The county is referred to as the "Sheep and Wool Capital" (Tom Green County Information Technology Department 2004). San Angelo, comprised of 58.6 square miles and a population of 88,439 in 2000 (US Census Bureau 2004), is the county seat. San Angelo is known as the "Agribusiness Capital of Texas" and serves as a trade center for the agribusiness region known as "Concho Valley", including Coke, Coleman, Concho, Crockett, Irion, McCulloch, Menard, Reagan, Runnels, Schleicher, Sterling, Sutton, and Tom Green Counties. Primary agricultural commodities for the Concho Valley, for 1998-2000 were beef cattle, sheep/goats, cotton, hunting and recreation, dairy/milk, wheat, grain sorghum, hay, and pecans (San Angelo Chamber of Commerce 2003).

San Angelo is also the regional center for communications, education, federal programs, health care, industry, recreation, retail, retirement, and tourism. Goodfellow Air Force Base is located southeast of San Angelo and employs the highest number of employees within the San Angelo area. Educational institutes include San Angelo State University, Howard College-San Angelo Campus, American Commercial College, and Texas A&M Research and Extension Center (San Angelo San Angelo Chamber of Commerce 2003).

**Recreational, Scenic, and Aesthetic Resources.** The study area is in a transition zone between several ecological regions. Although most agree the predominant ecological region of the study area is Rolling Plains, there are other areas closely resembling those of other ecological regions, including Edwards Plateau and High Plains ecological regions. The location allows for a tremendous diversity of plants and animals and is a natural confluence of the biology associated with each. Some 350 species of birds and 50 species of mammals are recorded to have utilized the site. (TPWD 2004).

The study area contains San Angelo State Park, an oasis of quality outdoor recreation comprising 7,677 acres. Due to the tremendous fluctuations in the lake levels of O.C. Fisher Lake, the park was not established specifically as a water-recreational park. The park was developed utilizing the cultural and natural resources found within the park. Within the park boundaries can be found Native American Petroglyphs, Prehistoric Permian vertebrate animal tracks, a small bison herd, a large herd of official Texas Longhorn cattle, a black-tailed prairie dog town, and a grave site that dates back to 1847. Frequent interpretive tours are given to each of these sites as part of the park's program. Bird-watching and wildlife viewing is very popular at the park. The establishment of almost 50 miles of hike/bike/horse trails is one of the largest attractions of the park and brings in enthusiasts from all over the state. The park has 61 established water/electricity sites for campers and numerous primitive sites. When the lake is at safe levels, water sports are very popular including boating, skiing, fishing and swimming. Numerous boat ramps are available on both the north and south sides of the park.

**Cultural Resources.** The area in general is rich in history. Archeological findings indicate some 18,000 years of Native American occupation in the expansive West Texas region, beginning with the Paleo-American hunters of giant Ice Age mammals. The Euro-American history of the area begins with 16th and 17th-century Spanish exploration and the missions established for the semi-settled Jumano Indians. Some of these Jumanos made their way along the forks of the Concho River on expeditions to trade with Indian groups in central and eastern Texas. By the mid-1800's, German immigrants began to acquire land in the Concho River region. The increasing need to protect California-bound travelers led to the establishment of Fort Concho in 1867. From then on, farmers, ranchers, and sheepherders all contributed to the settlement of Concho Country, with San Angelo (originally Santa Angela) becoming the county seat of Tom Green County in 1883 (San Angelo Chamber of Commerce 2003).

The original cultural resources survey was conducted in 1948. More recent surveys have been restricted to relatively small areas in advance of construction projects (water pipelines, oil well pads, power transmission lines, park development, etc.). There are 39 recorded cultural resource sites located on Corps fee property. These include both prehistoric and historic period archeological sites.

In consultation with the State Historic Preservation Officer (SHPO), areas were categorized as having low potential to contain significant cultural resource sites. These areas were identified on the basis of landforms and soil types where previously recorded sites have been surficial and often highly disturbed. The landforms are uplands and pre-Holocene terraces with little or no possibility for burial of cultural resources. These low potential areas will not require additional cultural resources survey.

Areas of medium and high potential for containing cultural resource sites, totaling 2,455 acres, were identified. These medium and high potential areas will require a cultural resources survey before the project may be implemented. In addition to this survey, the 39 known sites and any sites recorded during the survey would be evaluated for National Register eligibility. Project impacts to all potentially eligible sites shall be minimized by the use of vegetation removal methods which cause minimal ground disturbance.

**Hazardous, Toxic and Radioactive Waste.** Hazardous, Toxic and Radioactive Waste (HTRW) assessment was completed for the purpose of identifying possible HTRW and/or other environmental concerns within the study area. Environmental records were searched for identified environmental conditions. All of the recognized environmental conditions are outside the study area or along the perimeter of the study area with the exception of one. An aboveground storage tank site is located within a maintenance yard within the study area. It is unlikely that any of the recognized environmental conditions would pose an HTRW threat to the project; however, an HTRW site survey will be required to determine if feasible pathways exist between the recognized environmental conditions and planned excavation.

**Ecological Regions.** O.C. Fisher Lake lies within the Rolling Plains ecological region, but is somewhat transitory due to its proximity to the Edwards Plateau ecological region. The area is bordered on the west by the Caprock Escarpment, on the south by the Edwards Plateau, and on the east by the Western Cross Timbers and Lampasas Cut Plain. Generally, the alluvial soils at lower elevations along the major drainages support a Rolling Plains plant community and the shallow upland soils often exhibit Edwards Plateau plant community (Franklin and Sanchez 1999) (Johnson and Sanchez 2004). One study describes the study area to be near the boundary between the Mesquite Plains subregion of the Rolling Plains and the Live Oak-Mesquite Savanna subregion of the Edwards Plateau (Diamond et. al 1987). Historically, the area was probably influenced greatly by natural and human caused fires creating a mosaic of habitats. (Franklin and Sanchez 1999) (Franklin and Sanchez 2004).

**Water Resources.**

**Surface Water.**

Surface water within the study area is attributed to local surface runoff and springs. Perennial surface water bodies include O.C. Fisher Lake, North Concho River, Pott Creek and Turkey Creek. Eight tributaries, including Dry Creek, Bald Eagle Creek, and 6 un-named creeks, are intermittent streams. Figure 2 displays the lake tributaries, conservation pool, current lake level, and with-project lake level.

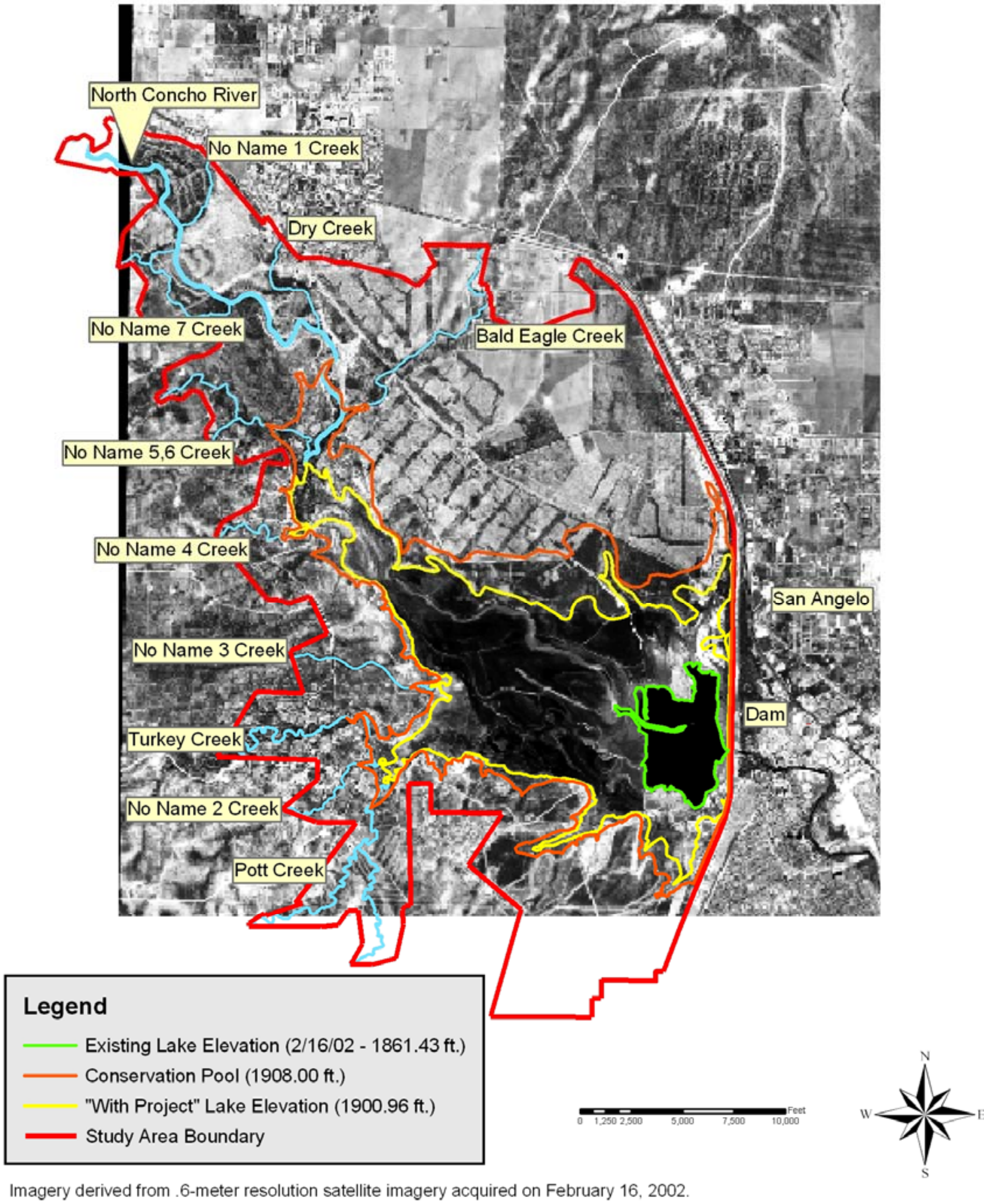


**FIGURE 2.** Tributaries and Lake Level Delineations.

**Groundwater.** Groundwater within the northern portion of the study area is within the Lipan Minor Aquifer. Remaining areas with the study area are not formally recognized as containing major or minor aquifers; however, the ecological site description for the study area provides that groundwater tables are usually high and within a few feet of the surface (Johnson and Sanchez 2004). The groundwater "naturally discharges by seepage to the Concho River and by evapotranspiration in areas where the groundwater table is at or near land surface" (Ashworth and Hopkins 1995). TPWD staff working within the study area report that several of the 20 springs within the study area are no longer flowing and remaining springs have progressively reduced their flow. Figure 3 shows the location of these known springs.

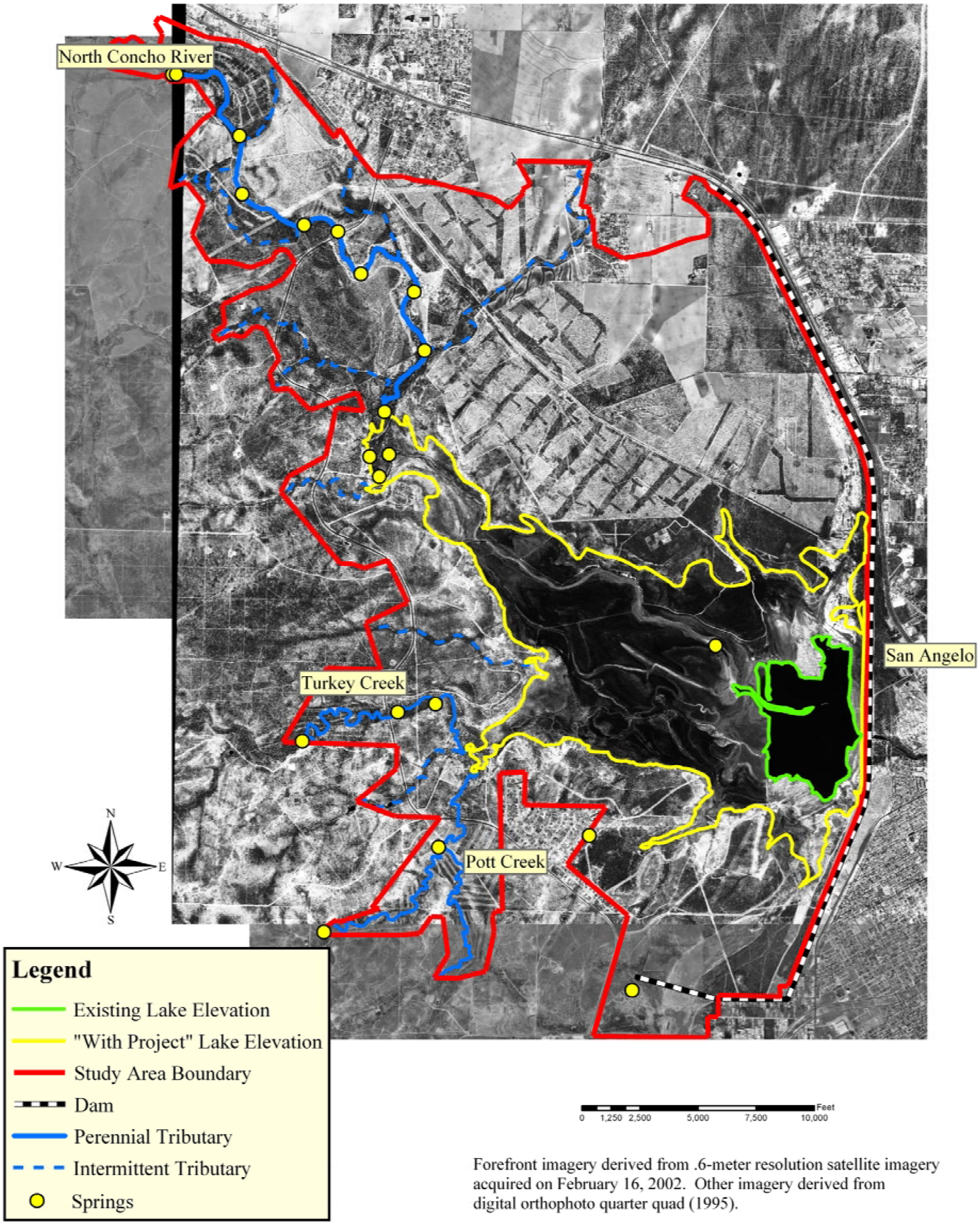


**FIGURE 3.** Springs within Study Area.

The project report compiled by the War Department in 1946 recognized a "ground water reservoir" and conducted a survey for those areas, approximately 120 square miles, which could potentially exhibit an effect upon the reservoir. The report stated the aquifer "consists of sand, gravel, and conglomeritic deposits having varying degrees of permeability" and "overlies primary formations, usually impervious shale or relatively impervious, well-cemented sandstone". It described the pervious horizon ranges in thickness from 5 to 30 feet and it is overlain by a "blanket of relatively impervious alluvium which has a minimum thickness of about 40 feet (War Department 1946). Existing groundwater wells within the proposed reservoir area were also studied in the project report. Groundwater wells were found to be from 50 to 100 feet deep and the aquifer ranges from 5 to 30 feet in thickness. Groundwater was described as being under partial artesian pressure confined on top and bottom by relatively impervious materials (War Department 1946).

**Water Quality.** O.C. Fisher Lake is included in the draft 2002 and 2004 List of Impaired Waters for high levels of chloride and total dissolved solids (Texas Natural Resource Conservation Commission 2004). High levels of chloride are presumably in part due to the exudation of salt crystals from large stands of salt cedar within the lake bed. Additionally, the quality of surface water has been reduced by invasive vegetative species through increased erosion as a result of the reduction in native groundcover vegetation. Monocultures created by invasive brushy species outcompete the native groundcover species and top soil becomes more exposed and susceptible to erosion. Surface run-off during heavy rain events carries sediments into waterways where they remain suspended for a time and then fall to the bottom, impacting aquatic resources.

**Aquatic Wildlife.** Common fish species that can be found within the perennial surface water within the study area are bass (Micropterus spp. and Morone sp.), catfish (Ictalurus spp. and Pylodictus sp.), sunfish (Lepomis spp. and Pomoxis spp.), various minnows (Notropis spp., Pimephales spp., Hybobsis sp., and Carpiodes sp.), mosquito fish (Gambusia spp.), killifish (Fundulus spp.), and some exotics including common carp (Cyprinus carpio), blue tilapia (Oreochromis oreas), and pacu (Piaractus brachypomus). Several species of frogs (Rana spp.) and turtles including the Texas map turtle (Graptemys versa), mud turtle (Kinosternon spp.), spiny softshell turtle (Apalone spineifera), American snapping turtle (Chelydra serpentina), Texas river cooter (Pseudemys texana), and slider (Trachemys scripta). Snakes commonly found in the river include cottonmouth (Agkistrodon piscivorus) and watersnakes (Nerodia spp. and Regina grahami) (USFWS 2004).

Given the climatic conditions and current low water levels, the lake may reach very high temperatures either stressing or killing fish during the hotter months. Largemouth bass occur in the lake and can be tolerant of high temperatures for short periods of time but if conditions exceed 97°F for an extended period of time, largemouth bass can not survive (McCormick and Wegner 1981). Also, the hatching rate of largemouth bass eggs is reduced 50% when exposed to temperatures around 84°F for a 24-hour period (McCormick and Wegner 1981). Based on the UCRA and TCEQ data, these conditions have not occurred at O.C. Fisher Lake, but may occur in the future if lake level continues to drop. However, USACE data for O.C. Fisher Lake shows maximum lake temperatures reaching over 100°F (USACE 2004). Catfish species are more tolerant than largemouth bass to both high temperatures and anoxic conditions and do relatively better in the current conditions of O.C. Fisher Lake. Temperatures may be lower and more moderate in the perennial pools within the upper river channel (USFWS 2004).

**Terrestrial Resources**. Classification of the existing vegetation is based upon the dominant species of the area and determined on a percent cover basis. Mesquite comprises various densities and was therefore classified on a density basis as heavy (greater than 70%), medium (30-69%) and light (15-29%) and areas dominated by grass and forb species with less than 10% mesquite present are classified as grassland. Prickly pear is found in all vegetative cover types in varying densities, but was not considered a dominant species.

**Riparian Woodland Habitat.** Quality riparian woodlands exist and extend 100 to 400 feet from the riverbed and are found along the upper reaches of the North Concho River where perennial surface water still exists. Quality riparian woodlands are also found immediately adjacent to ephemeral tributaries of the river. Vegetation in these areas is dominated by mature pecan, with scattered hackberry, live oak (*Quercus virginiana)*, black willow (*Salix nigra)*, western soapberry (*Sapindus drummondi*), American elm and desirable woody-understory species including bumelia (*Bumelia* spp.), skunkbush (*Rhus trilobata*), littleleaf sumac (*Rhus microphylla*), algerita (*Mahonia trifoliata*), and pricklyash (*Zanthoxylum americanum*). Approximately 48% (89.4 acres of 187.8 acres) of the riparian corridor along the North Concho River within the study area can be characterized as quality riparian habitat. Degraded riparian woodlands along the river include 56.4 acres of mesquite of various densities and 45.0 acres of grass and/or forbs (less than 10% mesquite) of various densities. The remaining riparian woodland habitat is highly fragmented and has been impacted by past management techniques.

The riparian corridor along Pott Creek is approximately 35 feet in width and Turkey Creek is approximately 30 feet. Only a few, scattered hardwood trees remain along the riparian corridors where perennial surface water remains most of the year. The riparian corridors are degraded to the point that 95% is dominated by mesquite and the remaining 5% is grass and/or forbs (less than 10% mesquite) of various densities.

**Transitional Habitat**. Transitional habitat is located adjacent to riparian areas extending to the boundary of the study area. A total of 11,758.9 acres of transitional habitat exists within the study area. The historical condition for these lands was grassland dominated with isolated oak and mesquite timber in the uplands and along ridges. The impacts of fire suppression, overgrazing and drought contributed to the proliferation of mesquite woodlands across the landscape. The vegetative community on approximately 3,091.9 acres, 26.3%, of the transitional habitat within the study area still contains the species and structure to provide some grassland habitat benefits. In general, these lands contain no more than 10% mesquite.

The remaining transitional habitat (8,666.9 acres) within the study area has been invaded by willow baccharis, saltcedar, or mesquite to a level which provides a more shrubland community composition than the historical grassland community. Mesquite has invaded and become the dominant vegetation on 8,466.4 acres of these grasslands. Areas dominated by mesquite are classified on a percent cover basis as heavy (greater than 70%), medium (30-69%) and light (10-29%). Of the 8,466.4 acres exhibiting a mesquite shrubland composition, 2,143.0 acres are light, 1,412.2 acres are medium, and 4,911.2 acres are heavy. The remaining 200.5 acres are dominated by willow baccharis (188.9 acres) and communities dominated by a mixture of saltcedar and willow baccharis (11.6 acres). Prickly pear is found in all vegetative cover types in varying densities, but was not considered a dominant species.

Additional species found within the transitional habitat include species of bumelia, skunkbush, littleleaf sumac, algerita, pricklyash and greenbriar (*Smilax* spp.). Indiangrass, big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium rhizomatum*), switchgrass, sideoats grama, Eastern (*Tripsacum dactyloides*), buffalograss (*Buchloe dactyloides*), plains bristlegrass (*Setaria vulpiseta*), green sprangletop (*Leptochloa dubia*), curly mesquite (*Hilaria belangeri*), various threeawns (*Aristida* spp.), tridens (*Tridens* spp.), Texas wintergrass (*Stipa leucotricha*), Canada wildrye (*Elymus canadensis*), and dropseeds (*Sporobolus* spp.) can be supported by the various soil types. A diversity of forb and legume species as well as over 140 species of wildflowers exist. Sumac (*Rhus* spp.) species, white brush (*Aloysia gratissima*), ephedra (*Eriogonum* spp.), lotebush (*Ziziphus obtusifolia*), feather dalea (*Dalea Formosa*), catclaw (*Acacia greggii*), and algerita are the most common shrub components found throughout the study area.

**Terrestrial Wildlife.** Existing riparian hardwood forest within the study area supports a large diversity of insects, fish, amphibians, reptiles, birds, and mammals. Signs of armadillos, raccoons, and opossums are fairly numerous throughout the study area. Leopard frogs and cricket frogs are abundant, as are snakes, butterflies, bees, and other flying insects. Bird species sighted are typical of bottomland riparian areas. The project area is used by both resident and migratory species. Migratory waterfowl, shorebirds, and resident wood ducks (Aix sponsa) can be seen in the open water and along perennial water areas of the river. A variety of migratory and resident passerine, owl, and hawk species use the woodlands. Some common resident birds that may be observed in the study area are sparrows (Emberizinae), cardinals (Cardinalinae), jays (Corvidae), crows and grackles (Icterinae), flycatchers (Tyrannidae), accipiters, buteos, and turkey (Meleagris gallopavo). Transitional sites still support some bobwhite (Colinus virginianus) and probably supported higher numbers in the past. Mammal species that may utilize habitat types in the study area include white-tailed deer (Odocoileus virginianus), raccoon (Procyon lotor), ringtail (Bassariscus astutus), armadillo (Dasypus novemcinctus), skunks (Mephitis spp., Spilogale sp., and Conepatus sp.), opossum (Didelphus marsupialis), coyote (Canis latrans), bobcat (Lynx rufus), rabbits (Lepus sp. and Silvilagus sp.), foxes (Vulpes sp. and Urocyon sp.), squirrels (Citellus spp. and Sciurus sp.), and small rodents (Peromyscus spp., Neotoma sp., Thomomys sp., Geomys spp., Perognathus sp., and Dipodymus spp.). Reptile species inhabiting the study area include lizards (green anole Anolis sp., skinks Eumeces spp., and spiny lizards Sceloporus spp.), numerous toads (Bufo spp.) including the state threatened Texas horned lizard (Phrynosoma cornutum) rattlesnakes (Crotalus spp.) rat snakes (Elaphe spp.), kingsnakes (Lampropeltis spp.), and turtles like the ornate box turtle (Terrapene ornate). One salamander species may be found within the project area, the Tiger salamander (Ambystoma tigrinum) is known from Tom Green County (USFWS 2004).

**Threatened and Endangered Species.** USFWS reports that two endangered species, two threatened species, and one candidate species are federally listed and known to occur within Tom Green County, as summarized in Table 1. In addition, the American peregrine falcon (*Falco perigrinus* var. *anatum*) and Texas horned lizard (*Phrynosoma cornutum*) are listed as State endangered species for Tom Green County. Most of these species are not known to occur within the study area. Species of particular interest identified by the USFWS within the proposed project area include the black-capped vireo and the Concho water snake.

**TABLE 1. Threatened and Endangered Species That May Occur within Study Area.**

| Common Name | Scientific Name | Federal or State | Status |
|---|---|---|---|
| Black-capped vireo | *Vireo atricapillus* | Federal and State | Endangered |
| Interior least tern | *Sterna antillarum* | Federal and State | Endangered |
| Bald eagle | *Haliaeetus leucocephalus* | Federal (de-list pending) and State | Threatened |
| Concho water snake | *Nerodia paucimaculata* | Federal | Threatened with critical habitat |
| Whooping crane | *Grus americana* | Federal and State | Endangered |
| Texas horned lizard | *Phrynosoma cornutum* | State | Threatened |
| American peregrine falcon | *Falco perigrinus* var. *anatum* | State | Endangered |

**Black-capped Vireo (*Vireo atricapillus*).** This strikingly beautiful endangered songbird is known to occur in Tom Green County and is considered a habitat specialist, nesting in mid-successional brushy areas (before areas develop into mature woodlands) where the dominant species are oaks, sumacs, persimmon, and other broad-leafed shrubs. Juniper may be common in vireo habitat, but juniper prominence is not essential or even preferred by the birds. Typical nesting habitat is composed of a shrub layer extending from the ground to about six feet covering about 35-55% of the total area, combined with a tree layer that may reach 30 feet or more. Open, sometimes grassy spaces separate clumps of trees and shrubs. The vireo depends upon broad-leafed shrubs and trees, especially oaks, which provide insects upon which it feeds. Due to the lack of suitable habitat and its relatively disturbed nature, it is unlikely that this species would utilize the study area.

**Concho Water Snake (*Nerodia paucimaculata*).** The Concho water snake was listed as threatened on September 3, 1986, with critical habitat designated on June 29, 1989. Critical habitat includes a stretch of the Concho River extending from Mullin's Crossing located 5 miles northeast of the town of Veribest, downstream to the confluence of the Concho and Colorado Rivers in Tom Green and Concho Counties (USFWS 1993). In addition, critical habitat includes a stretch of the Colorado River extending from FM 3115 bridge near the town of Maverick downstream to the confluence of the Colorado River and Salt Creek, northeast of the town of Doole, Runnels, Concho, Coleman, and McCulloch Counties; and the entire O.H. Ivie Reservoir basin. Although historically the Concho water snake occurred over about 276 miles of the Colorado and Concho Rivers, it is presently distributed discontinuously over about 199 river miles of the Colorado and Concho Rivers in 10 Texas counties (USFWS 1993).

Habitat for the Concho water snake consists of shallow riffles, rock debris, and crevices for shelter, and free-flowing streams over rocky substrates. Adults can live in either shallow or deep flowing water over various substrates but riffles are critically important to the survival of juveniles. Diet consists mostly of fish; juveniles feed almost entirely on minnows (Rose 1989). Decline of the species is due to loss of habitat and degradation due to large, main-stream reservoirs on the Colorado and Concho Rivers, plus several smaller impoundments on tributary streams. Other threats include pollution and water quality degradation due to refining, petroleum production, treated sewage disposal, pesticide use and feedlot activities. There is critical habitat designated for the Concho water snake in Tom Green County; however, it is downstream of O.C. Fisher Lake on the North Concho River. Due to the lack of suitable habitat and location, it is unlikely that this species would utilize the study area.

## ENVIRONMENTAL DEGRADATION

**Historical Landscape.** In 1683, Mendoza, an explorer, undertook a river expedition traveling southward along the Middle Concho River from its confluence with the North Concho River. In his journal, Mendoza wrote, "On both sides are great bottoms; there is a great luxuriance of plants, nuts, and other kinds of trees, and wild grapes, good pasturage, a variety of birds, and wild hens". He also described very many groves of pecan trees, lofty live oaks and many springs (Maxwell 1979). In 1898, H.L. Bentley, special agent in charge of the Grass Station in Abilene, Texas, published a report pertaining to the cattle ranges of "central Texas", a rather large area that included Tom Green County. The common characteristics Bentley used to describe the 1860's landscape are summarized as:

1) generally an open country with some oak timber on the uplands and ridges
2) a scattered growth of mesquite was present on lands away from the timbered streams
3) numerous streams furnished ample water and supported groves of pecan, elm, hackberry, wild china (soapberry), cottonwood and other trees
4) a climate pure and bracing with a well distributed 20 to 35 inch rainfall pattern, and a great variety of native forage plants and rich grasses.

Additional comments pertaining to Tom Green County state in 1867 the grass was everywhere one to three feet high, not only on the bottomlands, but also in places on the drier uplands (Maxwell 1979).

The historic grassland communities of the study area developed in response to a frequent fire regime (fire-climax). Woody vegetation existed in successional stages dependent upon the frequency of fire across the landscape creating a mosaic of habitats. After a fire, growth and reproduction of the young woody vegetation was suppressed. As time passed after a fire, growth and reproduction of the woody vegetation gradually increased until fire returned to suppress the woody vegetation again. Several factors played a part in the discontinuation of this successional process, but the elimination of fire may be one of the factors leading to the proliferation of plant communities dominated by phreatophytic plants.

**Construction/Operation of O.C. Fisher Lake.** The construction of the dam and the subsequent impoundment replaced approximately 23 acres of riverine habitat within lacustrine habitat. In addition, all woody vegetation (7,524 acres) was removed below 1928 feet MSL (War Department 1946). An estimated 253 acres of significant bottomland hardwood woodlands along the riparian corridor of the North Concho River was also destroyed. Approximately 103 acres of riparian woodland remained undisturbed along the North Concho River above the lake during construction.

Historical land management practices, prior to leasing, may have a contributing role in the establishment of invasive brushy species and prickly pear. Native vegetation within areas which were overgrazed and/or wildfire was suppressed have contributed to an environmental pallet favorable for their proliferation.

**Phreatophytic Plant Species.** The invasive brushy species of concern include the exotic saltcedar (*Tamarix ramosissima*), and two natives, mesquite (*Prosopis glandulosa*) and willow baccharis (*Baccharis salicina*). While mesquite and willow baccharis are considered native species, historically, they occupied only a small niche of the historical climax community. Interception, evaporation, and the ability of phreatophytic species to extract large amounts of water from the ground to meet transpiration requirements are the primary factors reducing water availability for the riparian and aquatic ecosystems.

**Saltcedar.** This non-native, deciduous, phreatophytic shrub or small tree grows rapidly, attaining a height of 30 feet, and forming dense, impenetrable thickets (Figure 4). Saltcedar is a native of Europe and Asia that was introduced in the United States in the early 1800's where it was sold as an ornamental, escaping cultivation in the 1870's. In the early 1900's, an attempt was made to use the trees for erosion control along waterways. Saltcedar became naturalized and spread rapidly in the 1930s and 1940s and by 1965, saltcedar had completed invasion of most suitable western riparian areas (DeLoach and Tracy 1997). An extremely invasive plant, saltcedar is now found across the western half of Texas and throughout the southwest.


**FIGURE 4.** Springs within Study Area.

Some of the undesirable traits of saltcedar include:

1) consumes more water than comparable native plant communities
2) crowds out native stands of riparian and wetland vegetation
3) dries up springs, wetlands, riparian areas and small streams by lowering surface groundwater tables
4) widens floodplains by clogging stream channels
5) increases sediment deposition due to the abundance of saltcedar stems in dense stands
6) increases the salinity of surfaces soil through salt exudation from its leaves rendering the soil inhospitable to native plant species
7) provides generally lower wildlife habitat value than native vegetation

Reproduction of saltcedar is accomplished through several pathways. From April through October, each plant can produce 500,000 small, wind-disseminated seeds. Additionally, the plant has strong vegetative reproduction properties with the ability to establish new plants from removed stems, and resprouting from the root collar if established plants are disturbed (Merkel and Hopkins 1957). For new seedlings to survive, the soil must remain saturated for several months. The seedlings grow faster than most native plants and send down a tap root rapidly, with little branching until it reaches the groundwater table. At the groundwater table, the root develops profuse secondary branching. One study documented a saltcedar tap root to be 16 feet deep, with a diameter of 3/16 inches, and still growing toward the groundwater table 26 feet deep (Hart 2003). At maturity, the roots exploit the groundwater table by placing the majority of the roots within the capillary zone above the groundwater table and extending some roots into the saturation zone. Saltcedar occupies 1,247 acres within the study area and continues to expand as surface water levels decrease.

Of the three species of concern, saltcedar possesses the highest evapotranspiration rate, and studies have shown the evapotranspiration rate of a mature saltcedar tree to be up to 200 gallons per day (McGinty and Hart 2001). An acre of dense saltcedar on the upper portion of the Pecos River in Texas, is estimated to use 5 to 7 acre-feet of water every year (Hart 2003). Brotherson et al. (1982) conducted a study showing that the longer the saltcedar occupies an area, the drier it becomes.

**Mesquite.** This species is a natural component of Texas rangeland, and historically, mesquites grew as single-trunk specimens that were limited to lowland areas. Today, dense stands of mesquite are found on lowland and upland sites, and the plant is now considered a noxious brush species occurring on millions of acres of Texas rangeland (Figure 5). Community types within the study area are referred to as the Mesquite Plains of the Rolling Plains and the Live Oak-Mesquite Savanna of the Edwards Plateau (Diamond et. al 1987).

**FIGURE 5.** Springs within Study Area.

Mesquite is a facultative phreatophyte (Sosebee and Wan 1987) capable of growing up to 60 feet and developing trunks three feet in diameter. If its canopy is damaged or killed, it resprouts from its basal bud zone (root collar) and develops a multi-trunk form that becomes very resistant to control. It is well adapted to both wet and dry conditions once established, and can easily dominate an area due to its extensive dual root system including lateral roots and tap roots. The lateral roots consume water from shallow depths as available and in drought conditions, tap roots pump water from far beneath the surface (Jensen 1988). Mesquite of various densities currently dominates 8,730 acres within the study area.

Mesquite possesses a dual root system including a shallow root system and a much deeper root system, which allows it to extract water directly from the groundwater table while following the resulting lowered groundwater levels to great depths. Mesquite tap roots have been found extending up to 60 feet below the surface to reach groundwater (Sosebee and Wan 1987). A study conducted in Throckmorton, Texas, approximately 140 miles northeast of O.C. Fisher Lake, found daily water loss of each mesquite tree to be between 7.9 to 19.8 gallons.

**Willow Baccharis.** Willow baccharis is a hardy, native perennial shrub that can grow to 13 feet tall (Hobbs and Mooney 1987) (Figure 6). Historically, it was confined to river banks and creek channels within the region, but it has expanded its range to include uplands areas as well. Willow baccharis is an aggressive invader species that quickly invades and dominates disturbed sites. It is a prolific seed producer that also spreads through adventitious buds along lateral roots and exhibits strong resprouting characteristics. It frequently forms dense, closed canopy stands (Holmes 1998). Willow baccharis is a phreatophyte estimated to utilize more water than mesquite (Gatewood et al. 1950).


**Figure 6.** Dense Stand of Young Willow Baccharis within Lake Bed.

Some dense stands of dead willow baccharis within the study area have been observed in recent years and it is surmised that the groundwater table dropped too low to support these stands. Willow baccharis occupies 2,258 acres within the study area.

**Impact of Phreatophytic Plant Species.** The invasive nature, high evapotranspiration rate, very efficient means of reproduction, and ability to better exploit groundwater resources than other, more historically and ecologically appropriate species, allows these phreatophytic species to exploit the historical vegetative community. The proliferation of these heavy water utilizing species has resulted in encroachment within the riparian zone and led to increased competition and further decreases in soil moisture within the riparian community. Consequently, many endemic trees, shrubs, and grasses are no longer dominant and becoming increasingly scarce. Not only has the phreatophytic species replaced the higher quality riparian habitat, they significantly decrease the amount of water available for groundwater recharge and in-stream base flows, thereby causing further degradation to the aquatic ecosystem.

Total stream discharge of the North Concho River significantly declined from 1925-1959, averaging 38,617 acre feet per year, to 1960-1996, averaging 8,358 acre feet per year, while the rainfall conditions remained nearly unchanged (UCRA 1998). The average annual flow in the upper North Concho River is 28.1 cfs dating back to 1925, but within the last ten years annual flow has been less than 7.5 cfs (U.S. Geological Survey 2004).

Since impoundment began in 1952, the only time the conservation pool level has been attained occurred in 1957. Since that time, the lake level is consistently low and continues to fall each year. Between 1987 and 2001, the lake levels steadily declined an average of two feet per year despite abnormally high rainfall amounts. Figure 7 provides a graphical representation of historical rainfall and lake levels. Currently, the lake is in the sediment reserve pool, approximately 53 feet below the top of the designed conservation pool elevation. Surface water within the lake comprises only about 8%, designated as reserve pool, of that which exists at the top of conservation pool. A major fish kill was experienced in September 2004 where thousands of fish were lost (Figure 8) due to lack of stream flow.

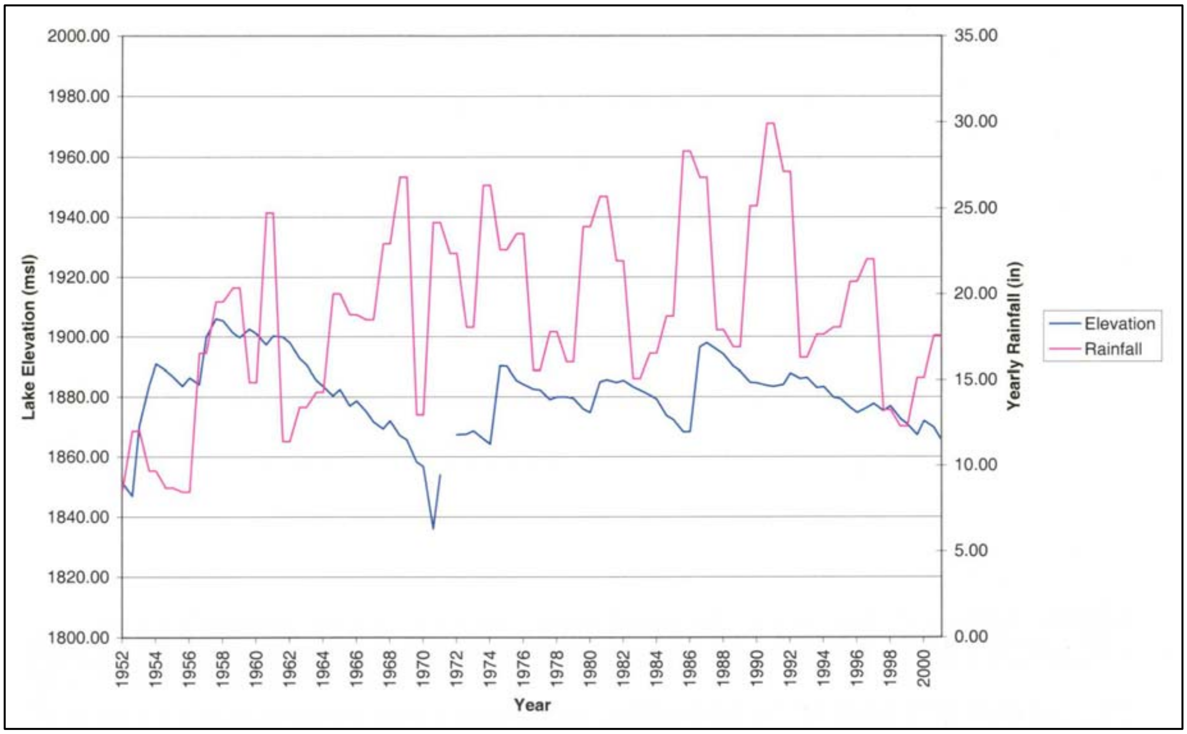


**Figure 7.** Historical Rainfall and Lake Levels.

**Figure 8.** Fish Kill of September 2004.

As the perennial surface water continues to fall, the dry beds are highly susceptible to invasion by invasive vegetative species. Invasive brushy species dominate large acreages within the dry lake, river and creek beds and continue to extend their range as perennial surface water continues to be lost. Mesquite, saltcedar, willow baccharis, and saltcedar/willow baccharis combine for a total of 2,750.8 acres, 71.4% of the 3,851.2 acres of lake, river and creek beds.

Disruption of the hydrological regime within the O.C. Fisher Lake ecosystem adversely impacts the native riparian woodlands and the wildlife species found there. Riparian woodlands are dependent upon the hydrology of the stream for recruitment and survival. Base flows of perennial streams within the study area are derived from local run-off during rain events, but to maintain their historical nature, the perennial streams are highly dependent upon spring flows. Spring flow rates are directly related to groundwater levels. The higher the groundwater table, the greater the flow rate and vice versa. The hydrology for some of the riparian woodlands within the study area is not derived from surface water, but instead from shallow groundwater. Several of the springs have ceased flowing and remaining have a significant reduction in flow.

Once the hydrology is removed for extended periods of time, be it surface water removed and/or groundwater levels depleted to levels below that which woody vegetation roots may utilize, the woody vegetation dies.

Overall, the riparian woodland habitat along the study area is highly fragmented and impacted by past management along the streambanks. There are dense pockets of properly functioning riparian habitat within the study area in the upper reaches of the river, as they are located at an elevation higher than that of the lake's conservation pool. It appears that clearing for the lake and subsequent management has greatly impacted the wildlife habitat within the riparian corridors.

Approximately 103 acres of quality riparian woodland remained undisturbed along the North Concho River above the lake during construction of the reservoir. As invasive phreatophytic vegetation has spread, the hydrology (surface water and groundwater) sustaining the aquatic ecosystem has been altered, and large tracts of prime riparian habitat, an estimated 16.8 acres, have been lost (Figure 9). The hydrology of the aquatic ecosystem continues to be altered and the remaining riparian habitat is in jeopardy.

Currently, native vegetation exists in conditions similar to historical conditions in only 34.5 percent (86.2 acres) of riparian woodland habitat and 4.5 percent (139.1 acres) of transitional habitat. As native vegetation is degraded from its historical condition, the carrying capacity for fish and wildlife species dependent upon the habitat is subsequently reduced. Currently, the study area supports approximately half of its potential carrying capacity in terrestrial habitats due to habitat degradation and approximately two percent of its potential carrying capacity in aquatic habitats.

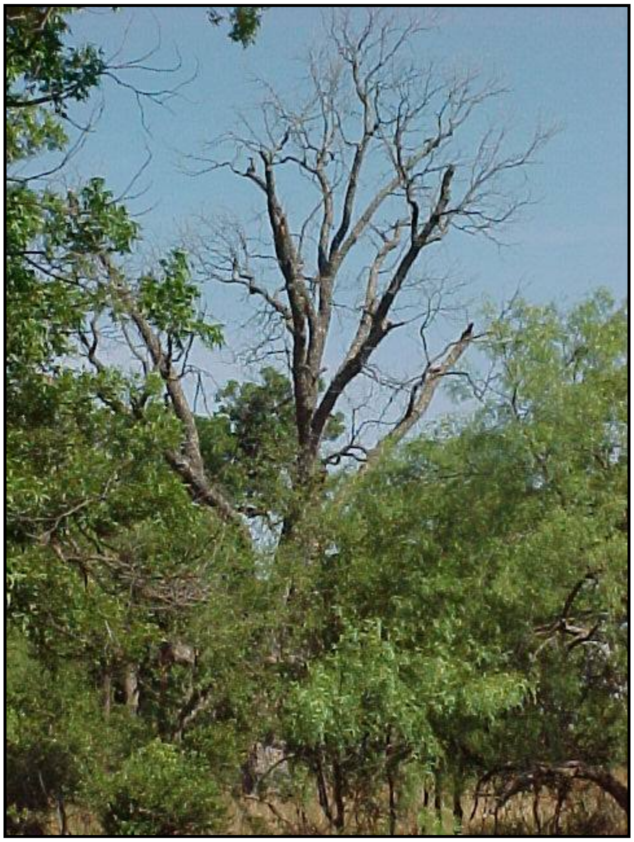

**Figure 9**. Dead Pecan Tree within Remnant Riparian Woodland.

**Prickly Pear.** Prickly pear (*Opuntia* spp.) is a native cactus that is extremely tolerant of drought and harsh conditions (Figure 10). It is a prolific seed producer with fruit and seed characteristics that ensure dissemination of the seeds and recruitment of seedlings. Vegetative reproduction occurs when pads become separated from the parent plant and readily root to establish new plants.


**Figure 10.** Dense Stand of Prickly Pear within ASU Lease.

Native species of prickly pear (*Opuntia* spp.) have also benefited due to land management practices. Diverse stands of native prairie gave way to thick, dense stands of prickly pear, and where mesquite dominates as the overstory vegetation, prickly pear dominates the understory. Like other invaders, prickly pear outcompetes the existing vegetation and creates dense monoculture stands, and the site's utility as wildlife habitat is lost. Additionally, monoculture prickly pear stands reduce the ability for the site to carry fire, which is required to sustain the historical vegetative community. Figure 11 shows the distribution of existing vegetation within the study area.

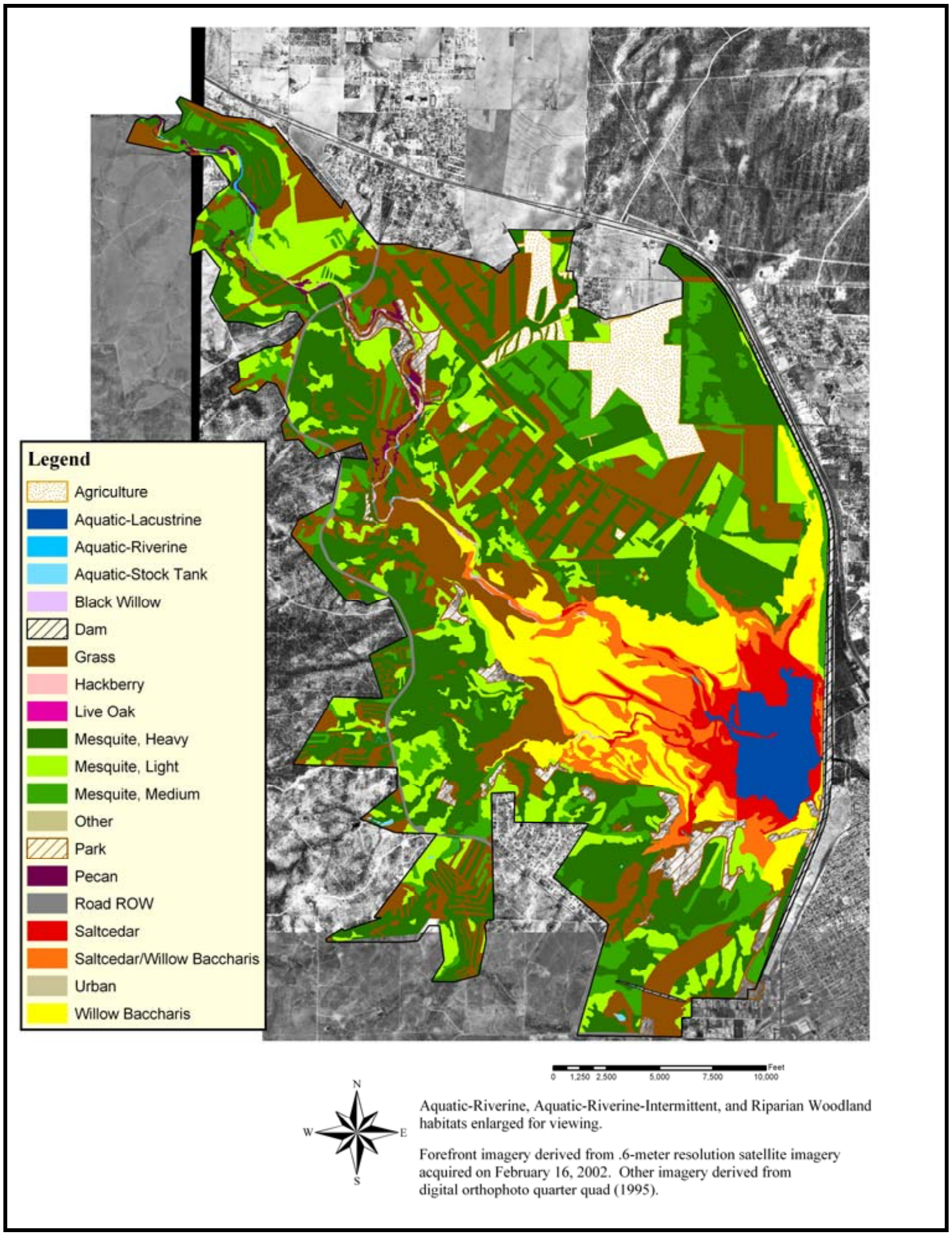


**FIGURE 11.** Existing Vegetation within Study Area.

Upon completion of the restoration project, it would be sustained through the use of prescribed fire and grass must serve as the fuel. Thick stands of prickly pear would not carry fire and encroachment of woody vegetation within these stands is highly likely. It is estimated that 9,194.8 acres of the study area contains medium to dense stands of prickly pear.

**Habitat Classifications.** In order to facilitate restoration planning, lands are classified in accordance to historical condition, with exception of converted lacustrine which is a non-historical condition. The study area is classified as five habitat classifications, which include aquatic-lacustrine, aquatic-riverine, aquatic-riverine-intermittent, riparian woodland and transitional. Figure 12 shows the distribution of the habitat classifications across the study area.

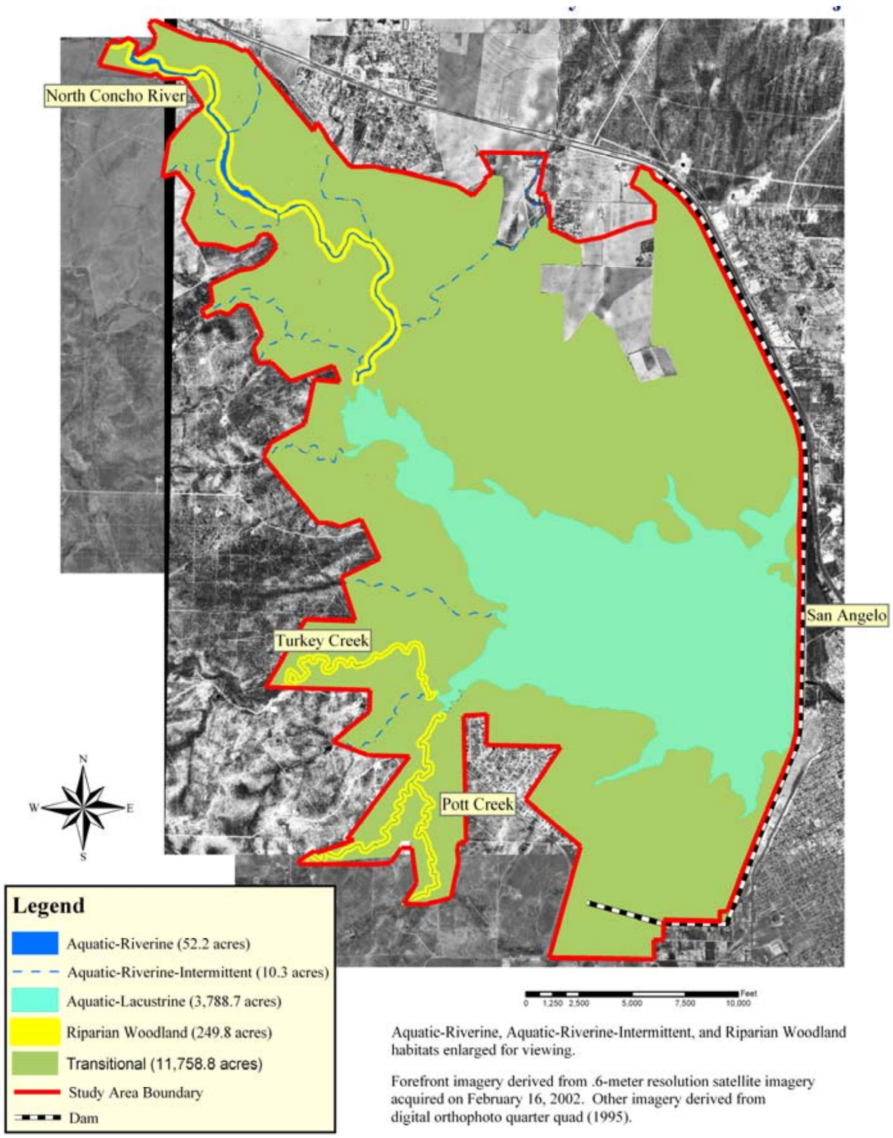


**FIGURE 12.** Habitat Classifications within Study Area.

Satellite imagery was utilized as the base map and this study is based upon existing conditions at the time the satellite imagery was taken, February 16, 2002. Reference to current conditions within this study refers to the existing conditions at the time the satellite imagery was taken.

Lands within "with-project" lake level, the predicted lake level in response to a fully implemented restoration project, are classified as aquatic-lacustrine. A report written by Fort Worth District, Reservoir Control Section, projects that full implementation of this proposed restoration plan will yield increased stream flows and will significantly increase base stream flows and the lake level. Using the computer program HEC-5 and monthly observed data from 1972-1996 for model calibration, and data bases for various alternative brush, range and riparian management schemes, the with-project lake level is predicted to rise, projected at 1900.96 MSL, assuming average rainfall, groundwater pumping amounts will remain relatively unchanged, and the North Concho River Brush Control Program will complete and maintain brush removal within the watershed. Streambeds of tributaries above the with-project lake level are classified as aquatic-riverine or aquatic-riverine-intermittent, dependent upon historical conditions.

**Aquatic-Lacustrine Habitat.** Lands up to elevation 1900.96 are classified as aquatic-lacustrine. Of the 5,440 acres of aquatic-lacustrine habitat at top of conservation pool, only 440.3 acres, 8%, are presently inundated. The aquatic habitat of O.C. Fisher Lake is limited to a mostly lentic system where little to no flows from the North Concho River, Pott Creek, Turkey Creek, and other tributaries. The remaining 92% of the lake bed has been invaded by saltcedar (520 acres), willow baccharis (1,221 acres), mixture of saltcedar and willow baccharis (758 acres) and mesquite (150 acres).

The average depth at the current lake level is 4 feet and is restricted to that immediately adjacent to the dam where there is little heterogeneity of the lake bottom. Based on Texas Commission of Environmental Quality (TCEQ) data, during the hotter months of the year water temperatures may exceed 86$^{o}$F with average annual water temperature around 69.8$^{o}$F. Despite average oxygen levels around 8 mg/l (TCEQ data), the lake has the potential to go anoxic.

**Aquatic-Riverine Habitat.** Aquatic-riverine habitat includes tributaries deriving water source from both springs and runoff during rain events. Aquatic-riverine habitat includes the North Concho River, Pott Creek and Turkey Creek.

The total length of the North Concho River to "with-project" lake level within the study area is approximately 6.4 miles. The river maintains contiguous surface water only in its upper reaches within the study area and only small pockets of surface water exist in conjunction with flowing springs as the river travels to O.C. Fisher Lake. Portions of the riverbed contain perennial surface water, while other areas lack water except for brief periods immediately after a heavy rainfall event (ephemeral). Within the study area, only 12.6 acres of the total 36.9 acres of the North Concho River presently contains perennial surface water. The remaining 24.3 acres of the river bed remain dry most of the year with stands of grass and/or forbs of various densities.

Pott Creek and Turkey Creek also have extremely limited pockets of perennial surface water. Pot Creek is 4.7 miles long extending to "with-project" lake level and contains an estimated 0.4 acres of perennial surface water acres, 3.4% of its potential 11.6 acres. Turkey Creek is 2.9

miles long extending to "with-project" lake level and contains an estimated 0.3 of perennial surface water acres, 8.1% of its potential 3.7 acres. Mesquite of various densities exists within 92% of the creek beds.

**Aquatic-Riverine Intermittent Habitat.** Remaining eight tributaries within the study area, which include Dry, Bald Eagle, No Name 1, No Name 2, No Name 3, No Name 4, No Name 5 & 6, and No Name 7 Creeks, combine for a total of 10.3 acres over a length of 13.3 miles. Mesquite dominates the creek bed with some isolated stands of grass and/or forbs. The tributaries only contain surface water as a result of local runoff during rain events for short durations.

**Riparian Woodland Habitat.** Lands adjacent to aquatic-riverine habitats, which include North Concho River, Pott Creek and Turkey Creek, are classified as riparian woodland habitat. An average width, or buffer, was estimated for each riparian woodland along each streambed through on-site visits and satellite imagery.

**Transitional Habitat.** All other remaining lands, excluding dam, road rows, and agricultural fields, are classified as transitional habitat.

**Habitat Evaluations**. A team of biologists and ecological planners from the USFWS, TPWD and USACE evaluated habitats within the study area. Evaluations included both existing habitat conditions and those predicted for the future under various conditions or measures, including no action.

Habitat evaluations were accomplished through utilization of the U.S. Fish and Wildlife Service's Habitat Evaluation Procedure (HEP). HEP is a species-habitat approach to assess habitat condition using Habitat Suitability Index (HSI) models developed for representative wildlife species that best represents a guild of wildlife species dependent upon a particular vegetative community. The HSI is derived from evaluation of key habitat variables', or Suitability Indexes' (SI), ability to supply the life requisites of selected wildlife species. The HSI is expressed numerically, ranging from 0.0 to 1.0, where 0.0 represents no suitable habitat for the representative wildlife species and 1.0 represents optimum conditions for the representative wildlife species. The HSI is then multiplied by the acreage of the habitat deriving the Habitat Unit (HU), the unit of measure allowing for comparison among habitat evaluations. HSIs and HUs were evaluated at intervals during the period of analysis (Years 0, 1, 5, 10, 25, 50) using professional judgment and HUs were annualized to estimate an average annual habitat unit (AAHU).

HEP provides numerical data allowing for two general types of wildlife habitat comparisons. The first is the relative value of different areas at the same point in time. The second is the relative value of the same area at future points in time. Therefore, the impact of land and water use changes on wildlife habitat can be estimated.

It was recognized that the habitat is degraded to such a detrimental state that existing habitats have deteriorated. In order to judiciously evaluate the restoration project, evaluation of the existing habitat was based upon the historical habitat of the specific area within the study area, with exception of converted lacustrine which is a non-historical condition.

Existing vegetation was derived through special computer programs utilizing satellite imagery, Geographical Information System (GIS)/Global Positioning System (GPS), and field investigations. Existing vegetative conditions were inventoried to provide a baseline condition from which to conduct the study (Figure 11).

Table 2 provides a summary of the habitats within the study area.

**TABLE 2. Existing Habitats within Study Area.**

| Habitats | | Acres within Study Area |
|---|---|---|
| Aquatic | Riverine | 52.2 |
| | Riverine - Intermittent | 10.3 |
| | Lacustrine | 3,788.7 |
| Terrestrial | Riparian Woodland | 249.8 |
| | Transitional | 11,758.8 |
| **Total** | | 15,859.8 |

**Aquatic HEP.** A total of 3,851.2 acres of aquatic habitats exists within the study area and include lacustrine, riverine and riverine-intermittent habitats. Aquatic habitat within the study area is severely degraded both quantitatively and qualitatively. Since the overwhelming proportion of the aquatic habitat simply lacks water, the team decided that a standard HEP using aquatic species models was unnecessary. The team elected to use a consensus of professional judgments to provide HSI values. Table 3 summarizes the aquatic HEP data evaluating existing conditions.

**TABLE 3. Existing Conditions-Aquatic HEP Data.**

| Aquatic Habitat | Acres | Average HSI | Habitat Units |
|---|---|---|---|
| Riverine | 13.3 | .20 | 2.7 |
| Riverine (dry) | 38.9 | .05 | 1.9 |
| Riverine-Intermittent | 10.3 | .20 | 2.1 |
| Lacustrine | 440.3 | .20 | 88.1 |
| Lacustrine (dry) | 3,348.4 | 0 | 0 |
| **Total** | 3,851.2 | NA | 94.8 |

**Aquatic-Lacustrine Habitat.** Only 440.3 acres, 11.6%, of the lacustrine habitat functions as such and the remaining 3,348.4 acres, 88.4%, lacks surface water entirely, rendering it completely useless as aquatic habitat. The perennial surface water that is present exhibits high levels of chloride and total dissolved solids. The habitat lacks a consistent surface flow and the lake experiences occasional anoxic conditions. Overall, the lacustrine habitat containing surface water rates poor with an HSI of .20 and the acreage lacking surface water rates an HSI of 0. The lacustrine habitat only provides 88.1 habitat units out of a potential 3,788.7 habitat units.

**Aquatic-Riverine Habitat.** Riverine habitat is tributaries historically containing perennial surface water and includes the North Concho River, Pott Creek and Turkey Creek. These tributaries combine for 52.2 acres.

The upper portions of the North Concho River within the study area may flow at certain times of the year, but the large majority of the time, the river is comprised of various sizes of pools maintained by spring flow and only approximately 25% of the riverbed contains surface water. The pools isolated in dry periods have very little flow and temperatures reach high values. The pools are very important during the summer because they serve as the only refuge for aquatic species in this system. With the river lacking the continuity and flow, the riverine habitat holding surface water year-round rates poor with an HSI of .20. Areas where riverbeds only hold surface water for brief periods, up to 2 months, offer only limited aquatic benefits for brief periods of time, mainly for amphibians and reptiles, rates an extremely poor HSI of .05. The riverine habitat (52.2 acres) only provides 4.6 habitat units.

**Aquatic-Riverine-Intermittent Habitat.** Riverine-intermittent habitat contains surface water only on a seasonal or temporary basis. Eight tributaries (Dry, Bald Eagle, No Name 1, No Name 2, No Name 3, No Name 4, No Name 5/6, and No Name 7 Creeks) are classified as riverine-intermittent habitat and total 10.3 acres. Because the habitat remains dry most of the year and only holds surface water for brief periods, up to one week, serving only reptiles and amphibians to some extent, the riverine-intermittent habitat rates an extremely poor HSI of .02. The riverine-intermittent habitat only provides 2.1 habitat units.

**Vegetative HEP.** A total of 12,008.6 acres of vegetative communities exists within the study area. Vegetative communities within west central Texas, and thus the study area, are comprised of riparian woodland, grassland and shrubland. Historical vegetation within the study area included riparian woodland and grassland (transitional); therefore, habitat evaluation is based upon these vegetation community types.

**Riparian Woodland Community Model.** Riparian woodland is found along three tributaries within the study area where perennial surface water is historically found, the North Concho River, Pott Creek and Turkey Creek, combining for a total of 249.8 acres. Classification of the existing vegetation within the riparian woodland corridor includes remnant woodlands (pecan, hackberry and live oak), black willow, mesquite (heavy density, medium density and light density), willow baccharis, and grassland. Fourteen sites were selected for evaluation to gain a thorough evaluation of the riparian woodland.

Wildlife species selected to represent the riparian woodland community for the HEP included the barred owl (*Strix varia*), turkey (*Meleagris gallopavo*), fox squirrel (*Sciurus niger*) and raccoon (*Procyon lotor*). These wildlife species were carefully selected because the team wanted to ensure the broadest evaluation of the habitat, to include tree, shrub and herbaceous vegetation, by evaluating as many variables within riparian woodland as possible so as to eliminate any biases towards any one specific species. The life requisites and corresponding HEP variables of the representative wildlife species assures this.

HEP variables for all the representative wildlife species require dense stands of large trees under optimum conditions. Turkey and fox squirrel allows for evaluation of the presence of hardmast trees and turkey also allows for evaluation of softmast trees. Shrub canopy cover is a variable evaluated for turkey and fox squirrel and herbaceous canopy cover is evaluated for turkey. Raccoon was selected in order to include a wildlife species that requires the presence of water.

The HSIs for all the representative wildlife species within each sampling site were combined and averaged within each existing vegetation type to provide an average HSI value for the habitat. Table 4 summarizes the riparian woodland vegetative HEP data evaluating existing conditions.

**TABLE 4. Existing Conditions-Riparian Woodland Vegetative HEP Data.**

| Riparian Woodland Habitat | Acres | Sites Sampled | Average HSI | Habitat Units |
|---|---|---|---|---|
| Remnant Woodland | 89.4 | 3 | .71 | 63.4 |
| Black Willow | 5.7 | 2 | .50 | 2.9 |
| Mesquite, Heavy | 77.3 | 3 | .40 | 30.9 |
| Mesquite, Medium | 9.8 | 1 | .35 | 3.4 |
| Mesquite, Light | 26.3 | 2 | .30 | 7.9 |
| Willow Baccharis | 0.1 | 1 | .10 | 0.01 |
| Grassland | 41.2 | 2 | .02 | 0.8 |
| **Total** | 249.8 | 14 | NA | 109.3 |

Average HSI for remnant woodland habitat was significantly higher than other community types as expected because remnant woodland most closely resembles that of optimum riparian woodland. The remnant woodlands were not disturbed during reservoir construction and some of the areas still contain significant desirable areas with large diameter hardwood trees and good shrub and ground cover that rated very high HSI values for the representative wildlife species. However, some of the large diameter hardwood trees within significant acreage of the remnant woodland habitat are dead due to lack of surface water and lowered groundwater tables and these areas significantly lowered the average HSI. Black willow habitat was found to be somewhat desirable, but lacks the dense canopy cover and hardwood mast trees. Mesquite habitat provides some limited value as riparian woodland, more so at a higher density. Willow baccharis and grass habitat completely lacks hardwood trees and offer little to no riparian woodland value.

The majority of the riparian woodland lacked large diameter trees and the majority of the trees present were less than ten (10) inches in diameter that significantly lowered HSI values for cover variables for all representative wildlife species. Mast producing trees greater than or equal to 6 inches diameter at breast height (dbh) were fairly rare throughout the riparian woodland and thus the food value for turkey and fox squirrel rated poorly. Fox squirrel habitat rated low for both winter food production and cover/reproduction values.

**Transitional Vegetation Community Model.** A total of 11,758.8 acres of transitional habitat exists within the study area. Existing vegetation of the transitional habitat includes habitat dominated by grassland, heavy density mesquite, medium density mesquite, light density mesquite, willow baccharis and mixed stands of saltcedar and willow baccharis. Thirty-two sites were selected for evaluation to allow for sufficient sampling within each vegetation type to gain a meaningful representation of the vegetation type. Mesquite vegetation was sampled proportionally higher than other vegetation types because it exhibited more variability than the other vegetation types.

In order to accurately capture the transitional nature of this habitat, the evaluation was based upon a mixture of species representative of grasslands and those requiring woody vegetation. Therefore the team was required to select wildlife species which thrive in grasslands, but also require a component of woody vegetation. Three wildlife species were selected in order to evaluate the grassland more holistically and prevent any biases towards any one wildlife species. These species included eastern meadowlark (*Sturnella magna*) red-tailed hawk (*Buteo jamaicensis*) and scissor-tailed flycatcher (*Muscivora forficata*). These species rely heavily upon grasslands as a direct or indirect food source.

The meadowlark requires productive grassland as its main diet is grass seeds. It also requires good cover for nesting on the ground and perching locations in scattered trees or brush. Variables evaluated included percentage and height of herbaceous canopy cover, proportion of herbaceous canopy cover that is grass, percentage of shrub crown cover, and distance to perch site.

Red-tailed hawk predominately prey upon rodents and rabbits and sometimes birds, reptiles and grasshoppers inhabiting healthy, productive grasslands. The hawks require large, open, relatively flat grasslands to allow them to hunt and capture prey in flight. They also require tall trees or brush scattered throughout the grassland for perching locations for hunting, nesting, resting, and roosting. Due to the high numbers of red-tailed hawks observed within the study area, the team inferred that roosting and nesting sites were not a limiting factor and habitat suitability was solely based upon food availability. Variables evaluated included average height and percent cover of herbaceous and shrub canopy, topography, and quantity, size and distance to woody vegetation.

Scissor-tailed flycatcher has similar requirements as hawks, except they prey upon flying insects found within grasslands. They rely more heavily upon the presence of tall trees or brush scattered throughout the grassland for hunting purposes as they hunt perched upon the tree or brush and take flight in order to capture flying insects on the wing. They require large, open, relatively flat grassland to allow them to capture prey in flight. They also require tall trees or brush scattered throughout the grassland for perching locations for hunting, nesting, resting, and roosting. They rely more heavily upon the presence of tall trees or brush for use as perching locations for hunting purposes as they generally do not hunt in flight. Variables evaluated included percentage and height of herbaceous canopy cover and quantity and distance to nearest deciduous trees.

The HSIs for all the representative wildlife species within each sampling site were combined and averaged within each existing vegetation type to provide an average HSI value for the habitat. Table 5 summarizes the transitional habitat vegetative HEP data evaluating existing conditions.

**TABLE 5. Existing Conditions-Transitional Habitat Vegetative HEP Data.**

| Transitional Habitat | Acres | Sites Sampled | Average HSI | Habitat Units |
|---|---|---|---|---|
| Grassland | 3,091.9 | 7 | .67 | 2,071.6 |
| Mesquite, Heavy | 4,911.2 | 10 | .49 | 2,406.5 |
| Mesquite, Medium | 1,412.2 | 6 | .65 | 917.9 |
| Mesquite, Light | 2,143.0 | 5 | .38 | 814.3 |
| Willow Baccharis | 188.9 | 3 | .10 | 18.9 |
| Saltcedar/Willow Baccharis | 11.6 | 1 | .10 | 1.2 |
| **Total** | 11,758.8 | 14 | NA | 6,230.4 |

Average HSI for grassland was found to be the highest and most desirable vegetation as expected. Willow baccharis and saltcedar/willow baccharis were the least desirable vegetation because of their dense, shrub monoculture growth habit and lack of herbaceous layer. Average HSIs for mesquite varied dependent upon mesquite density, but overall, the values were significantly higher than willow baccharis and saltcedar/willow baccharis. Light mesquite scored the lowest average HSI and medium mesquite scored the highest.

The average HSIs for the three densities of mesquite required qualification as the HSIs deviate from what one may expect when evaluating the vegetation as grassland without the benefit of a site visit. On the basis of dominance of the woody vegetation within grassland, it is expected that HSI values will decrease as the woody vegetation increases. This was not the case and is attributed to several evaluation variables.

Evaluation of perching sites was required for all three HSI species. Light mesquite did not offer a great value as a perching site, but larger mesquite trees within the medium density mesquite stands offered ideal perching sites. Mesquite within heavy density mesquite stands was too dense to serve much value as a perching site.

Evaluation of the herbaceous component was also required for all three HSI species. The light mesquite areas sampled contained large stands of prickly pear and bare ground which significantly decreased the value as grassland. Medium mesquite areas contained a fair herbaceous layer with only a few dense stands of prickly pear. In the heavy mesquite areas, very little herbaceous layer was present due mostly to the dense mesquite canopy and the subsequent bare ground and prickly pear found at ground level.

**Future Without-Project Condition.** The ecosystem is already severely degraded and without restoration the study area would become increasingly so. A report written by Fort Worth District, Reservoir Control Section, predicts O.C. Fisher Lake level to drop to elevation 1852.00 feet MSL, based upon best available data, effectively resulting in no surface water held within the lake bed. The hydrological function of the ecosystem within the study area would be completely removed and the ecosystem would become even more severely degraded. The invasive vegetative species within the study area would continue to expand their range and increase their density across the study area replacing native vegetation and in doing so, the value of the habitat would be consequentially decreased. The high rates of evapotranspiration of invasive brushy species and their phreatophytic characteristics would successfully remove all surface water, including flowing springs, from the ecosystem and drop groundwater levels to points beyond which native vegetation may utilize. Surface water runoff within the study area would quickly be lost below ground to fill the void above fallen groundwater table levels and surface water would not remain for sufficient time in order to provide a positive influence upon the habitat.

As the lake level continues to fall, saltcedar seeds would quickly germinate in the moist soil and saltcedar would eventually colonize all aquatic-lacustrine habitat which currently holds water. Saltcedar would also displace the entire aquatic-riverine habitat in response to receding surface water. Remnant woodland, supported by perennial surface water and high groundwater table levels, would die as the surface water is removed from the ecosystem and groundwater levels supporting them drop. Dense stands of mesquite with prickly pear understory would eventually replace the remnant woodlands. All transitional habitat and habitat where mesquite currently exists within remnant woodland habitat and upper portions of the aquatic-lacustrine habitat, would become heavy mesquite with an understory of prickly pear. All aquatic habitat and riparian woodland habitat within the ecosystem would be effectively lost, 4,101 acres, and replaced with transitional habitats of dense stands of saltcedar at lower elevations and mesquite with prickly pear understory in upper elevations. Existing transitional habitats, 11,758.8 acres, would be increased to 15,859.8 acres. The value of existing habitat condition, 6,434.5 habitat units, is predicted to drop approximately 36% to a value of 2,376.8 habitat units after fifty years under the future without-project condition**.** Table 6 compares habitat units under future without-project conditions and existing conditions.

**TABLE 6. Comparison between Existing and Future Without-project Conditions.**

| Habitat | | Existing Condition | | | Without Project (50 YRS) Condition | | |
|---|---|---|---|---|---|---|---|
| | | Acres | HSI | Habitat Units | Acres | HSI | Habitat Units |
| Aquatic | Lacustrine/ Lacustine (Dry) | 440.3/3,348.4 | 0.20/0 | 88.1/0 | 0 | 0 | 0 |
| | Riverine/ Riverine (Dry) | 13.3/38.9 | 0.20/0.05 | 2.7/1.9 | 0 | 0 | 0 |
| | Riverine-Intermittent | 10.3 | 0.2 | 2.1 | 0 | 0 | 0 |
| Riparian Woodland | Remnant Woodland (Pecan) | 86.2 | 0.71 | 61.2 | 0 | 0 | 0 |
| | Remnant Woodland (Hackberry) | 2.6 | 0.71 | 1.8 | 0 | 0 | 0 |
| | Remnant Woodland (Live Oak) | 0.6 | 0.71 | .4 | 0 | 0 | 0 |
| | Black Willow | 5.7 | 0.5 | 2.9 | 0 | 0 | 0 |
| | Mesquite, Heavy | 77.3 | 0.40 | 30.9 | 202.8 | .20 | 40.6 |
| | Mesquite, Medium | 9.8 | 0.35 | 3.4 | 0 | 0 | 0 |
| | Mesquite, Light | 26.3 | 0.30 | 7.9 | 0 | 0 | 0 |
| | Willow Baccharis | 0.1 | 0.10 | 0.01 | 0 | 0 | 0 |
| | Saltcedar | 0 | 0 | 0 | 47.0 | .10 | 4.7 |
| | Grass | 41.2 | .02 | 0.8 | 0 | 0 | 0 |
| Transitional | Mesquite, Heavy | 4,911.2 | 0.49 | 2,406.5 | 15,409.5 | .15 | 2,311.4 |
| | Mesquite, Medium | 1,412.2 | 0.65 | 917.9 | 0 | 0 | 0 |
| | Mesquite, Light | 2,143.0 | 0.38 | 814.3 | 0 | 0 | 0 |
| | Saltcedar | 0 | 0 | 0 | 200.5 | .10 | 20.1 |
| | Saltcedar/Willow Baccharis | 11.6 | 0.10 | 1.2 | 0 | 0 | 0 |
| | Willow Baccharis | 188.9 | 0.10 | 18.9 | 0 | 0 | 0 |
| | Grassland | 3,091.9 | 0.67 | 2,071.6 | 0 | 0 | 0 |
| Other | Agriculture | 687.9 | NA | NA | 687.9 | NA | NA |
| | Aquatic-Stock Tank | 7.9 | NA | NA | 7.9 | NA | NA |
| | Road ROW | 127.9 | NA | NA | 127.9 | NA | NA |
| | Dam | 224.0 | NA | NA | 224.0 | NA | NA |
| | Urban | 6.2 | NA | NA | 6.2 | NA | NA |
| **TOTAL** | | **16,913.7** | **NA** | **6,434.5** | **16,913.7** | **NA** | **2,376.8** |

# PLAN FORMULATION

Plan formulation is the process of developing and evaluating alternatives that meet planning objectives and avoid planning constraints. Plans were evaluated on the basis of wildlife habitat units and an incremental cost analysis was performed for each alternative plan. The alternative plan offering cost-effective maximum net benefits will be that which is recommended and will be known as the National Ecosystem Restoration (NER) Plan.

**Problems and Opportunities.** As described previously, the ecosystem within the study area is severely degraded. The degradation can be summarized as follows:

- Construction of the dam and impoundment of the reservoir destroyed:
  - Riverine habitat
  - Riparian woodlands
  - Prairies and woody vegetation

- The removal of the native vegetation coupled with the failure of the reservoir to reach and maintain the conservation pool and the historical low lake levels lead to the proliferation of invasive, phreatophytic plant species.

- The phreatophytic plant species are responsible for decreased stream-flows and lowered groundwater table level resulting in:
  - Additional degradation to the quantity and quality of aquatic habitats
  - Additional degradation to the quantity and quality of riparian woodland habitats
  - High salinity and turbidity of surface water
  - A cycle of ever-increasing proliferation of phreatophytic plant species as the native aquatic and riparian vegetation dies (from lack of suitable hydrologic influences).

The team identified some potential opportunities. Invasive vegetative species are becoming an ever-increasing problem within the lands surrounding the study area and the region in general. It is important to demonstrate to the public that disturbed lands lost to invasive vegetative species can be restored back to their historical condition. The project area is easily visible by the public due to its proximity to San Angelo and the major highways traversing and adjacent to the project area. A successful project may convince other landowners to restore their land and a region-wide restoration may be sparked.

Education is a prime mission of both ASU and TPWD. A successful project would enable ASU and TPWD to utilize their restored lands as an outdoor classroom and provide a valuable environmental education tool.

**Planning Objectives**. Planning objectives are an expression of public and professional concerns about the use of water and related land resources resulting from the analysis of existing and future-without project conditions in the study area. The planning objectives for the period of analysis between the years 2005 to 2055 are as follows:

- Increase the quantity and quality of riverine habitat
- Increase the quantity and quality of riparian woodland habitat
- Increase the quantity and quality of lacustrine habitat

**Planning Constraints**. In development of an ecosystem restoration project, the following constraints were identified to direct plan formulation efforts such that beneficial impacts would be maximized and adverse impacts would be minimized:

- Alternatives will be limited to the study area within the land owned or leased by USACE.

- The formulation of alternatives must avoid adverse impacts to significant ecological resources; and if avoidance is not feasible, then adverse impacts to ecological resources must be minimized. Unavoidable adverse impacts to ecological resources must be mitigated.

- The formulation of alternatives must avoid adverse impacts to significant cultural resources; and if avoidance is not feasible, then adverse impacts to cultural resources must be minimized. Unavoidable adverse impacts to cultural resources must be mitigated.

- The formulation of alternatives should avoid areas that are either known or suspected to be contaminated and/or contain hazardous, toxic, and radioactive waste.

- The recommended plan must avoid adverse impacts to the objectives of Angelo State University and Texas Parks and Wildlife Department.

- The recommended plan must be generally acceptable to the public.

- The recommended plan must have a local non-Federal sponsor.

- Combined Federal expenditures on the planning, design, and implementation of the recommended plan shall not exceed $5.0 million.

**Plan Formulation Rationale**. Plans are formulated to meet planning objectives and avoid constraints. The following paragraphs discuss the technical, economic, environmental, and social criteria used to develop the formulated alternatives to meet the stated study objectives. In order to develop a plan that would satisfy the primary objective of reducing flood damages and costs within the study area, the following criteria was adopted for use in developing, evaluating, and comparing alternative plans:

- The plan should be effective and efficient with regard to achieving the planning objectives.

- The plan must be technically feasible using engineering methods and equipment available in the study region.
- Plans should be adequate to provide a project life of at least 25 years.
- Existing facilities should be utilized to the maximum extent possible.
- The plan is to be complete within itself and not require additional future improvements other than normal replacements, and operation and maintenance.
- Preserve and/or enhance social, cultural, educational, and aesthetic values as well as historical and cultural attributes of any sites within the project area.
- Promote the development of areas of natural beauty and human enjoyment and protect areas of valuable natural resources.

*** Restoration Alternatives.**

**Hydrological Interaction.** Restoring the hydrology to the ecosystem is paramount. Due to the connectivity between groundwater and surface water within the study area, groundwater levels must increase in order to increase and sustain surface water necessary to support riparian woodland habitat restoration. In order to increase groundwater levels, reduction and removal of invasive brushy species across the entire study area must be performed. Restoring the hydrology to the ecosystem would significantly benefit the aquatic, riparian, and transitional habitats of the study area.

Transitional habitat plays a key role in the success of the restoration project. Although a groundwater study was not completed, an assumption can be drawn that groundwater within the study area is generally connected based upon available information contained within this report. This connectivity is further suggested by the observation of TPWD staff along Turkey Creek in January 2005. Water was found within the stream bed at and below spring locations, unrelated to a rain event, where it had been previously dry and mesquite within the adjacent area recently entered winter dormancy and dropped their leaves (TPWD 2005).

Transitional habitat would be restored from a shrubland dominated by mesquite to a more historic grassland condition, dominated by native grass and forbs with scattered mottes of native trees and shrubs. The restoration from shrubland to a more historic grassland condition would aid in groundwater recharge. As a shrubland dominated by mesquite, a significant amount of water which percolated into the groundwater is lost to mesquite through evapotranspiration. Because a more historic grassland condition contains significantly less mesquite, significantly more water would remain in the groundwater after percolation into the groundwater. As groundwater levels rise, spring flow into perennial tributaries would result in increased stream flow and duration. The increased stream flow would provide the hydrology necessary to sustain riparian woodland habitat restoration. The increased groundwater level would be within reach of riparian woodland vegetation to sustain it through any extended periods of below average rainfall.

Optimum riparian woodland habitat condition within the study area will consist of 100% tree canopy cover of mature bottomland hardwood trees, predominately pecan (*Carya illinoiensis*), and will include mostly live oak (*Quercus virginiana*), hackberry (*Celtis laevigata*), eastern cottonwood (*Populus deltoides)*, and black willow (*Salix nigra*). Western soapberry (*Sapindus saponaria*), American elm (*Ulmus Americana*), and possibly green ash (*Fraxinus pensylvanica*) may also be present. A full understory consisting of some woody scrub shrub species such as roughleaf dogwood (*Cornus drummondii*), gum bumelia (*Bumelia lanuginose*), yaupon (*Ilex vomitoria*), deciduous holly (*Ilex decidua*), honey mesquite (*Prosopium gladulosa*), and common buttonbush (*Cephalanthus occidentalis*) will exist. Various low-light tolerant woodland grasses and forbs will be prevalent such as Canada wild-rye (*Elymus Canadensis*), inland sea-oats (*Chasmanthium latifolium*), Texas wintergrass (*Stipa leucotricha*), switchgrass (*Panicum virgatum*), eastern gammagrass (*Tripsacum dactyloides*), aster (*Aster spp*.), verbena (*Verbena sp*.), cardinal flower (*Lobelia cardinalis*), goldenrod (*Solidago sp*.), evening primrose (*Oenethera sp*.), and western ironweed (*Vernonia baldwinii*).

Optimum grassland habitat condition within the study area is somewhat variable and dependent upon soil type. It is dominated by 65 to 80% grass canopy cover comprised of a mixture of short, mid-, and tall grass species. These grasslands may include sideoats grama (*Bouteloua curtipendula*), sand dropseed (*Sporobolus cryptandrus*), white tridens (*Tridens albescens*), vine mesquite (*Panicum obtusum*), Wright's threeawn (*Aristida wrightii*), silver bluestem (*Bothriochloa saccharoides*), little bluestem (*Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*), Arizona cottontop (*Digitaria californica*), buffalograss (*Buchloe dactyloides*), blue grama (*Bouteloua gracilis*), hairy grama (*Bouteloua hirsute*), and Hall panicum (*Panicum hallii*). Forbs (aster (*Aster spp*.), Engelmann's daisy (*Engelmannia sp*.), Maximillian sunflower (*Helianthus maximiliana*), verbena (*Verbena sp*.), blazing star (*Liatris punctata*), and Cuman ragweed (*Ambrosia psilostachya*), shrubs (lotebush (*Ziziphus obtusifolia*), Texas almond (*Prunus minutiflora*), *Ephedra antsyphilitica*, and *Condalia sp*.) and prickly pear (*Opuntia sp*.) in varying proportions should represent approximately 5 to 20% canopy cover in scattered areas. Mottes consisting of mesquite, littleleaf sumac (*Rhus microphylla*), sand shinnery oak (*Quercus sinuata*), and Texas oak (*Quercus buckleyi)*) at least five feet tall scattered about the grassland in a mosaic pattern representing approximately five to 15% canopy cover.

**Saltcedar Removal.** Saltcedar within the study area grows extremely thick, estimated up to 3,000 stems per acre, and limits the methods available for consideration. Several removal methods were considered, including mechanical, chemical and biological means. The preferred method must kill or remove the root crown located approximately 18 inches beneath the ground surface.

Mechanical removal means considered to remove saltcedar included powergrubbing, extraction, excavation, cabling, chaining, root plowing, and hydraulic shearing with herbicide application. The thick growth of the saltcedar stands makes mechanical removal ineffective and inefficient. Mechanical methods would require more than one treatment to ensure the removal of all root crowns, root fragments, and other remnants capable of sprouting, and can be non-selective disturbing roots of desirable herbaceous and woody species. Further, heavy equipment cannot access most of the saltcedar areas because saltcedar is located in lower areas capable of holding water at or near the surface periodically. Additionally, saltcedar is found within areas where there is a high potential for significant cultural resource sites to be found there. Ground disturbance within these areas would require extensive cultural resource surveys adding additional cost to the removal method. Therefore, mechanical removal was not considered further as a viable means of saltcedar removal.

Hydraulic shearing with herbicide application is also not considered a viable alternative for saltcedar within the study area. Hydraulic shearing is not designed for dense growths of saltcedar and proper herbicide application is not possible, rendering this removal method ineffective.

Conducting a prescribed burn across stands of saltcedar is highly effective at removing the top growth, but it would sprout vigorously from its roots. Additional treatment would then be required and prescribed burning saltcedar is therefore not a viable consideration.

Biological control of saltcedar was also explored. The saltcedar leaf beetle, *Diorhabda elongata*, introduced from northern China and Kazakhstan in central Asia is approved for release by the United States Department of Agriculture-Animal and Plant Health Inspection Service (APHIS). The beetle was rigorously studied to ensure that beetles would not threaten other non-target species. Both adults and larvae feed on the saltcedar leaves and repeated feeding by subsequent generations of beetle larvae is expected to cause dieback and suppress growth. The number of beetles required to make an impact in a timely manner upon such large acreage of saltcedar are unavailable and therefore it cannot be considered a viable alternative for initial control.

The most cost effective method is herbicide application of *Habitat* applied in August or September. To obtain optimum kill rate, saltcedar should remain undisturbed for two years. Due to the dense growth of the saltcedar and difficulty accessing saltcedar stands, ground spraying is not possible and aerial spraying is required.

Herbicide application by rotary-wing aircraft (helicopter) is more effective than herbicide application by fixed-wing aircraft for several reasons. Helicopters fly at a much slower air speed enabling accurate application to non-linear populations of saltcedar, especially beneficial along tributaries. Helicopters have much less spray pattern distortion during turns than fixed-wing aircraft, and are equipped with special booms that deliver the herbicide in larger droplet sizes, preventing the danger of spray drift that fixed-wing aircraft possess.

Approximately 1,310.1 acres will require saltcedar removal. A secondary treatment, biological control by releasing of the saltcedar leaf beetle, would occur three years after initial treatment to control any existing stands and prevent future saltcedar expansion.

**Willow Baccharis Reduction.** Willow baccharis is very similar to saltcedar in its growth habit within the study area, growing dense stands up to 3,000 stems per acre, although it does not grow as tall. The same comparison results are drawn. Alternatives considered for removal of willow baccharis included mechanical removal, prescribed burn and herbicide application. For the same reasons as saltcedar, removal of willow baccharis through mechanical means and prescribed burning is ineffective and requires additional treatments. Therefore, mechanical means and prescribed burning were not considered viable alternatives.

Like saltcedar, the most cost efficient means is herbicide application, and it must be done from the air due to dense growth and the difficulty accessing the willow baccharis stands. Again, due to the non-linear growth of the willow baccharis stands, rotary-wing aircraft (helicopter) more effectively applies herbicide. Herbicide application of *Weedmaster* herbicide in spring, with one year non-disturbance, is over 90% successful. Approximately 2,257.7 acres will require removal. An additional individual plant spray treatment will be required two years after initial treatment.

**Mesquite Reduction.** Eradication of mesquite is not the intent of the restoration project. The intent of the proposed project is to reduce the dense monoculture stands to a more historical condition in order to restore the hydrological regime and historical vegetative diversity.

Mesquite possess a root crown approximately 18 inches underground that must be killed or removed in order to successfully kill the mesquite. Several alternatives available for removal of mesquite were investigated. Alternatives considered for mesquite removal included several mechanical methods, herbicide application, and prescribed burning. Prescribed burning is not effective upon mature mesquite plants, those greater in age than a few years. Mesquite trees within the study area are predominately very mature trees and fire is not a viable alternative for initial removal of mesquite.

Herbicide application is an effective means of removing mesquite. Due to the vast acreage, density, height of the mesquite and the terrain, herbicide application through individual plant treatment is not feasible for consideration. The only feasible alternative for herbicide application within the study area is aerial application. Aerial herbicide (fixed wing) application can result in significant vapor drift during application and the herbicide has been documented to kill agricultural crops, especially cotton, and other desirable vegetation within vapor drift areas. Helicopter aerial herbicide application will reduce vapor drift, but due to the nature of the herbicide and application requirements it cannot be reduced significantly. There are residential areas and businesses adjacent to mesquite areas and vapor drift is a major concern. Due to the serious consequences of vapor drift, aerial herbicide application was not considered further.

Mechanical removal methods considered were powergrubbing, extraction, excavation, chaining/cabling, root plowing, and hydraulic shearing with herbicide application. Effectiveness of all mechanical removal methods were comparable, 85% and above when performed properly. Chaining/cabling is only effective for removing trees 4 to 18 inches in diameter. It is also very non-selective and impacts desirable woody vegetation. Due to its limited use on specific sizes of mesquite and its non-selectivity, chaining/cabling was not considered a viable alternative.

Powergrubbing is probably the next least effective means of mesquite removal, but it can be fairly effective with a good operator and good ground conditions. It is very selective, but not as selective as the most selective methods, excavation and extraction. As compared to excavation and extraction, powergrubbing disturbs a much greater area because the dozer must push the mesquite out of the ground creating an entrance and an exit trench, totaling approximately 8 feet in length and at least 2 feet wide, and the dozer must also travel to each mesquite in order to remove it, creating further ground and desirable vegetation disturbance. Follow-up treatments to remove the mesquites not initially removed is also required. Powergrubbing was removed as an alternative because it was not one of the most cost effective alternatives.

Root plowing creates the most ground disturbance of all the mechanical removal means, but it may be the most effective method. However, root plowing is an entirely non-selective removal method severing all roots within the path of the blade, including desirable herbaceous and woody species and the areas would require extensive reseeding and planting.

The impact of root plowing upon cultural resources within the removal areas is also a major consideration. Although mechanical removal would be performed in areas receiving cultural resource clearance from State Historical Preservation Office, there may be a possibility that an area may contain an unknown cultural resource site and if the site is contained within the root plow depth, the site would be severely negatively impacted. Taking into consideration the vegetative destruction of desirable species, extensive restoration cost and potential for damaging unknown cultural resource sites, root plowing was removed from further consideration as a viable alternative. In some limited areas, less than an estimated 300 acres, mesquite is growing as a monoculture less than 2 feet apart and root plowing is the best solution. The State Historical Preservation Office will be consulted prior to root plowing. Cost estimate is $70 per acre, including root plowing, raking and seed planting.

Hydraulic shearing with herbicide application is highly selective and can be highly effective, up to 90%, but its effectiveness is dependent upon the care exercised when applying the herbicide. . The ground immediately adjacent to the trunk of the mesquite is left undisturbed. Hydraulic shearing with herbicide application is considered a viable alternative. Due to its high effectiveness and minimal ground disturbance, hydraulic shearing with herbicide application would be performed in known and high potential archaeological areas, with SHPO's clearance. Estimated cost is $75 per acre for light density, $100 per acre for medium density, and $125 per acre for heavy density.

Excavation and extraction are two very similar methods that offer the highest effectiveness and are highly selective. Only plants growing immediately adjacent to the mesquite, up to 3 feet from the trunk, are detrimentally affected. Both methods are considered about 95% effective.

Excavation and extraction secondarily generate desirable environmental benefit. The methods creates small holes after mesquite is removed. Holes left are approximately three to four feet wide, sloping from the edge to about 18 inches deep in the middle. These holes would serve to retain water during rain events and hold moisture for longer periods of time than is possible on flat, undisturbed areas. This is a vital component to maintaining desirable grass and forb species under the dry and hot summer conditions the study area experiences.

Estimated cost for mesquite removal using an excavator is $75 per acre for light density, $100 per acre for medium density, and $125 per acre for heavy density. Heavy density mesquite areas within the ASU portion of the study area will require additional raking into piles, estimated at $30 per acre, because mesquite is so thick and large that leaving the removed mesquite on the ground would create safety concerns for outdoor classroom activities, recreation, and livestock. Initial mesquite treatment of 8,729.9 acres using an excavator is estimated at a total cost of $945,263. Estimated cost for mesquite removal using an extractor is $200 per acre for light density, $600 per acre for medium density, and $800 per acre for heavy density. Initial mesquite treatment of 8,729.9 acres using an extractor is estimated at a total cost of $5,376,740.

Additional individual plant spray treatment at $50 per acre two years after initial treatment may also be required at a total cost of $436,495.

**Prickly Pear Reduction.** In order to sustain the restoration project, grass must be restored in sufficient densities to allow for prescribed fire to carry across the landscape and aid in preventing woody vegetation encroachment, especially mesquite and willow baccharis. Dense prickly pear does not carry fire well and would decrease effectiveness of prescribed fire.

All mechanical removal means for prickly pear were removed as an alternative for consideration because it would be too costly to conduct the mechanical removal and dispose of the removed prickly pear so as to prevent prickly pear pads from setting roots after removal.

Herbicide application is the only viable alternative for prickly pear removal. Individual plant spray treatment is not practical because of difficulty gaining access to all prickly pear infested areas. Therefore, herbicide application through individual plant spray treatment was removed as an alternative for consideration.

Herbicide (aerial) application is the most viable alternative for prickly pear removal because of the dense growth and difficulty accessing the prickly pear infested areas. As large acreages of mesquite are removed, large dense stands of prickly pear would be sprayed by fixed wing using *Surmount* herbicide. Helicopter application was removed from consideration because it would be significantly more expensive with no added habitat benefits as compared to fixed wing applications. Once treated, these stands would be left undisturbed for a minimum of two years to increase herbicide effectiveness. Estimated acreage requiring treatment is 9,194.8 acres. No further herbicide application is anticipated.

**Vegetative Plantings (Reforestation).** After removal of invasive vegetative species from degraded riparian woodland habitat (113.5 acres) along the North Concho River, Pott Creek and Turkey Creek, native tree and shrub species would be planted after sufficient hydrology has been restored to the tributaries to sustain riparian woodland habitat restoration. Grasslands within the riparian woodland habitat (41.2 acres) would also be planted. Black willow riparian habitat along the North Concho River would not be included in the reforestation. No restorative measures would be performed within remnant woodland habitat.

Three scales were considered for native tree and shrub planting within degraded riparian woodland areas and grasslands within riparian woodland habitat are included below. All scales include planting vegetation of various sizes to create a beneficial layering effect within the riparian woodland habitat as much as possible. All containerized trees would be maintained for a period of two years to increase survivability rate.

1) 40 one-inch caliper containerized trees, 20 one-gallon shrubs, and 150 tree seedlings per acre
2) 10 one-inch caliper containerized trees, 10 one-gallon shrubs, and 200 tree seedlings per acre
3) 300 tree and shrub seedlings per acre

After removal of invasive vegetative species from black willow degraded riparian woodland habitat (5.7 acres) along the North Concho River, native tree and shrub species would be planted after sufficient hydrology has been restored to sustain riparian woodland restoration. Two scales considered for native tree and shrub planting within black willow degraded riparian woodland habitat along the North Concho River are included below.

1) 10 one-inch caliper containerized trees, 5 one-gallon shrubs, and 100 seedlings per acre
2) 150 tree and shrub seedlings per acre

**Riparian Area Fencing.** Cattle and bison are present within the study area and are not desirable within riparian woodland habitat. Fencing would be installed to prevent cattle access to the North Concho River, Pott Creek and Turkey Creek and adjacent riparian woodland habitat. Additional cross fencing may be necessary in other areas as well to ensure proper rotation of livestock and to restrict livestock access to lacustrine habitat whereby access to riparian woodland habitat could be gained. Approximately 28.2 miles of fence would be required. Additional scales are not considered because cattle and bison must be prevented from entering riparian woodland habitat.

**Grasses/Forbs Seeds.** In areas where mesquite was removed through excavation, the soil surface will contain numerous shallow holes lacking vegetation for short period of time. To aid in establishing vegetation within these disturbed area, sowing native grass and forb seeds was considered. Upon further investigation, it was determined that only a short term habitat benefit would be realized as compared to relying upon existing seed source to revegetate these areas. Additionally, timely rainfall is necessary for successful germination. Considering these factors and the cost, sowing native grass and forb seeds was not considered further.

**Prescribed Burning.** Fire would be returned to the ecosystem to allow it to play its natural role in sustaining the ecosystem. As invasive brushy species are removed from the system, grass would dominate and provide the fuel necessary to successfully conduct prescribed burns and prevent encroachment of invasive brushy species and prickly pear. Prescribed burns would take place on a rotational basis every four to seven years to sustain the project as fuel loads allow. For the purpose of plan formulation), prescribed burns would take place in Year 5 and every four years thereafter (vegetative condition will dictate time intervals).

**Cost Effectiveness / Incremental Cost Analysis.** The U.S. Army Corps of Engineers, Institute for Water Resources developed the software used to conduct Cost Effectiveness / Incremental Cost Analysis (CE/ICA) (IWR-PLAN Version 3.3). IWR-PLAN has been used to evaluate all solutions using average annual habitat unit (AAHU) gains versus average annual costs (AAC). The analyses require three types of data: solutions, estimates of each solution's output, and estimates of each solution's cost.

The plan formulation capabilities of IWR-PLAN were utilized to perform the CE/ICA for this study. The plan formulation function builds combinations of solutions based upon a set of relationships established by the user. The various combinations (plans) are compared, incrementally, to determine those which are cost-effective. The program then compares the cost-effective plans to determine which plans provide the greatest incremental AAHU gains for the incremental AAC expended; these are the "best-buy" plans. The solutions used for the analysis and their relationships to each other are shown in Table 7. The following sections describe the specific inputs into IWR-PLAN, and the outputs generated by IWR-PLAN.

**TABLE 7. Solutions and Relationships Used to Conduct the CE/ICA.**

| Code | Solution | Relationships |
|---|---|---|
| A | Invasive removal - mesquite by extractor | Not combinable with B or C |
| B | Invasive removal - mesquite by excavator | Not combinable with A or C |
| C | Invasive removal - mesquite by hydrashear | Not combinable with A or B |
| D | Reforestation of non-black willow riparian habitat after mesquite removal by excavator or extractor | Dependent on A or B |
| E | Reforestation of non-black willow riparian habitat after mesquite removal by hydrashear | Dependent on C |
| F | Enhancement of black willow riparian habitat | Dependent on A or B or C |

**Costs of Alternatives.** Implementation costs were developed for chemical and mechanical removal of invasive vegetative species along with individual plant follow-up treatments, reforestation of riparian corridors, riparian fencing, and prescribed burning. The development of these costs is described briefly below. Most unit costs were based upon industry standards, discussions with manufacturers and material providers, and experience with recent projects. For evaluation purposes, it was necessary to refer to a specific effective herbicide. Prior to implementation of the restoration project, other herbicides demonstrating similar characteristics will be considered.

**Saltcedar, Willow Baccharis, and Prickly Pear Removal/Reduction by Aerial Herbicide Application.** Estimated costs were developed for herbicide applications to remove stands of saltcedar, willow baccharis, and prickly pear. Cost estimates for removal of saltcedar were based on materials, labor, and equipment required for a helicopter application of *Habitat* herbicide (estimated at $200 per acre and a total initial treatment cost of $262,020). Secondary biological control treatment using the saltcedar leaf beetle is estimated at $15 per acre and a total cost estimate of $19,651. Material, labor, and equipment cost for helicopter application of *Weedmaster* herbicide was used to calculate the initial cost of willow baccharis reduction (estimated $75 per acre and a total initial treatment cost estimate of $169,327) and subsequent follow-up treatment (estimated at $25 per acre and a total cost estimate of $56,442). The cost associated with aerial spraying *Surmount* by a fixed-wing aircraft (estimated at $26 per acre and a total cost estimate of $239,064) was used in calculating the implementation cost of prickly pear control. The cost associated with one follow-up treatment by prescribed burning was included in the first cost for saltcedar removal, willow baccharis reduction, and prickly pear reduction. Additionally, materials, labor, and equipment costs for installing a 5-wire livestock fence along riparian woodland areas (estimated at $6,000 per mile and a total estimated cost of $169,200) was included in the implementation costs. Operation and maintenance costs for all areas of mesquite, willow baccharis, and prickly pear removal were calculated using the cost associated with performing a prescribed burn on a 4-year interval. The cost estimate for conducting initial prescribed burn is estimated at $46,500, including firelane construction. Subsequent prescribed burns are estimated lower, $23,600 (prorated at $5,900 per year), because firelanes will only require maintenance.

**Mechanical Removal of Mesquite.** Cost estimates were developed for three types of mechanical removal; hydrashear, extractor, and excavator for the cost effectiveness analysis. The cost of materials, labor, and equipment were used in the estimation of implementation cost for each method. Cost estimates for specific mechanical removal method are contained in Table 8 below.

**TABLE 8. Estimated Mesquite Removal Method Costs.**

| Removal Method | Light Density | | Medium Density | | Heavy Density | | Total Cost |
|---|---|---|---|---|---|---|---|
| | Per Acre Cost | Total Cost | Per Acre Cost | Total Cost | Per Acre Cost | Total Cost | |
| Hydraulic Shearing w/ Herbicide Application | $ 75 | $164,768 | $ 100 | $144,520 | $ 125 | $ 635,976 | $ 945,264 |
| Extractor | $ 200 | $439,380 | $ 600 | $867,120 | $ 800 | $4,070,240 | $5,376,740 |
| Excavator | $ 75 | $164,768 | $ 100 | $144,520 | $ 125 | $ 635,976 | $ 945,264 |

For the purpose of the IWR-PLAN, additional costs were compiled with the first cost for each mesquite removal method costs. These additional costs include root plowing, raking and seeding of 300 acres within ASU lease (estimated at $70 per acre and a total estimated cost of $21,000), installing a 5-wire livestock fence (estimated at $6,000 per mile and a total estimated cost of $169,200) along riparian woodland areas, and a one-time follow-up with individual plant herbicide treatment (estimated at $50 per acre and a total estimated cost of $436,495), and a one-time follow-up application of prescribed burning within mesquite removal areas outside riparian woodland areas.

Costs associated with operation and maintenance included prescribed burning on a 4-year interval. The cost estimate for conducting initial prescribed burn is estimated at $46,500, including firelane construction. Subsequent prescribed burns are estimated lower, $23,600 (prorated at $5,900 per year), because firelanes will only require maintenance.

**Reforestation.** Costs were developed for three scales of planting within degraded riparian woodlands, excluding black willow areas. Planting costs included herbicide treatment of individual planting sites, materials, labor, and equipment. The first cost for a planting scale was multiplied by a percentage to calculate the replacement costs for that given planting scale. For scale 1, the replacement costs were assumed to be 15% of the first cost for that scale; 10% of the first cost for scale 2 was used to calculate replacement, and 5% of first costs were assumed to cover replacement for scale 3. Cost for planting 40 one-inch caliper containerized trees, 20 one-gallon shrubs, and 150 tree seedlings is estimated at $9,000 per acre and a total estimated cost of $1,392,300. Cost for planting 10 one-inch caliper containerized trees, 10 one-gallon shrubs, and 200 tree seedlings is estimated at $5,750 per acre and a total estimated cost of $889,525. Cost for planting 300 tree and shrub seedlings is $3,000 per acre and a total estimated cost of $464,100.

**Enhancement.** Costs were developed for two scales of planting within degraded riparian woodlands containing black willow. Planting costs included herbicide treatment of individual planting sites, materials, labor, and equipment. The first cost for a planting scale was multiplied by a percentage to calculate the replacement costs for that given planting scale. Replacement costs were assumed to be 15% and 12% of first costs for scale 1 and scale 2, respectively. Cost for planting 10 one-inch caliper containerized trees, 5 one-gallon shrubs, and 100 seedlings is estimated at $2,875 per acre and a total estimated cost of $16,100. Cost for planting 150 tree and shrub seedlings is estimated at $1,500 per acre and a total estimated cost of $8,400.

**Alternative Plan Outputs.** Existing, future without-project, and future with-project environmental outputs were established for four broad habitat types: riparian, riverine, lacustrine, and transitional. However, for the purposes of identifying the NER Plan only the benefits associated with the riparian and riverine habitats were used in the CE/ICA. The benefits gained to the lacustrine and transitional habitats as a result of implementing invasive vegetative species removal were examined as secondary benefits to each "best buy" plan identified by IWR-PLAN.

Using the habitat evaluation methodology, HSI values were assigned for each period of analysis to the various vegetative cover types contained within a habitat based upon their existing condition, their response to assumed future without-project conditions, and their assumed response to incremental implementation of the solutions identified in Table 9. Using the acreage and HSI values, the average annual habitat units (AAHUs) were calculated for the future with-project condition of each solution. Additionally, AAHUs were calculated for the future without-project condition to allow comparison of the true benefits gained by implementation of any of the solutions.

Table 9 displays the future without-project condition and all other solutions with their corresponding IWR-PLAN code, AAHUs and AAC which were used in the CE/ICA. These values were input to IWR-PLAN with their corresponding relationships described in Table 7.

**TABLE 9. Acres, Average Annual Habitat Units, and Average Annual Costs for Ecosystem Restoration Solutions.**

| Code | Solution | Acre | AAHU | AAC | AAC/AAHU |
|---|---|---|---|---|---|
| A1 | Invasive removal - mesquite by extractor | 15,859.80 | 172.0 | $452,379 | $ 2,630 |
| B1 | Invasive removal - mesquite by excavator | 15,859.80 | 172.0 | $166,062 | $ 965 |
| C1 | Invasive removal - mesquite by hydroshear | 15,859.80 | 171.0 | $166,062 | $ 971 |
| D1 | Reforestation of non-black willow riparian habitat after mesquite removal by excavator or extractor; Option 1 | 154.70 | 48.0 | $ 94,133 | $ 1,961 |
| D2 | Reforestation of non-black willow riparian habitat after mesquite removal by excavator or extractor; Option 2 | 154.70 | 46.0 | $ 59,251 | $ 1,288 |
| D3 | Reforestation of non-black willow riparian habitat after mesquite removal by excavator or extractor; Option 3 | 154.70 | 45.0 | $ 30,450 | $ 677 |
| E1 | Reforestation of non-black willow riparian habitat after mesquite removal by hydrashear; Option 1 | 154.70 | 45.0 | $ 94,133 | $ 2,092 |
| E2 | Reforestation of non-black willow riparian habitat after mesquite removal by hydrashear; Option 2 | 154.70 | 40.0 | $ 59,251 | $ 1,481 |
| E3 | Reforestation of non-black willow riparian habitat after mesquite removal by hydrashear; Option 3 | 154.70 | 45.0 | $ 30,450 | $ 677 |
| F1 | Enhancement of black willow riparian habitat; Option 1 | 5.70 | 0.5 | $ 1,089 | $ 178 |
| F2 | Enhancement of black willow riparian habitat; Option 2 | 5.70 | 0.3 | $ 563 | $ 1,877 |

**NOTE: Future without-project yields 96.0 AAHUs.**

**CE/ICA Results.** Based upon the relationship constraints, of a possible 384 combinations there were 37 actual combinations examined for cost-effectiveness. Thirteen of the 37 were determined to be cost effective, and five of those plans were carried forward to the best-buy array. The AAHU, AAC, and Average Cost per AAHU for cost-effective plans are displayed in Table 10 using their corresponding codes from Table 9. The best-buy plans are differentiated with an asterisk (*) and their incremental cost, incremental cost, and incremental cost per output are also shown. Figure 7 is a graphical representation of the best-buy array. All scales of riparian habitat reforestation and black willow riparian habitat enhancement were identified as cost-effective. Of the three methods of removing invasive mesquite, only the excavator method was identified as being cost-effective. Therefore, all cost-effective and best-buy plans are combinations of the saltcedar removal, willow baccharis reduction, and prickly pear reduction by aerial herbicide application, mesquite removal by excavator, one of three scales of riparian habitat reforestation, one of two scales of black willow riparian habitat enhancement.

**TABLE 10. Cost-effective and Best-buy Plan Array from CE/ICA.**

| Plan Combination | AAHU | AAC | Average Cost per AAHU | Incremental Cost ($) | Incremental Output | Incremental Cost per Incremental Output |
|---|---|---|---|---|---|---|
| *B0-D0-F0 | 96.00 | 0.00 | 0.00 | 0.00 | 96.00 | 0.00 |
| B1-D0-F0 | 268.00 | 166,062 | 619.63 | --- | --- | --- |
| B1-D0-F2 | 268.30 | 166,625 | 621.04 | --- | --- | --- |
| B1-D0-F1 | 268.50 | 167,151 | 622.54 | | | |
| *B1-D3-F0 | 313.00 | 196,512 | 627.83 | 196,512 | 217.00 | 905.58 |
| *B1-D3-F2 | 313.30 | 197,075 | 629.03 | 563 | 0.30 | 1,876.667 |
| *B1-D3-F1 | 313.50 | 197,601 | 630.31 | 526 | 0.20 | 2,630.00 |
| B1-D2-F0 | 314.00 | 225,313 | 717.56 | --- | --- | --- |
| B1-D2-F2 | 314.30 | 225,876 | 718.66 | --- | --- | --- |
| B1-D2-F1 | 314.50 | 226,402 | 719.88 | --- | --- | --- |
| B1-D1-F0 | 316.00 | 260,195 | 823.40 | --- | --- | --- |
| B1-D1-F2 | 316.30 | 260,758 | 824.40 | --- | --- | --- |
| *B1-D1-F1 | 316.50 | 261,284 | 825.54 | 63,683.00 | 3.00 | 21,227.67 |

* Best-buy Plan

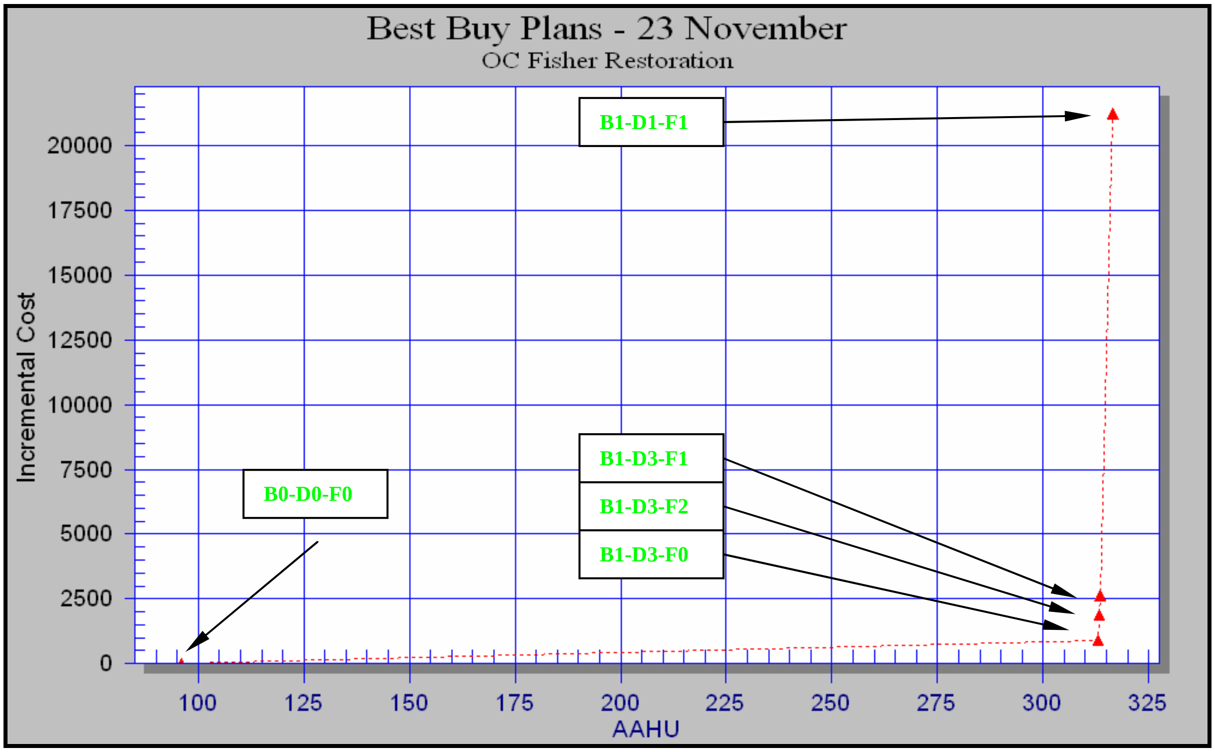


**FIGURE 7.** Best-buy Plan Array.

**Identification of National Ecosystem Restoration Plan.** The National Ecosystem Restoration (NER) plan would be selected from the best-buy plans listed in Figure 7. The CE/ICA identified five best-buy plans in the final array. The plans were evaluated with respect to the Corps ecosystem restoration mission, the study planning objectives, total habitat gains, incremental cost per incremental output gained, total project cost, level of support, and significance of habitat outputs. The following paragraphs provide justification for each incremental increase in cost associated with each incremental increase of output ultimately leading to the identification of the NER plan.

**B0-D0-F0 - Plan 1.** This combination represents the no-action or future without-project conditions. The no action plan was eliminated from consideration as the NER plan. Under the no-action plan, invasive vegetative species would continue to proliferate, and the aquatic and riparian habitats would continue to degrade. The no-action plan has an average annual output of 96.0 habitat units.

**B1-D3-F0 - Plan 2.** There are two increments isolated in this combination over the no-action plan. These increments include removal of all invasive vegetative species using chemical and mechanical means, and reforestation of the riparian zone with 300 seedlings per acre. Saltcedar, willow baccharis, and prickly pear would be removed/reduced using aerial applications of herbicide, and mesquite density would be reduced throughout the study area by removing individual specimens using an excavator. Removal or reduction of these non-native and native species would meet most of the stated objectives, and represents a substantial habitat improvement over the without-project condition. Perhaps the most significant improvement provided by invasive brushy species removal or reduction is the increases to the water resources of the study area. A reduction in the number of phreatophytic species on the landscape would increase the amount of water which would percolate through the soil thus increasing the amount of groundwater available to increase in-stream baseflows for the riverine habitats. Additionally, removing the invasive brushy species would redistribute the available water for native riparian and transitional plant species, thus increasing the species diversity for those habitats.

Reforestation of riparian habitat along the riverine system is another component of this plan. A functioning riparian corridor functions as a donor of nutrients, water, and sediment. The riparian vegetation also serves a regulator of light and temperature for the adjacent stream and serves as a vital link between the aquatic ecosystem and the upland ecosystem. Providing a contiguous block of habitat, including aquatic, riparian, and transitional habitats, allows wildlife species to meet their spatial and temporal life requisites. Inclusion of the riparian reforestation helps to meet the stated objectives for restoration within the study area.

This best-buy plan provides an average of 313.00 habitat units annually; this is an increase of 217.00 average annual habitat units over the future without-project condition at a cost $905.56 per habitat unit gained.

**B1-D3-F2 - Plan 3.** The incremental increase in output and cost isolated for this plan is the measure of enhancement of the black willow riparian habitat with 150 seedlings per acre. Implementation of this plan would address all the degradation within the study area. The black willow riparian habitat are the smallest and least degraded habitats. There are currently 5.7 acres of black willow riparian habitat that is providing 2.9 habitat units under the existing condition. Under the future without-project condition, these habitats would continue to degrade, and in year 50 it is expected they would be providing only 0.57 habitat units. Assuming the previous plan were implemented, which does not include enhancement for these black willow areas, the average annual habitat unit output would increase over the future without-project condition assuming the proper vegetative species are recruited into the various strata of the riparian habitat. However, reforestation of these areas provides insurance that the proper species fill the available niches, thus providing a more sustainable and functioning ecosystem throughout the study area.

This increment provides an average of 313.30 habitat units annually, which is 0.30 average annual habitat units over the previous best-buy plan. The incremental increase in average annual cost to implement this plan over the previous plan is $563 and would raise the incremental cost per incremental output by approximately $971.08 annually.

**B1-D3-F1 - Plan 4.** This best-buy plan includes the invasive vegetative species removal, riparian habitat reforestation, and black willow riparian habitat enhancement components of the previous plan. The incremental increases for this combination are due to changes in the planting pallet for the black willow areas. The black willow riparian habitat would be planted with 10 1"-caliper trees, 5 1-gallon shrubs, and 100 seedlings per acre. Providing larger, more mature specimens allows the habitat to begin functioning at a higher level earlier in the analysis period. The result is an increase in the average annual habitat units provided.

This increment provides an average of 313.50 habitat units annually, which is an increase of 0.20 over the previous best-buy plan. The incremental increase in average annual cost to implement this plan over the previous plan is $526.00 and would raise the incremental cost per incremental output by approximately $753.33 annually.

**B1-D1-F1 - Plan 5.** This best-buy combination changes the previous plan's planting pallet for the riparian habitat to planting 40 1"-caliper trees, 20 1-gallon shrubs, and 150 seedlings per acre; thus, this plan greatly increases the number of large, more mature trees and shrubs which would be present in the early years of analysis. The resulting increase in average annual habitat unit output is 3.0 over the previous plan. The incremental increase in average annual cost to implement this plan over the previous plan is $63,683.00 and would raise the incremental cost per incremental output by approximately $18,597.67.

**Plan Selection**

Plans 4 and 5 provide incrementally higher AAHUs than Plan 3, but these increases are attributable to beginning the analysis period for the reforestation measure with slightly more mature vegetation. Plan 3 begins the analysis period with all seedlings, while the other plans have varying densities of larger trees mixed in with the seedlings. Because of growth differences between seedlings and older vegetation, the seedlings would begin providing the same outputs as the larger vegetation by year 15 of the 50-year analysis period. Because the higher outputs provided by Plans 4 and 5 actually occur only during the early maturation stages of the restoration, but increase the cost per output substantially over Plan 3, it was determined that outputs provided were not worth the costs for Plans 4 and 5. Identification of the NER Plan then centers on Plan 2 and Plan 3. Plan 2 provides most of the habitat units and meets most all of the planning objectives established for the study area. However, implementation of Plan 2 would leave 5.7 acres of riparian habitat to recover on its own. The dominant vegetation on these 5.7 acres is currently black willow, an appropriate and desirable riparian tree species. However, the area currently does not provide a diversity of vegetative species required for a fully functioning riparian zone. The increment provided by Plan 3 would allow planting a diversity of tree species in the black willow riparian habitat, thus insuring the proper vegetative species would occupy the site, and therefore, providing a greater sustainability and functionality to the entire aquatic ecosystem of the study area. It was determined that the 0.20 AAHUs gained by Plan 3 over Plan 2 were worth the incremental increase of $526 annually.

Based upon the analysis described above, Plan 3 has been identified as the NER Plan. Plan 3 provides a comprehensive and balanced restoration of lost riverine and riparian habitats than any other plan evaluated during plan formulation. The cost of implementing this plan is justified based upon the significant outputs it provides to the aquatic ecosystem of the North Concho River. These outputs include significant increases in the quality and quantity of scarce aquatic and riparian habitats in the project area, and are technically and institutionally significant. Restoration of these habitats is considered of great ecological importance to the City of San Angelo, the state of Texas, and the Nation.

## * RECOMMENDED NER PLAN

To successfully restore the ecosystem and gain optimum riparian habitat benefits, adequate hydrology is required along the North Concho River, Pott Creek and Turkey Creek. It is anticipated that this will be achieved through near average rainfall, stream flow along North Concho River into the study area derived in response to state brush control program and the removal of invasive brushy species within the study area to a more historical vegetative condition. Groundwater table levels within the study area will rise and increase spring flows benefiting stream flows of the tributaries within the study area.

**Description.** The recommended restoration plan is the NER Plan. The plan includes removal of saltcedar and reduction of mesquite, willow baccharis and prickly pear. The plan also includes native tree and shrub plantings within degraded riparian woodlands (154.7 acres with 300 seedlings planted per acre) and black willow riparian habitat (5.7 acres and 150 seedlings per acre). After full implementation of the recommended restoration plan, the five existing habitat classifications (aquatic-lacustrine, aquatic-riverine, aquatic-riverine-intermittent, riparian woodland and transitional) will be significantly improved by restoring the biological integrity, diversity and stability of the ecosystem within lands owned by USACE at O.C. Fisher Lake. It is recognized that existing leases with ASU and TPWD are in effect, and will remain so. The restoration plan will not negatively affect these leases; the purposes are highly compatible. Cultivated lands and any research lands not compatible with the restoration project, comprising approximately 611 acres, are excluded from the restoration project. Existing grazing programs will remain in effect as specified in existing leases, except as excluded from riparian woodland habitat.

Figure 6 provides a depiction of the habitat classification as the resulting from implementation of the recommended restoration plan. Table 11 provides a comparison between existing condition, with-project condition and without-project condition.

**TABLE 11. Comparison between Existing, Future With-project, and Future Without-project Conditions.**

| Habitat | | Existing | | | With Project (50 YRS) | | | Without Project (50 YRS) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Acres | HSI | Habitat Units | Acres | HSI | Habitat Units | Acres | HSI | Habitat Units |
| Aquatic | Lacustrine/ Lacustine (Dry) | 440.3/ 3,348.4 | 0.20/ 0 | 88.1/ 0 | 3,788.7 | .85 | 3,220.4 | 0 | 0 | 0 |
| | Riverine/ Riverine (Dry) | 13.3/ 38.9 | 0.20/ 0.05 | 2.7/ 1.9 | 52.2 | .92 | 48.0 | 0 | 0 | 0 |
| | Riverine-Intermittent | 10.3 | 0.2 | 2.1 | 10.3 | .92 | 9.5 | 0 | 0 | 0 |
| Riparian Woodland | Remnant Woodland (Pecan) | 86.2 | 0.71 | 61.2 | 86.2 | .95 | 81.9 | 0 | 0 | 0 |
| | | | | | 154.7 | .92 | 142.3 | | | |
| | Remnant Woodland (Hackberry) | 2.6 | 0.71 | 1.8 | 2.6 | .95 | 2.5 | 0 | 0 | 0 |
| | Remnant Woodland (Live Oak) | 0.6 | 0.71 | .4 | 0.6 | .95 | .6 | 0 | 0 | 0 |
| | Black Willow | 5.7 | 0.5 | 2.9 | 5.7 | .95 | 5.4 | 0 | 0 | 0 |
| | Mesquite, Heavy | 77.3 | 0.40 | 30.9 | 0 | 0 | 0 | 202.8 | .20 | 40.6 |
| | Mesquite, Medium | 9.8 | 0.35 | 3.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Mesquite, Light | 26.3 | 0.30 | 7.9 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Willow Baccharis | 0.1 | 0.10 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Saltcedar | 0 | 0 | 0 | 0 | 0 | 0 | 47.0 | .10 | 4.7 |
| | Grass | 41.2 | .02 | 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |
| Transitional | Mesquite, Heavy | 4,911.2 | 0.49 | 2,406.5 | 0 | 0 | 0 | 15,409.5 | .15 | 2,311.4 |
| | Mesquite, Medium | 1,412.2 | 0.65 | 917.9 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Mesquite, Light | 2,143.0 | 0.38 | 814.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Saltcedar | 0 | 0 | 0 | 0 | 0 | 0 | 200.5 | .10 | 20.1 |
| | Saltcedar/Willow Baccharis | 11.6 | 0.10 | 1.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Willow Baccharis | 188.9 | 0.10 | 18.9 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Grassland | 3,091.9 | 0.67 | 2,071.6 | 11,758.8 | .9 | 10,582.9 | 0 | 0 | 0 |
| Other | Agriculture | 687.9 | NA | NA | 687.9 | NA | NA | 687.9 | NA | NA |
| | Aquatic-Stock Tank | 7.9 | NA | NA | 7.9 | NA | NA | 7.9 | NA | NA |
| | Road ROW | 127.9 | NA | NA | 127.9 | NA | NA | 127.9 | NA | NA |
| | Dam | 224.0 | NA | NA | 224.0 | NA | NA | 224.0 | NA | NA |
| | Urban | 6.2 | NA | NA | 6.2 | NA | NA | 6.2 | NA | NA |
| | TOTAL | 16,913.7 | NA | 6,434.5 | 16,913.7 | NA | 14,093.5 | 16,913.7 | NA | 2,376.8 |

Removal and reduction of invasive brushy species within the study area would restore the vital hydrology component necessary to sustain the restored ecosystem. Moisture lost from high evapotranspiration rates of invasive brushy species would be retained within the ecosystem, allowing groundwater level to rise, springs to flow, and perennial surface water to significantly increase. Base flows and perennial surface water would be restored to the North Concho River, Pott Creek and Turkey Creek. The lake level is predicted to rise a result of restored base flows. The quantity of aquatic habitat would increase substantially. The perennial tributaries, including the North Concho River, Pott Creek and Turkey Creek, would increase four times the present acreage of 13.3 acres to 52.2 acres. Areas within aquatic riverine-intermittent habitat would not only increase acreage containing periodic surface water, but increase the duration of time surface water is present.

Aquatic habitat value would increase significantly in response to increased surface water. Lacustrine and riverine habitat would become contiguous and increased base flows would significantly improve dissolved oxygen levels, lower high summer water temperatures and stabilize fluctuating water temperatures. Additional water quality benefits include reduced chloride levels from the removal of saltcedar and decreased amounts of suspended sediment due to reduced erosion resulting from increased vegetative groundcover. Aquatic plant diversity would increase and aquatic vegetation would grow in a healthier, more vigorous state benefiting aquatic organisms. Overall, aquatic habitat condition would increase from existing 94.8 habitat units to 3,277.9 habitat units.

Restoring the perennial surface water along the North Concho River, Pott Creek and Turkey Creek would halt the progressive degradation of existing remnant woodlands of pecan, hackberry and live oak. Degraded riparian woodlands presently dominated with mesquite, willow baccharis, and grass would be restored to a more historical condition through plantings of native trees and shrubs producing a desirable 100% tree canopy cover with a diverse understory of shrubs and herbaceous plants. Existing desirable remnant riparian woodland habitat, 89.4 acres, would be conserved and 160.4 acres of degraded riparian woodland habitat would be restored to desirable habitat. Overall, riparian woodland habitat would increase from existing 109.3 habitat units to 232.7 habitat units.

Transitional habitat condition would be improved from existing condition supporting 6,230.4 habitat units to a condition supporting 10,582.9 habitat units. Transitional habitat within the study area that is critical to the hydrological regime of the ecosystem would also improve significantly.

Habitat value would more than double that of existing conditions. As compared to without-project conditions, overall habitat value would increase 2.7 times. With full implementation of the recommended plan, perennial surface water would increase from 453.6 acres to 3,840.9 acres. The progressive loss of riparian woodland habitat would halt, conserving the existing 89.4 acres of remnant woodland, and an additional 160.4 acres of remnant woodland would be restored towards historical condition. The recommended plan would also restore 8,666.9 acres of habitat to a more natural, historic and sustainable condition which is critical to the hydrological regime of the ecosystem.

Restoration will generally be conducted from the lower elevations to the higher elevations. Work will begin within lacustrine, riverine, and riverine-intermittent habitats and their adjacent habitats and then expand outward into transitional habitat. This would allow for maximum surface water retention during the restoration process as the invasive, phreatophytic vegetation is removed within the perennial aquatic habitat. Riverine base flows will increase as the groundwater table rises and spring flows improve. Lacustrine habitat will increase with increased base flows within riverine and riverine-intermittent habitats. Riparian areas will be restored as riverine habitat is capable of sustaining it. Fire will be returned to the transitional habitat within the ecosystem in the form of prescribed burns to aid in sustaining the ecosystem.

Saltcedar will be sprayed by helicopter using *Habitat* herbicide in September. Water intake located at dam will be shut down during application for a minimum of 48 hours as required by herbicide label for applications near active potable water intakes.

Willow baccharis will be sprayed by helicopter using Weedmaster herbicide in the spring and will remain undisturbed for at least a year for effectiveness. A “no-spray buffer zone” will be established adjacent to surface water to prevent application directly to water as specified by herbicide label.

Mesquite located outside of known or potential cultural resource sites will be removed by excavator and those within known or potential cultural resource will be removed through hydraulic shearing with herbicide application, with SHPO’s clearance.

Large dense stands of prickly pear will be reduced by fixed wing herbicide application of *Surmount* herbicide in the spring after mesquite removal is completed. With adequate fuel loads, prescribed fire will be conducted in the winter prior to herbicide application to improve prickly removal effectiveness. No herbicide applications will be made adjacent to surface water. These stands will be left undisturbed for a minimum of two years to increase herbicide effectiveness.

Two years following initial treatment, any existing dense stands of willow baccharis will receive individual herbicide plant treatment with Weedmaster herbicide. Any existing mesquite requiring removal will receive individual herbicide plant treatment, using mixture of Remedy and Reclaim herbicides, two years following initial treatment. Saltcedar leaf beetle will be released three years after initial saltcedar treatment to remove any stands of saltcedar still present.

Barbed-wire fence will be installed along the outside edge of all riparian woodland habitat to prevent livestock access within the study area. Additional cross fences within transitional areas will also be constructed to allow for adequate livestock rotation and prevent overgrazing.

Within riparian woodland habitat, mesquite will be removed to a density of approximately 10 percent (with exception of areas designated by lessees), that which was historically found there, along the riparian woodland of the North Concho River, Pott Creek and Turkey Creek. Mesquite will be removed by excavator outside of known or potential cultural resource sites and by hydraulic shearing with herbicide application in area within known or potential cultural resource sites, with SHPO’s approval. All existing native woody trees and shrubs found within the riparian woodland will be left undisturbed. Mesquite left undisturbed will generally be the larger trees.

All existing native woody trees and shrubs found will be left undisturbed. Mesquite left undisturbed will generally be the larger trees and will form tree mottes of various shapes and sizes with existing native trees and shrubs. Existing native grass and forb seed source will revegetate as the invasive brushy species are removed. Depressions left by the excavator upon mesquite removal will serve as an extremely beneficial microclimate environment for revegetation. The depressions will retain vital moisture for greater periods of time and offer vegetation protection from heat and wind, and provide for a reliable seed source under harsh conditions.

Planting riparian woodland habitat will occur after sufficient hydrology has been returned to the ecosystem to sustain the plantings. As determined by the NER plan, 160.4 acres of previously existing black willow, mesquite, willow baccharis and saltcedar will be planted with native tree and shrub species. Tree and shrub species planted will consist of a variety of native mast and fruit-bearing species. Tree species will include bitter pecan (*Carya illinoiensis*), live oak (*Quercus virginiana*), hackberry (*Celtis laevigata*), eastern cottonwood (*Populus deltoides),* black willow (*Salix nigra*) as commercially available for the ecoregion. Shrub species will include roughleaf dogwood (*Cornus drummondii*), gum bumelia (*Bumelia lanuginose*), deciduous holly (*Ilex decidua*) and common buttonbush (*Cephalanthus occidentalis*). The existing seed source should be adequate to establish low-light tolerant woodland grasses such as Canada wild-rye (*Elymus Canadensis*), inland sea-oats (*Chasmanthium latifolium*), Texas wintergrass (*Stipa leucotricha*), switchgrass (*Panicum virgatum*), eastern gammagrass (*Tripsacum dactyloides*), aster (*Aster spp*.), verbena (*Verbena sp*.), cardinal flower (*Lobelia cardinalis*), goldenrod (*Solidago sp*.), evening primrose (*Oenethera sp*.), and western ironweed (*Vernonia baldwinii*).

Fire will be returned to the ecosystem to allow it to play its natural role to aid in sustaining the ecosystem. As invasive brushy species are removed from the system, grass will dominate and provide the fuel necessary to successfully conduct prescribed burns. Prescribed burns will be conducted on a rotational basis as fuel allows.

**Importance of Project Outputs.** The importance of the restoration habitat outputs cannot be overstated. The importance of the habitat outputs are described below.

**Institutional Recognition.** Numerous laws, executive orders, and partnerships demonstrate the importance of wildlife and native habitat to our Nation. The Water Resources Development Act of 1986, Section 906(b) establishes that significant damages to fish and wildlife resources have occurred as a result of past USACE water resource projects and authorizes the Corps to "mitigate" for these damages. Environmental damages occurred directly as a result of construction of O.C. Fisher Lake and the subsequent operation of the project. Construction of O.C. Fisher Lake in 1952 required significant clearing of existing vegetation in order to construct the 38,254-foot long dam, outlet works and uncontrolled spillway. The Definite Project Report written in 1946 states that 7,524 acres of woody vegetation would be completely removed to an elevation twenty (20) feet above conservation pool. In addition to the large acreages of native prairie that were lost, it is estimated that 253 acres of prime riparian habitat, bottomland hardwood, was destroyed.

Upon reservoir completion, operation of the project contributed further environmental degradation. In the early years after reservoir construction, livestock were allowed to graze upon the lands and naturally occurring wildfires were suppressed. Overgrazing and removal of fire, coupled with drought conditions and subsequent drop in lake level, allowed invasive brushy species the opportunity to dominate the habitat and negatively impact the hydrology of the ecosystem. Each year, invasive brushy species continue to expand their range, further depleting the hydrological regime of the ecosystem through high rates of evapotranspiration, and transform existing aquatic, prime riparian habitats, and native grasslands to an unnatural shrubland condition. Full implementation of the proposed restoration plan will restore the hydrological regime to the ecosystem. As a result, habitats within the project will be restored to a more natural and sustainable state. The aquatic habitat will be restored, the progressive degradation of the remaining prime riparian habitat will be halted, degraded riparian habitat will be restored, and existing transitional shrubland habitat will be restored to a more historical grassland condition.

Executive Order 13112 recognizes the significant contribution native species provide towards the well-being of the Nation's natural environment and directs Federal agencies to take preventive and responsive action to the threat of non-native species invasion and to provide restoration of native species and habitat conditions in ecosystems that have been invaded. Construction and operation of O.C. Fisher Lake negatively impacted native vegetative species through their removal for construction of the project and subsequent operation of the project. Saltcedar, an exotic plant comprising 1,310 acres of land within the study area and more than 500,000 acres in Texas (Hart 2003), “is one of the most invasive, hard-to-control woody plants in the world”, states Allen McGinty and Charles Hart of the Texas Agricultural Extension Service (McGinty and Hart 2001). Without intervention, saltcedar will continue its proliferation and invade all remaining aquatic and riparian habitats within the study area, permanently altering the ecosystem. Although mesquite and willow baccharis are native species within the study area, they also thrived under the altered conditions, further degrading existing native species populations in their quantity and diversity. Currently, native vegetation exists in conditions similar to historical conditions in 89.4 acres of riparian habitat, only 34.5%, and 139.1 acres of transitional habitat, only 4.5%. As native vegetation is degraded from its historical condition, the carrying capacity for fish and wildlife species dependent upon the habitat is subsequently reduced. Currently, the study area supports approximately half of its potential carrying capacity in terrestrial habitats due to habitat degradation and approximately 3% of its potential carrying capacity in aquatic habitats.

The Migratory Bird Treaty Act shows the Federal commitment to the protection of migratory birds and the Fish and Wildlife Conservation Act, shows the Federal commitment to the conservation of nongame species. Amendments to the Fish and Wildlife Conservation Act adopted in 1988 and 1989 direct the Secretary to undertake activities to research and conserve migratory nongame birds. Executive Order 13186 directs Federal agencies to promote the conservation of migratory bird populations, including restoring and enhancing habitat. Migratory Nongame Birds of Management Concern is a list maintained by the USFWS to fulfill a primary goal of the USFWS to conserve avian diversity in North America. Additionally, the USFWS' Migratory Bird Plan is a draft strategic plan to strengthen and guide the agency's Migratory Bird Program. The Department of Defense signed an MOU with Partners in Flight, a cooperative effort involving partnerships among federal, state, and local government agencies, philanthropic foundations, professional organizations, conservation groups, industry, the academic community, and private individuals. A major focus of Partners in Flight is for the conservation of neotropical migrants. Implementation of the recommended plan should greatly benefit many bird species.

**Public Recognition.** The ecosystem restoration project sparked some political interest throughout the course of the feasibility study. Former Congressman Charles Stenholm, Representative, 17th District, contacted USACE on several occasions during the study requesting information and status reports of the project. There were also some requests from interested individuals for restoration project information to be disseminated at San Angelo City Council meetings.

A general population survey conducted cooperatively by TPWD and Texas Tech University in 2001, found that water resources, including both water quantity and quality, is by far the most important natural resource and environmental concern of Texans. One hundred percent of those surveyed expressed that it was very important or somewhat important that Texas' water resources are safe and well protected, with 93% of those rating it as very important.

The aforementioned survey also found that 97% felt it was either very important or somewhat important that natural areas exist in Texas for enjoying and experiencing nature, with 79% of those responding that it was very important (Texas Parks and wildlife Department and Texas Tech University 2001). The diversity of the natural resources located at O.C. Fisher Lake attracts large numbers of visitors each year, contributing to the local economy and providing recreational opportunities. Bird-watching, wildlife viewing, hiking, biking, horseback riding, hunting, and fishing are common activities enjoyed within the study area. The close proximity of O.C. Fisher Lake to a major metropolitan area allows large numbers of visitors the opportunity to visit O.C. Fisher Lake on a more frequent basis. Last year alone, San Angelo State Park received 41,643 visitors (TPWD 2004).

Numerous events are held within the study area. The Texas Ornithological Society conducts annual Christmas bird counts. ASU also uses the study area for annual bird counts, as well as for studies on mammals, reptiles, bats and range management classes. Medieval, military and other living history re-enactments are routinely held under the large pecan trees along the North Concho River at the confluence of Bald Eagle Creek and the North Concho River. The Boy Scouts of America and Girl Scouts of the USA hosts biennial events attracting thousands of Scouts and leaders to San Angelo State Park. Nearly one-thousand school children of all ages utilize the area for field trips annually. Various equestrian trail rider, mountain bike, and triathlon associations take advantage of the San Angelo State Park trail system for races and fun rides throughout the year. Other groups commonly utilizing the area include, San Angelo Convention and Visitors Bureau, San Angelo Recreation Department, Concho Valley Gymnastics, Adult Day Care, and RV Clubs.

Friends of San Angelo State Park, a non-profit organization comprised of 150 members and in existence for 6 years, is extremely supportive of the state park and its resources. The organization's mission statement includes 1) ensuring the future of the park, 2) enhancing the quality of education, interpretive and recreational opportunities, 3) recruiting and organizing volunteers, and 4) soliciting and administering gifts and endowments for the park. To date, the organization raises an average of $8,000 per year and received a grant of $30,000. (Friends of San Angelo State Park 2004). Hundreds of volunteers from Goodfellow Air Force Base annually perform lakeshore and trail cleanups. Various volunteers construct, install and maintain nesting boxes, benefiting wood ducks, black-bellied whistling ducks, and various owls.

**Technical Recognition.** The O.C. Fisher Lake Ecosystem Restoration Project is a very significant environmental resource, as is evidenced through its technical recognition. The project contains a high level of biodiversity and uniqueness and contains scarce and declining resources.

**Biodiversity.** NatureServe, a non-profit organization that is the leading source of scientific information about rare and endangered species and threatened ecosystems, states in its 2002 report, States of the Union: Ranking America's Biodiversity, Texas ranks second to California in terms of overall biodiversity nationwide. It has the highest number of bird and reptile species and second highest number of plants and mammals. It also has the 3$^{rd}$ highest rate of endemism (species unique to Texas) and has the 4$^{th}$ highest number of extinct species (NatureServe 2002).

Lands within the study area include aquatic, riparian and transitional habitats offering a high level of biodiversity. Bottomland hardwoods and associated aquatic habitats support approximately 116 species of fish, 31 species of amphibians, 54 species of reptiles, 273 species of birds, and 45 species of mammals (Fentress 1986). The ecosystem restoration project contains 86.2 acres of undisturbed bottomland hardwood community, and restoration of an additional 160.4 acres, will significantly benefit the large majority of these bottomland hardwood wildlife species.

The state of Texas lies directly in the center of the Central Flyway for migrating birds. Over 300 species of birds are listed as Nearctic-Neotropical migrants in North America, and over 98% of those have been recorded in Texas. Meaning, of the more than 600 species of birds documented in Texas, 54% of them are neotropical species which depend upon Texas to provide habitat for nesting or migration, and many of those are dependent upon west central Texas riparian areas specifically (Smithsonian Migratory Bird Center). Tens of millions of neotropical migrants pass through the state each year. TPWD reports use of the study area by 350 bird species since the reservoir has been in operation (TPWD 2004), including aquatic, riparian, and terrestrial bird species. Stop-over sites for migratory birds in arid areas of the United States are restricted to small defined habitats along shelter belts, hedgerows, desert oases and riparian corridors. These areas are especially significant in west central Texas because they are limited due to their very nature. In order to maintain migratory and non-migratory bird populations in Texas, it is vital that resources within federally owned lands exist in their native habitats. The significance of conserving, improving, and restoring habitat for migratory birds, game and nongame species, has been established by the Fish and Wildlife Conservation Act, Migratory Bird Treaty Act, USFWS List of Migratory Nongame Birds of Management Concern, USFWS Migratory Bird Plan, Executive Order 13112, and the MOU signed with PIF. Table 12 provides a partial list of bird species likely to benefit from restored habitats.

**TABLE 12. Partial List of Bird Species of Tom Green County Which May Benefit from Restored Habitats.**

| Common Name | Scientific Name | Habitat |
|---|---|---|
| Swainson's thrush | *Catharus ustulatus* | Riparian woodlands |
| Rusty blackbird | *Euphagus carolinus* | Riparian woodlands |
| Swainson's warbler | *Limnothylypis swainsonii* | Riparian woodlands |
| *Red-headed woodpecker | *Melanerpes* | Riparian woodlands |
| Swamp sparrow | *Melospiza georgiana* | Riparian woodlands |
| Song sparrow | *Melospiza melodia* | Riparian woodlands |
| Kentucky warbler | *Oporornis formosus* | Riparian woodlands |
| Northern parula | *Parula americana* | Riparian woodlands |
| Rose-breasted grosbeak | *Pheucticus ludovicianus* | Riparian woodlands |
| Scarlet tanager | *Piranga olivacea* | Riparian woodlands |
| American Woodcock | *Scolopax minor* | Riparian woodlands |
| Barred owl | *Strix varia* | Riparian woodlands |
| Carolina wren | *Troglodytes troglodytes* | Riparian woodlands |
| Red-eyed vireo | *Vireo olivaceus* | Riparian woodlands |
| Bullocks oriole | *Icterus galbula* | Riparian and upland woodlands |
| *Olive sparrow | *Arremonops rufivirgatus* | Riparian and upland woodlands |
| *Vermillion flycatcher | *Pyrocephalus rubinus* | Riparian and upland woodlands |
| *Yellow-billed Cuckoo | *Coccyzua americanus* | Riparian & upland woodlands |
| House wren | *Troglodytes aedon* | Riparian woodlands & uplands understory |
| *American bittern | *Botaurus lentiginosus* | Perennial waterways |
| *Peregrine falcon | *Falco perginus* | Perennial waterways |
| Violet-green swallow | *Tachycineata thalassina* | Perennial waterways |
| Bank swallow | *Riparia riparia* | Perennial waterways |
| *Least grebe | *Tachybaptus dominicus* | Perennial waterways |
| Tree swallow | *Tachycineata bicolor* | Perennial waterways |
| Northern waterthrush | *Seiurus noveboracensis* | Perennial waterways, edge of flowing streams |
| Belted Kingfisher | *Ceryle alcyon* | Intermittent and perennial waterways |
| Common Snipe | *Capella gallinago* | Marshes, flooded meadows, fields |
| Red-winged blackbird | *Agelaius phoeniceus* | Marshes, perennial waterways, riparian woodlands |
| Western meadowlark and /or eastern meadowlark | *Sturnella magna* and/or *S. nealecta* | Prairies |
| Scissor-tailed flycatcher | *Muscivora forficata* | Prairies |

*Species from USFWS List of Migratory Nongame Birds of Management Concern for Region 2. Source: Birds and Other Wildlife of South Central Texas: A Handbook. Edward A. Kutac and S. Christopher Caran

Several Federal and Texas species listed as endangered or threatened species that may potentially benefit from implementation of this restoration plan. The restoration plan will restore the hydrological regime within the study area, creating a significant increase in the riverine habitat, quantitatively and qualitatively. Although the Concho water snake, federally listed as threatened with designated critical habit, has not been documented within the study area, restored base flows within the North Concho River will restore the river to a free-flowing stream and its shallow riffles and rocky substrate may once again serve as habitat for the Concho water snake.

The potential also exists to benefit the black-capped vireo, federally and state listed as an endangered species, with implementation of this restoration plan. The bird is a habitat specialist and nests in mid-successional brushy areas. Currently, black-capped vireos do not utilize the area due to lack of suitable habitat. With restoration, vegetation along the riparian areas adjacent to riverine habitat may advance through a successional stage as suitable habitat for black-capped vireos. Prescribed fire will be utilized to maintain the restoration project and as a result, the potential exists that some of the areas will remain in the successional stage conducive for black-capped vireos. Whooping crane, federally and state listed as an endangered species, could utilize the aquatic habitat during its migration, but migratory patterns of the whooping crane have not been documented through the study area. The bald eagle, federal (de-list pending) and state listed as a threatened species, will benefit from increased aquatic habitat for foraging, especially during winter months. The American peregrine falcon, state listed as endangered, will benefit from the conversion of transitional lands from shrubland to grassland. The falcon prefers open country, especially along rivers and lakes. The Texas horned lizard, state listed as threatened, may also benefit, as it prefers flat, open terrain with sparse plant cover, especially in sandy, rocky, or loamy soil. The restoration project will remove the dense shrublands and vegetation within some areas, due to the rocky substrate, will only contain scattered clumps of grass, a preferred habitat for the Texas horned lizard. The lizard will also benefit from some of the early successional stages of the restoration project as dense stands of invasive brushy species are removed and restored as grassland.

**Scarcity/Trends.** Riparian forests, especially those in the South, were designated in 1995 as a nationally endangered ecosystem (Noss et al. 1995). It is estimated that less than 40% of the original bottomland hardwood ecosystem in Texas still remains, with only a few small isolated patches of old growth scattered amongst the floodplains of the eastern third of the state (Frye 1986). Only a small percentage of undisturbed bottomland hardwood communities exist within the O.C. Fisher Lake region and the removal of the hydrology component supporting them by invasive brushy species continues their demise. It is critically important to restore the ecosystem within the study area in order to retain the existing 89.4 acres of undisturbed bottomland hardwood community and restore an additional 160.4 acres.

Not only is riparian habitat scarce and declining, but the aquatic habitat, from which the riparian habitat depends upon for sustainability, is also becoming increasingly scarce and declining. The primary tributary of O.C. Fisher Lake, the North Concho River, generally provided continuous perennial flows from 1925 to 1959, but now only small areas of water impoundments replenished solely by major storm events and minor sporadic stream flow exist (UCRA 1998). Aquatic and riparian habitats within the study area and along the North Concho River above the study area are historically supported by numerous perennial flowing springs. TPWD staff working within the study area report that several of the 20 springs within the study area no longer flow and remaining springs have progressively reduced their flow.

Native prairie within the study area is also highly degraded and scarce. Native prairie has probably been degraded more than any other habitat type in Texas. The U.S. Biological Service claims a 99% loss because of introduced grasses, overgrazing, urban development, and lack of fire (Noss et al. 1995). Approximately 95% of the transitional lands within the study area are altered from historical native prairie to a shrubland dominated by dense stands of mesquite and prickly pear.

As native habitat declines and degrades, corresponding declines in fish and wildlife species result. Diversity of neotropical migratory birds have declined in numbers for several decades. Recently it has been recognized that the loss, fragmentation, and degradation of stop-over habitat is potentially the greatest threat to the survival and conservation of neotropical birds.

The significance of protecting and restoring declining species and their habitat is established with both national and state laws and funds. The Endangered Species Act of 1973 (ESA), as amended, "provides a means whereby the ecosystems upon which endangered and threatened species depend may be conserved, and to provide a program for the conservation of these species." The Department of the Interior, acting through the USFWS, is responsible for the protection of most threatened and endangered species. The Texas Endangered Species Act, also enacted in 1973 gave TPWD the authority to establish a list of fish and wildlife that are endangered or threatened with statewide extinction. The Nongame and Endangered Species Conservation Fund of Texas enables Texas Parks and Wildlife Department to contribute to ongoing education, research and management activities for the conservation, restoration, research, and regulation of all nongame species and their habitats.

**Connectivity.** The riparian corridors of west central Texas provide an opportunity for the birds to replenish fat reserves, provide shelter from predators and water for re-hydration prior to continuing, what is for most neotropicals, a trip of over 1000 miles one-way. For most migratory birds, the region surrounding O.C. Fisher Lake is located towards the end of a long flight during fall migration and provides the vital link between having enough fat reserves to complete the trip or perish. The aquatic habitat and riparian habitat afforded within the study area is vital for those migratory bird species dependent upon surface water and associated riparian habitat because surface water in west central Texas is extremely limited (Woodin et. al. 1998).

Significant connectivity benefits will be realized within aquatic and riparian habitats along the North Concho River as the result of full implementation of the O.C. Fisher Lake Ecosystem Restoration Project. The benefits of the on-going North Concho River Brush Control Project along the North Concho River above the study area are already evident in that flow has returned to springs which lacked flow for years and base flow is returned to portions of the river which were generally dry for years (UCRA 2004). The project is in its sixth year and its purpose is to enhance the amount of water flowing from the North Concho River watershed through brush control on 432,000 acres, approximately half of the entire river's watershed. Currently, 295,510 acres of brush have been treated and treatment is continuing with additional state funding. Landowners participating in the program must cost share with the State, funding 30% of the cost (TSSWCB 2004). The landowners also sign a ten-year agreement with the state.

With full implementation of the restoration project, the benefits of both the North Concho River Brush Control Project and the O.C. Fisher Lake Ecosystem Restoration Project will combine forming a greater environmental benefit than that which would be realized individually. The improved aquatic and riparian habitats of the North Concho River Brush Control Project along

approximately 70 miles of the North Concho River above the study area will combine with the restored aquatic and riparian habitats along approximately 6.4 miles of the North Concho River within the study area, forming contiguous restored and improved aquatic and riparian habitats along approximately 76.4 miles of the North Concho River. Large contiguous habitats provide greater wildlife habitat value than small, fragmented habitats of equivalent size.
Without full implementation of the restoration project, base flow restored within the North Concho River by the North Concho River Brush Control Project will be lost to the invasive brushy species existing within the study area as the base flow enters the study area. Most of the base flows will be lost to the groundwater table through ground percolation and draining into dry springs along the riverbed within the study area. The temporary rise of the groundwater table will then be depleted by invasive brushy species and their phreatophytic nature.

**Total Project Costs.** The total project cost is comprised of all expenditures for the feasibility study producing the Detailed Project Report, the plans and specifications phase, and construction phase. Tables 13, 14, and 15 display a summary of the costs associated with the plans and specifications phase and the construction phase respectively. The total project cost to implement the recommended plan is $3,863,920 based upon actual costs incurred in previous years for similar work within the local area, previous federal projects and cost estimates provided by local contractors. Some construction cost estimates required adjustment from those contained previously in this report so as to reflect the most accurate cost estimates available. The average annual operation and maintenance cost is estimated to be $25,372 based on an interest rate of %5.375.

**TABLE 13. Estimated Total Project Costs.**

| Items | | Estimated Costs |
|---|---|---|
| Feasibility Study Phase | | $ 215,000 |
| Plans and Specifications Phase | | $ 253,800 |
| Lands, Easements, Rights-of-Way, Relocations, Disposal Areas | | $ 0 |
| Construction | Contract | $ 2,484,200 |
| | Supervision and Administration | $ 205,000 |
| | Engineering During Construction | $ 0 |
| | Interest During Construction | $ 266,500 |
| | Monitoring & Adaptive Management | $ 155,000 |
| | Contingency (10%) | $ 284,420 |
| Total Project Cost | | $ 3,863,920 |
| Average Annual Operation and Maintenance | | $25,372 |

**TABLE 14. Plans and Specifications Phase Costs.**

| Items | Estimated Costs |
|---|---|
| Plans and Specifications | $ 30,000 |
| Hazardous, Toxic and Radioactive Waste On-site Survey | $ 2,000 |
| Cultural Resources Survey | $ 161,800 |
| Contract Advertisements and Awards | $ 60,000 |
| Total Plans and Specifications Phase Cost | $ 253,800 |

**TABLE 15. Estimated Construction Costs.**

| Items | Estimated Costs |
|---|---|
| Saltcedar Removal | $ 249,400 |
| Saltcedar Removal – Follow-up Treatment | $ 5,400 |
| Willow Baccharis Removal | $ 169,300 |
| Willow Baccharis Removal - Follow-up Treatments | $ 56,400 |
| Mesquite Removal | $ 1,116,500 |
| Mesquite Removal – Follow-up Treatments | $ 139,800 |
| Prickly Pear Removal | $ 119,600 |
| Fence Construction | $ 108,600 |
| Firelane Construction/Maintenance/Prescribed Burns | $ 46,500 |
| Riparian Woodland Plantings | $ 472,700 |
| Monitoring and Adaptive Management | $ 155,000 |
| Supervision and Administration (S&A) | $ 205,000 |
| Contingency (10%) | $ 284,420 |
| Interest During Construction | $ 266,500 |
| Total Construction Cost | $ 3,395,120 |

## * ENVIRONMENTAL EFFECTS

**Existing Project and Land Use.** The proposed project will not have any adverse impacts to project or land use in the area. Land use authorized under existing leases will remain in effect. Improved streamflow and increased native vegetation diversity will significantly improve land use. It is hoped that the proposed restoration project will serve as a model for landowners with lands under similar degraded conditions and demonstrate the positive environmental benefits that may be achieved through restoration.

**Soils.** The recommended plan will utilize the qualities of existing soils to develop aquatic, riparian woodland and transitional habitats. Tree and shrub planting within riparian woodland habitat is expected to cause extremely minimal disturbance to the soil and then only in the immediate vicinity of the selected planting sites. Trees and shrubs will be planted as seedlings, greatly reducing soil disturbance as compared to plantings of larger trees and shrubs. As willow baccharis and saltcedar are removed, soil may be exposed for a brief period but herbaceous vegetation should reestablish readily. Safeguards to reduce soil erosion will be implemented as necessary if the potential for erosion exists, such as sloped elevations and lack of ground cover .

Mesquite removal through excavation presents the most soil disturbance of the restoration project, creating holes approximately three to four feet wide, sloping from the edge to about 18 inches deep in the middle. Excavated soils will remain immediately adjacent to the hole and over time the holes will gradually recapture the soil. Safeguards to reduce soil erosion will be implemented as necessary if the potential for erosion exists, such as sloped elevations and lack of ground cover.

**Aquatic Habitat and Species.** No adverse impact to the aquatic habitat or aquatic species is anticipated from implementation of the proposed project. No work will be performed within existing aquatic habitat containing surface water. Because the restoration project involves excavation adjacent to surface water, there is some potential for temporary adverse impacts from sediment deposition within streambeds. Safeguards to reduce soil erosion will be implemented as necessary if the potential for erosion exists, such as sloped elevations and lack of ground cover. As the restoration project progresses, the hydrology component so lacking within the ecosystem will drastically improve, increasing available surface water and improving water quality. Vegetation along adjacent riparian areas would provide shade to maintain water temperatures within ranges optimal for the growth and development of aquatic organisms.

**Wetlands.** No wetlands are indicated within the study area on National Wetland Inventory (NWI) maps. Small areas adjacent to existing springs and tributaries may function marginally as wetlands. Restoring the hydrology within the ecosystem may transform these to a more aquatic habitat, but overall, the restoration project would improve the quantity and quality of any wetlands found within the study area.

**Terrestrial Habitat and Species.** There will be no adverse impacts to the terrestrial resources in the proposed project area from implementation of the recommended plan. Existing terrestrial habitat will be restored from the dominant degraded shrubland condition to its historical condition dominated by grass species with scattered tree mottes. Wildlife diversity will increase within the study area significantly.

**Threatened and Endangered Species.** The proposed restoration project was reviewed by the USFWS and TPWD. The Planning Aid Report provided by USFWS reviewed the potential impact of the restoration project upon endangered and threatened species within Tom Green County. The report states that due to lack of suitable habitat and/or location, most of the species are not expected to be found within the study area. The report provided a discussion of two endangered species which may occur within the study area, the Concho water snake and the black-capped vireo, but concluded that it is unlikely that either species currently utilize the study area (USFWS 2004). Potential exists that the improved habitat condition derived during and upon implementation of this restoration may benefit most of the state and federal listed endangered or threatened species, including the Concho water snake, black-capped vireo, American peregrine falcon, bald eagle, whooping crane (migration), and Texas horned lizard.

**Air Quality.** No significant adverse impacts to air quality would occur from implementation of the proposed project.

**Water Quality.** The recommended plan has very little potential for adversely impacting water quality within O.C. Fisher Lake, North Concho River, Pott Creek and Turkey Creek on a temporary basis. As willow baccharis and saltcedar are removed, soil may be exposed for a brief period but herbaceous vegetation should reestablish readily. Tree and shrub seedling planting within riparian woodland habitat will cause extremely minimal disturbance to the soil. Safeguards to reduce soil erosion will be implemented as necessary if the potential for erosion exists. As the restoration project progresses and natural vegetative succession takes place, improved water quality will result because total suspended and dissolved solids will be reduced. Grass and forb species will create a thicker herbaceous layer offering greater protection from erosion. Additionally, high chloride levels due to salt exudation of saltcedar will drop as saltcedar is removed from the ecosystem.

**Archeological and Cultural Resources.** The richness of cultural resources within the study area requires special consideration. The SHPO reviewed the restoration project and provided recommendations with which to follow to prevent adverse impacts upon the cultural resources within the study area. Cultural resource surveys will be conducted within those areas identified as having medium to high potential to contain cultural resources before mesquite removal will take place. Where sites are identified, impacts would be minimized as approved by the SHPO by the use of hydraulic shearing with herbicide application instead of the use of an excavator. Vegetative plantings will involve planting only seedlings within riparian woodland as approved by SHPO. (State Historical Preservation Office 2003).

**Hazardous, Toxic and Radioactive Waste.** No restoration project work will be conducted within identified hazardous, toxic, or radioactive waste locations within the study area. Only one documented environmental condition exists, an aboveground storage tank located within a maintenance yard where no work will be performed.

USACE will conduct an on-site visit to verify that any environmental conditions will not impact proposed restoration work.

**Herbicide Use.** Implementation of the recommended plan requires use of herbicides in order to provide the most cost effective and efficient means to remove specific invasive vegetative species. All herbicides are approved for use by the Environmental Protection Agency. Herbicide application will only be performed by applicators who are licensed or certified by the state and will be done in strict compliance with herbicide labels. All applications would be coordinated with the Upper Colorado River Authority, City of San Angelo, Texas Parks and Wildlife Department and USACE.

Herbicides will be selected based upon being the most environmentally friendly, yet effective on the invasive species. This report references specific herbicides; however, if future herbicides will better suit the project's needs, they will be utilized instead.

Initial herbicide applications will be conducted through the use of helicopters, flying at the lowest possible height, which permit accurate herbicide placement to target vegetative species and minimize overspray and vapor drift. Helicopters will be equipped with special application booms to minimize vapor drift potential. Areas adjacent to private property will only be treated when wind direction will prevent potential spray drift towards private property.

With exception noted below for *Surmount*, potential detrimental effects to fish and wildlife are not published. Grazing animals are present within some treated areas and some herbicide labels contain precautions with herbicide use on lands where grazing takes place. These precautions will be considered and followed as deemed necessary by the lessee.

***Habitat.*** Saltcedar will be treated with *Habitat* applied in September. The herbicide is approved for application to public waters for control of aquatic weeds; however, water application is not required because saltcedar does not grow in water and application is only necessary to the water's edge. Although application to surface water is not intended, the potential exists that inadvertent overspray of water may occur. As a precaution, potable water intake would be turned off and the dam operational gates would be closed prior to application of *Habitat* and remain so for a minimum of 48 hours after completion of application, as directed for specific applications over water.

Other vegetative species may be killed or damaged should *Habitat* come into contact with them, including aquatic and terrestrial species. Very little potential exists for damage to vegetative species within the water because of the accurate herbicide placement. Due to the thick monoculture habitat of saltcedar and subsequent lack of vegetative diversity, potential damage to non-target species is very unlikely, with black willow being the exception. Saltcedar exists adjacent to, and within, areas containing black willow and black willow will likely be inadvertently treated. It is believed that the trees will only suffer leave burn and most will survive.

***Weedmaster.*** Willow baccharis will be treated with *Weedmaster* in April. *Weedmaster* is for terrestrial use and not to be used where surface water is present. Buffers will be established around surface water to prevent inadvertent overspray into surface water. Other vegetative species are susceptible to *Weedmaster*, but potential damage to non-target species is very unlikely because willow baccharis grows in thick monocultures and the areas lack vegetative diversity.

***Surmount.*** *Surmount* will be used in late summer or early fall to treat dense stands of prickly pear in limited areas due to its potential for leaching through the soil into shallow groundwater and its toxicity to fish. Prickly pear treatment will only be performed within transitional habitat and it will not be used in areas adjacent to surface water, including known springs (flowing or non-flowing) or areas susceptible to run-off.

Other broadleaf species are also susceptible to *Surmount* at very low concentrations. As with the other invasive vegetative species, prickly pear dominates the treated areas and few other vegetative species are found there. Trees can be affected by leaf uptake of the herbicide and will not be used in areas containing desirable trees. The herbicide exhibits some residual soil activity to newly emerging susceptible plants so the effect of the herbicide re-establishing any susceptible vegetative species within these treated areas may be delayed a few months. Adjacent seed sources are sufficient to re-establish vegetation within the treated areas.

**Recreational, Scenic and Aesthetic Resources.** The recommended plan will have extremely significant beneficial impacts upon the recreational, scenic and aesthetic resources within the study area. Restoring the hydrology within the ecosystem is predicted to increase surface water within the lacustrine and riverine habitats and will in-turn increase the recreational opportunities available to the public. Existing conditions render boat ramps and swimming areas useless, but the increased shoreline resulting from the project would increase opportunities for boating and swimming. With the increased lacustrine and riverine habitat, opportunities for fishing, hunting, birdwatching, wildlife viewing, and sight-seeing will also increase. The habitat through which existing recreational trails traverse will offer significantly improved scenic and aesthetic resources for the public.

**Socioeconomic Conditions.** The restoration plan will create positive socioeconomic impacts within San Angelo and local communities, as well as Tom Green County as a whole. San Angelo Chamber of Commerce reports that a significant portion of local revenues are derived from tourism (San Angelo Chamber of Commerce 2003). As lacustrine and riparian habitats increase, recreational opportunities will also increase and benefit the local areas. An increased lake level will provide a more reliable water supply for San Angelo, and San Angelo and the surrounding areas will derive positive socioeconomic benefits.

The recommended plan is consistent with state and federal government initiatives to improve water quality and conserve/improve native habitats. It is also consistent with the North American Waterfowl Management Plan to preserve and increase North America's waterfowl population.

**Cumulative Impact Analysis.** Construction of the reservoir and historical land management practices, prior to leasing, within the study area played a contributing role in the establishment of invasive brushy species and prickly pear. Native vegetation within areas which were overgrazed and/or wildfire was suppressed have contributed to an environmental pallet favorable for their proliferation. Although some limited invasive brushy species removal occurred in the past, lack of resources prevented control on a large scale basis.

Reasonably foreseeable future actions on or near the study area are predicted to remain much the same. The lands are owned by USACE in perpetuity and are leased to ASU and TPWD through separate license agreements, with exception of the dam and associated areas. These entities promote wise land stewardship and both USACE and the lessees intend to renew leases upon expiration. Use of adjacent and surrounding lands is also predicted to remain the same.

Grazing takes place within both leased areas under existing leases and is anticipated to continue in the future. ASU utilizes grazing for education and research purposes and TPWD conducts limited grazing of "showcase" livestock (longhorns and bison) as an enhancement to recreation. Fence construction required for the recommended restoration plan will not interfere with current and future grazing.

Grazing and prescribed burning occurs within large tracts of the leased lands as a component of natural resource management. These land management techniques occurred historically, and returning grazing and prescribed burning to the ecosystem promotes and sustains the lands to a more natural and historical condition. Vegetative condition is monitored by natural resource staff of the lessee and USACE to ensure proper management. However, under current conditions, the effectiveness of fire and managed grazing as management tools is somewhat constrained by inadequate grass cover and the proliferation of prickly pear. The proposed project is expected to enhance the effectiveness of future grazing, prescribed burning, and monitoring in promoting sustainable ecological conditions at the project site.

Since reservoir construction, recreation has been a major mission of O.C. Fisher Lake. O.C. Fisher Lake affords many recreational activities, including camping, picnicking, fishing, hunting, hiking, wildife viewing, and boating activities as the lake level allows. These recreation opportunities will remain available in the future with the lessees' intent to renew the leases upon expiration. In the future upon completion of the restoration project, recreational opportunities will be enhanced. Increased surface water within the study area (lake and tributaries) will provide increased opportunities for water-related recreation. Non-water related recreational activities are predicted to remain unchanged or increase with lands restored to a more historical condition.

Benefits of the North Concho River Pilot Brush Control Project within the watershed of O.C. Fisher Lake are recognized through increased base flows of the river within the study area. Landowners participating in the brush control project sign a ten-year agreement for participation in the program. Combination of the brush control project and the completed restoration project are expected to have a synergistic and cumulative effect restoring the natural hydrology within the study area.

## PROJECT IMPLEMENTATION

**Plans and Specifications.** As per 21 March 2005 memorandum issued by Southwestern Division, formal engineering plans and specifications are not required and an abbreviated Plans and Specifications will take place. The District will prepare a design report that includes sufficient scope, schedule, sketches, and cost to construct the project.

**Value Engineering.** As per 21 March 2005 memorandum issued by Southwestern Division, value engineering is not required. As per Division MEMO, value engineering is not required.

**Contracts.** Because construction of this restoration project must be flexible in nature, Indefinite Delivery/Indefinite Quantity (IDIQ) contracts will be utilized to the fullest extent possible. IDIQ contracts include a list of various work items available to the government for request. The government then selects the work items and quantities necessary to accomplish the task at hand. Separate IDIQ contracts will be procured for mechanical work, herbicide application, and fence work.

**Project Construction.** After funding is secured, construction contracts will be awarded and the project will promptly move to construction. Table 16 displays the anticipated construction schedule for the restoration project by fiscal year (October through September). Adaptive management will be utilized to its fullest to allow for schedule modification as vegetative response and site conditions dictate.

**TABLE 16. Anticipated Construction Schedule**

| Fiscal Year | Construction Items | Estimated Costs | Total Cost |
|---|---|---|---|
| 2006 | Saltcedar Removal<br>Monitoring/S&A/Contingency | $ 249,400<br>$ 41,543 | $ 290,943 |
| 2007 | Mesquite Removal<br>Willow Baccharis Removal<br>Prickly Pear Removal<br>Fence Construction<br>Monitoring/S&A/Contingency | $ 1,116,500<br>$ 169,300<br>$ 119,600<br>$ 108,600<br>$ 350,909 | $ 1,864,909 |
| 2008 | Firelane Construction/Maintenance/Prescribed Burn<br>Willow Baccharis Removal – Follow-up Treatment<br>Saltcedar Removal – Follow-up Treatment<br>Riparian Woodland Planting<br>Monitoring/S&A/Contingency | $ 23,300<br>$ 56,400<br>$ 5,400<br>$ 232,700<br>$ 88,885 | $ 406,685 |
| 2009 | Firelane Construction/Maintenance/Prescribed Burn<br>Mesquite Removal – Follow-up Treatment<br>Riparian Woodland Planting - Maintenance<br>Monitoring/S&A/Contingency | $ 23,200<br>$ 46,600<br>$ 120,000<br>$ 64,365 | $ 254,165 |
| 2010 | Mesquite Removal – Follow-up Treatment<br>Riparian Woodland Planting - Maintenance<br>Monitoring/S&A/Contingency | $ 46,600<br>$ 90,000<br>$ 54,212 | $ 190,812 |
| 2011 | Mesquite Removal – Follow-up Treatment<br>Riparian Woodland Planting - Maintenance<br>Monitoring/S&A/Contingency | $ 46,600<br>$ 30,000<br>$ 44,506 | $ 121,106 |

**Real Estate Plan.** The real estate necessary for this project is currently owned in fee by the United States of America and is under the primary jurisdiction of the Department of the Army as a part of O.C. Fisher Lake. Approximately 15,860 acres of project land will be leased to the non-Federal Sponsor, the City of San Angelo, to authorize their operation and maintenance responsibilities. Most of the land is under existing leases, which have been granted for compatible purposes. These leases will continue with amendments to accommodate the restoration project. Additional detail is contained in the Real Estate Plan.

**Monitoring and Adaptive Management.** An important component of project implementation is the monitoring of the ecosystem's response to the restoration measures. By connecting the ecosystem response to the restoration as well as the management measures, potential beneficial adaptations and adjustments to the project or management plan can be identified to ensure continued success of the project.

As is true with all vegetative restoration measures, complete success is rarely achieved. It is expected that vegetative removal methods may not be completely successful to the level desired and follow-up treatments may be required. Therefore, monitoring will be conducted following treatments to allow for timely follow-up treatments. It is also necessary to monitor the hydrological response as the restoration project progresses to allow for successful plantings within riparian woodland areas. The hydrological response prescribes optimum planting locations in order to ensure greater planting success. Environmental conditions can also negatively influence planting success after warranty period lapses and unanticipated additional plantings may be required.

Quarterly monitoring will be conducted throughout the restoration project and monitoring may be increased as the restoration process warrants. In this manner, proper and timely measures can be taken so that the predicted benefits of the project are fully achieved.

**Project Cooperation Agreement.** The Project Cooperation Agreement (PCA) is a contract between the Federal Government and the non-Federal partner describing the rights and responsibilities of each party during project implementation, including cost sharing, and upon completion of the restoration project. The PCA will be executed after the receipt of the commitment of Federal funds for construction and prior to the advertisement of a construction contract.

**Cost Apportionment.** As described in the PCA, the total project cost will be shared between the Federal Government and the non-Federal partner, known as the sponsor, on a 75% and 25% proportion, respectively. The sponsor's 25% share may consist of a credit for the value of any work-in-kind (WIK) services performed by the sponsor or its contractors. Credit for WIK is limited to 80% of the total sponsor's contribution, and cannot result in a reimbursement. Further, with regard to WIK, the sponsor will comply with applicable Federal and state laws and regulations, including the requirement to secure competitive bids for all work to be performed by contract. Contributions of cash, funds, materials or services from other than the sponsor or their contractor(s) may be accepted; however, such contributions will not be credited to the sponsor's share, but rather will be applied to the entire total project cost and therefore reduce both the Federal and sponsor's share. Table 17 displays the current estimate cost apportionment.

**TABLE 17. Cost Apportionment.**

| | |
|---|---|
| Total Project Cost | $ 3,863,920 |
| Federal Share | $ 2,897,940 |
| Sponsor's Share | $ 965,980 |
| | |
| Work-in-Kind | $ 68,800 |
| Cash Contribution | $ 897,180 |

**Work-in-Kind.** Work-in-kind are services or materials provided by the sponsor during the post-feasibility phase design and construction. At the present time, $68,800 of work in kind has been approved for design, management and fence work by Angelo State University.

**Operation and Maintenance.** Upon completion of the restoration project as described in the PCA, the sponsor, City of San Angelo, is responsible for all project operations and maintenance required to sustain project. Because operation and maintenance is dependent upon vegetative response throughout the project life, cost estimates must be derived from projected vegetative responses and actual vegetative responses may vary. The estimated average annual operation and maintenance cost is based upon those calculations contained within the incremental cost analyses and additional information acquired since the incremental cost analyses was conducted. Breakdown of the estimated cost is summarized as follows:

1) maximum $50,000 the first year for invasive vegetative species control to maintain invasive vegetative species in as close as possible to the post restoration project (construction) conditions so as to prevent encroachment, reduced by 5% every year thereafter (adjusted for inflation each year within the project life).
2) $1,000 per year associated with fence repair
3) $5,900 per year associated with prescribed burns prorated

The average annual operation and maintenance cost over the 25-year life of the project is estimated to be $25,372 using an interest rate of %5.375.

The sponsor is not required to expend more than the specified amount for annual invasive vegetative species control contained within the Operation, Maintenance, Repair, Replacement, and Rehabilitation Manual. It is expected that as the invasive vegetative species are monitored and controlled, annual control of invasive species will decrease over time.

Prescribed burns will be conducted on a rotational basis across the study area on a four to seven year frequency, dependent upon vegetative conditions, climatic conditions, and lessee management. Any invasive vegetative species found within riparian areas will be treated through herbicide application to individual plants and shall not be burned until such time that the growth state of planted woody vegetation can endure burns. The entire area will be routinely monitored for encroachment of invasive vegetative species. It is anticipated that the only invasive brushy species potentially requiring herbicide application for individual plants will be mesquite. The entire fence line will be routinely monitored and maintenance performed as necessary. Firelanes will also be maintained.

## COORDINATION OF RECOMMENDED PLAN

**View of Sponsor.** The City of San Angelo is identified as the non-Federal sponsor. The sponsor reviewed the draft Detailed Project Report and concurs with its findings. The City supports the recommended plan and provided a letter of intent to participate in the implementation of the recommended plan. TPWD and ASU will continue to work closely with the City of San Angelo during the implementation of the project.

**Results of Agency Coordination.** The team comprised of team members from USFWS, NRCS, TPWD, TAES, UCRA, TSSWCB, ASU and City of San Angelo developed potential restoration measures for consideration. USFWS, TPWD and USACE staff evaluated each measure on the basis of habitat benefit. In addition, information on water and air quality was obtained from the Texas Natural Resources Conservation Commission. A draft of this Detailed Project Report was sent to TPWD, USFWS, Environmental Protection Agency (Region 6), Texas Historic Commission and the Texas Natural Resources Conservation Commission for review and comment in accordance with coordination requirements as set forth by the National Environmental Protection Act (NEPA). Initial coordination with SHPO was conducted and recommendations were received. In accordance with SHPO's recommendation, a cultural resources survey will be conducted upon potential locations within the study area. Upon completion of the survey, a letter and report will be furnished to the SHPO for review and concurrence with the survey findings. USFWS supports the proposed project and provided a letter of support and a draft copy of their Coordination Act Report. Any comments received during the mandatory 30-day Public Notice period will be included in the final draft of this report, along with any letters received from the coordinating agencies.

**Regulatory Requirements.** USACE Fort District Regulatory Branch reviewed the recommended plan and determined the restoration activities recommended meet the conditions of Nationwide Permit 27, Wetland and Riparian Restoration and Creation Activities of Section 404 of the Clean Water Act. The State of Texas has issued a water quality certificate for Nationwide Permit 27 and therefore, no further coordination is required under Section 401. It was further determined that the restoration project will not involve activities subject to the requirements of Section 10 of the Rivers and Harbors Act of 1899. The proposed project is in compliance with Executive Order 11990 as it does not adversely impact nor result in any loss of wetland areas.

The State Historical Preservation Officer reviewed the restoration project and provided recommendations with which to follow to prevent adverse impacts upon the cultural resources within the study area. In addition to 39 recorded cultural resources sites, an additional 2,455 acres were identified to exhibit medium to high potential to contain cultural resources within mesquite removal areas. Cultural resource surveys would be conducted within these areas before mesquite removal would take place. Mesquite removal within potentially National Register eligible sites shall be minimized by the use of hydraulic shearing with herbicide application which may cause only minimal surface ground disturbance as the equipment operates across the landscape. Vegetative plantings would involve planting only seedlings within riparian woodland as approved by SHPO.

An Environmental Assessment (EA) was conducted and a draft Finding of No Significant Impact (FONSI) has been completed. The FONSI is expected to be signed by the District Commander in August 2005. Mitigation is not required for the restoration project.

## CONCLUSIONS

This Detailed Project Report documents the results of a study conducted under the authority of Section 1135 of the Water Resources Development Act of 1986, as amended (33 USC 2201). The purpose of the study was to identify the environmental degradation caused by the construction and operation of O.C. Fisher Lake, develop and evaluate measures to restore the hydrological function of the ecosystem and the historical habitat, and recommend a cost effective ecosystem restoration project for implementation that would result in functional stability, integrity, and sustainability of important ecological resources.

With full implementation of the recommended plan, perennial surface water would increase from 453.6 acres to 3,840.9 acres. The progressive loss of riparian woodland habitat would halt, conserving the existing 89.4 acres of remnant woodland, and an additional 160.4 acres of remnant woodland would be restored towards historical condition. The recommended plan would also restore 8,666.9 acres of habitat to a more natural, historic and sustainable condition which is critical to the hydrological regime of the ecosystem.

The total project cost is estimated at approximately $3,863,920 of which $965,980 is the local sponsor share. The report identifies significant positive environmental benefits upon full implementation of the recommended plan.

The City of San Angelo is identified as the non-Federal sponsor and reviewed the findings of this report. The city has offered their support for the recommended plan, including cost sharing, and agreed to assume responsibilities for all operation and maintenance upon completion of the restoration project in accordance with the PCA. A review of the information provided by the city regarding its financial capability to meet the cost sharing requirements found the City of San Angelo to exhibit the statue authority and the financial capability to provide the required non-Federal items of local cooperation.

An Environmental Assessment (EA) was integrated into the DPR to assess the potential impacts of the recommended plan. A public notice will be released July 2005 disclosing the availability of the EA. A Finding of No Significant Impact, if appropriate, will be issued after reviewing comments received.

Extensive coordination and input was obtained from the USFWS and TPWD during the development of the recommended plan and both agencies are supportive of the project. The recommended plan is consistent with state and federal government initiatives to improve water quality and conserve/improve native habitats. It is also consistent with the North American Waterfowl Management Plan to preserve and increase North America’s waterfowl population.

## RECOMMENDATIONS

I propose the recommended plan described in this Ecosystem Restoration Report be authorized for implementation under the authority of Section 1135 of the Water Resources Development Act of 1986, as amended, as a Federal project, with such modifications as in the discretion of the Chief of Engineers may be advisable. The total first cost of the project is estimated to be $3,863,920 which includes all costs through construction.

Prior to commencement of construction, local interests must agree to meet the requirements for non-Federal responsibilities as outlined in this report and future legal documents. The City of San Angelo has demonstrated that they have the authority and the financial capability to provide all non-Federal requirements for the implementation, operation, and maintenance of the project. The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works' construction program nor the perspective of higher review levels within the Executive Branch.

John R. Minahan
Colonel, Corps of Engineers
District Engineer

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**APPENDIX D**

**KICKAPOO CREEK AQUATIC ECOSYSTEM RESTORATION PROJECT**

# Concho River, Kickapoo, Texas

**Purpose:** The goal of the project would be to identify a recommended restoration plan that could restore the once perennial flows that existed within Kickapoo Creek prior to the landscape becoming dominated with dense, water-loving brush species.  In addition, the recommended plan could restore bottomland hardwood and transitional habitat within the watershed.

**Sponsor:**  Upper Colorado River Authority

**Congressional District:** Conaway TX-11

CESWF-PM-C 7 February 2005

FACT SHEET Updated Version

CONSTRUCTION, GENERAL

(CONTINUING AUTHORITY PROGRAM-SECTION 206)

PROJECT NAME AND STATE: Concho River, Kickapoo, TX

AUTHORIZATION: Section 206, Water Resources Development Act of 1996.

| SUMMARIZED FINANCIAL DATA: | Feasibility |
|---|---|
| Estimated Federal Cost | $ 370,000 |
| Estimated Non-Federal Cost | 0 |
| Total Estimated Project Cost | 370,000 |
| | |
| Allocation thru FY 2004 | 139,000 |
| Budget Request for FY 2005 | 0 |
| Allocation for FY 2005 | 0 |
| Budget Request for FY 2006 | 0 |
| Balance to Complete After FY 2006 | 76,000 |
| Amount That Could Be Used in FY 2006 | 165,000 |

LOCATION AND DESCRIPTION: The Kickapoo Creek watershed begins in northeastern Schleicher County and runs northeast (46 miles) to its confluence with the Concho River, two miles west of Paint Rock in northern Concho County. Paint Rock is the county seat of Concho County and is situated 220 miles southwest of Fort Worth and 30 miles east of San Angelo.

ALLOCATIONS FOR FY 2005: We do not anticipate receiving any funds in FY 2005.

APPLICATION OF THE AMOUNT THAT COULD BE USED IN FY 2006: FY 2006 funds would be used to complete an assessment of existing conditions within the watershed and begin plan formulation.

ISSUES AND OTHER INFORMATION: The goal of the project would be to identify a recommended restoration plan that could restore the once perennial flows that existed within Kickapoo Creek prior to the landscape becoming dominated with dense, water-loving brush species. In addition, the recommended plan could restore bottomland hardwood and transitional habitat within the watershed.

ADMINISTRATION POSITION: The Administration supports this project.

CONGRESSIONAL INTERESTS: Congressman Mike Conaway, TX-11.

## APPENDIX E

## STAKEHOLDER MEETING SUMMARIES
## AND ATTENDEE LISTS

Freese and Nichols

# MEMORANDUM

**TO:** Upper Colorado River Watershed Restoration and Management Plan Stakeholders

**FROM:** Freese and Nichols, Inc.

**SUBJECT:** Stakeholder Meeting Summary – June 28, 2005

**DATE:** July 8, 2005

On June 28, 2005, Freese and Nichols, Inc. (FNI) and the Colorado River Municipal Water District (CRMWD) held a Stakeholder Meeting at the CRMWD office in Big Spring, Texas. The purpose of the meeting was to discuss the Upper Colorado River Watershed Restoration and Management Plan as well as funding sources that can be utilized to implement the plan.

The meeting commenced with an introduction and a description of the purpose of the plan, during which Okla Thornton (CRMWD), John Grant (CRMWD), and Randall Howard (FNI) explained that this plan will seek to address water quantity and water quality issues in the watershed as well as habitat restoration relating to the delisting of the Concho water snake.

Bob Pine (U.S. Fish and Wildlife Service (USFWS)) provided a brief history of the listing of the Concho water snake and the requirements of the USFWS Biological Opinion for avoiding or minimizing impacts to the Concho water snake:

- September, 1986 – The Concho water snake was listed as a threatened species.
- December, 1986 – The original Biological Opinion was issued by the USFWS.
- June, 1989 – The critical habitat of the Concho water snake was identified.
- July, 2004 – The U.S. Army Corps of Engineers (USACE) reinstated consultation with the USFWS due to the emergency situation in the watershed caused by a limited water supply in the area. This limited water supply arose due to the 10-year drought and the implementation of the conditions in the original Biological Opinion.
- December, 2004 – The most recent Biological Opinion was issued which contained two requirements for avoiding or minimizing impacts to the Concho water snake while also taking into consideration the water supply crisis occurring in West Texas. One of these requirements is the development and implementation of a watershed restoration and management plan. Implementation of this effort should allow the Concho water snake to be delisted from the threatened species list.

The stakeholders were asked to briefly discuss changes in agricultural practices that could be causing water quantity and water quality crises in the watershed. It was mentioned that due to the lack of rainfall, there has been a depletion of grass from overgrazing, but generally landowners are involved in more aggressive land management practices than they were in the past.

## Related Projects

The panel was asked to discuss saltcedar control and/or habitat restoration projects that have been undertaken in and around the watershed. Chris Higgins (Texas State Soil and Water Conservation Board (TSSWCB)) and



Freese and Nichols, Inc. ◆ Engineers ◆ Environmental Scientists ◆ Architects
10814 Jollyville Rd., Bldg. 4 ◆ Suite 100 ◆ Austin, Texas 78759
(512) 451-7955 ◆ Fax (512) 451-7956

(TSSWCB)) and Okla Thornton (CRMWD) discussed the three-year, 10,000-acre saltcedar control project that will involve chemical and biological control of saltcedar stands:

- In 2005, this project will begin at Lake J.B. Thomas and continue to the confluence at Beals Creek; major tributaries that contain significant stands of saltcedar will also be targeted.
- In 2006, the spraying will continue down the length of the Colorado River.
- A future project will include the O.H. Ivie Reservoir, which is also being impacted by saltcedar.
- The chemical control will be followed by a biological control using Middle Eastern beetles. These beetles have an exclusive appetite for saltcedar and will hopefully control re-growth in the sprayed areas.
- Currently, the beetles are being kept in three separate containment areas near Big Spring, but the goal is to eventually create a nursery and include landowners in the biological control process.

Many of the stakeholders discussed the difficulty of measuring the success of saltcedar removal. The consensus of the stakeholders was that success must be measured over long periods of time, and large quantities of monitoring data must be collected.

Chuck Brown (Upper Colorado River Authority (UCRA)) mentioned a watershed-scale project that is being undertaken by the UCRA and the USACE, in which the goal is for Kickapoo Creek to be restored (150,000 acres) to perennial flow from its headwater to its confluence with the Concho River. This project is now in infancy stages.

## Possible Funding Sources

The stakeholders than began a discussion about possible funding sources for riparian practices and saltcedar control. Charles Coffman (National Resources Conservation Service (NRCS) Zone 1) mentioned the following programs:

- Wildlife Habitat Incentives Program – This program is a voluntary program for individuals who want to develop and improve wildlife habitat primarily on private land.
- Continuous Conservation Reserve Program – This program provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner.
- Environmental Quality Incentives Program – This program provides a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals.
- Grassland Reserve Program – This is a voluntary program which offers landowners the opportunity to protect, restore, and enhance grasslands on their property.
- Conservation Security Program – This is a voluntary program that provides financial and technical assistance to promote the conservation and improvement of soil, water, air, energy, plant and animal life, and other conservation purposes on Tribal and private working lands. This program is funded through Washington and administered at the local level. Watersheds in each NRCS zone are prioritized, and the money is allocated based on priority. If concerned organizations petition the NRCS, watersheds can possibly move up the priority list.

Becky Griffith (USACE) described a watershed restoration project that was recently adopted for the Bosque River Watershed. This project has not yet been funded, but could serve as an important example for this area. She also mentioned that the USACE does not have broad-scale programs, but they do have individual projects and an interest in restoration. There is a potential for having a watershed-wide project formed for the Upper Colorado River. Mike Martin (Bureau of Reclamation (BuRec)) also mentioned that the BuRec does not have broad-scale programs, but specific projects can be requested.

Following the mid-morning break, the stakeholders were asked to discuss non-governmental sources of funding for the implementation of this project, such as volunteer organizations. The following non-governmental sources were identified by the panel:

- National Wild Turkey Federation – This group has been involved in restoring riparian areas in the panhandle, and may be able to provide technical and financial assistance for this project.
- The Nature Conservancy Sustainable Rivers Project – This group is involved in restoring and preserving rivers across the country by acquiring, managing, and restoring crucial lands.
- The National Fish and Wildlife Foundation, Acres for America Program – This program is a partnership with Wal-Mart in which one acre of priority wildlife habitat will be conserved for every acre of Wal-Mart's current footprint as well as the company's future development over the next ten years.
- Cattle and Rancher's Associations – These organizations may be able to provide financial assistance for this project.

## Prioritization of Watershed Concerns

Following lunch, the panel was asked to prioritize the following watershed concerns:

- Saltcedar Control
- Brush Management
- Riparian Restoration
- Desalination
- Education

The consensus of the stakeholders was that saltcedar control, brush management, and riparian restoration to restore the Concho water snake habitat are linked to each other and will each require significant funding sources; however, these funding sources can possibly overlap.

Many stakeholders agreed that education and awareness to landowners must be increased, but there is a lack of technical on-ground help to carry out funded projects. The following groups were mentioned as possible sources for education to landowners:

- Texas Cooperative Extension (TCE) – This group has a direct connection to the landowners and could possibly provide educational assistance.
- TSSWCB – There are available field office guides that can possibly provide assistance, as well as grant money that can fund an individual to send out newsletters about issues concerning the watershed.
- Cattle and Rancher's Associations – These organizations can possibly contribute by mentioning the importance of watershed restoration and management programs in their newsletters.

The Stakeholder Meeting concluded with a reminder about the next meeting which will take place at the CRMWD office in Big Spring, Texas on August 9, 2005. Stakeholder participation and feedback will be greatly appreciated at this meeting as well.

CRMWD
Colorado River Municipal Water District

# UPPER COLORADO RIVER WATERSHED RESTORATION AND MANAGEMENT PLAN STAKEHOLDER MEETING ATTENDEE LIST JUNE 28, 2005

| | Name | Affiliation/Email/Phone |
|---|---|---|
| 1. | Fred W. Taylor | Llano Grande/(325) 458-2625 |
| 2. | Chris Higgins | TSSWCB/chiggins@tsswcb.state.tx.us |
| 3. | Kevin Wright | NRCS – Snyder |
| 4. | Bob Pine | USFWS – Austin |
| 5. | Becky Griffith | Corps of Engineers – Fort Worth |
| 6. | W.L. Metcalf | NRCS – Coke County |
| 7. | Charles Coffman | NRCS – Lubbock |
| 8. | Mike Martin | USBR – Austin |
| 9. | John Grant | CRMWD |
| 10. | Okla Thornton | CRMWD |
| 11. | Wade Kress | USGS/(325) 944-4600 |
| 12. | Jim Schiller | USGS |
| 13. | Greg Larson | TCEQ – Midland/glarson@tceq.state.tx.us/(438) 570-1359 |
| 14. | Randall Howard | FNI/rh@freese.com/(512) 617-3159 |
| 15. | Makenzie Vessely | FNI/mmv@freese.com/(512) 617-3140 |
| 16. | Patrick Garnett | FNI/png@freese.com/(512) 617-3148 |
| 17. | Eddy Spurgin | NRCS – Big Spring |
| 18. | Preston Irwin | NRCS – Big Spring |
| 19. | Chuck Brown | URCA – San Angelo |
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Freese and Nichols

# MEMORANDUM

**TO:** Upper Colorado River Watershed Restoration and Management Plan Stakeholders

**FROM:** Makenzie Vessely

**SUBJECT:** Stakeholder Meeting Summary – August 9, 2005

**DATE:** August 29, 2005

On August 9, 2005, Freese and Nichols, Inc. (FNI) and the Colorado River Municipal Water District (CRMWD) held a Stakeholder Meeting at the CRMWD office in Big Spring, Texas. The purpose of the meeting was to update the stakeholders on the progress of the Upper Colorado River Watershed Restoration and Management Plan and to discuss funding sources that can be utilized to implement the plan.

The meeting commenced with an introduction and a description of the purpose of the plan, during which Okla Thornton (CRMWD) and Randall Howard (FNI) explained that this plan will seek to address water quantity and water quality issues in the watershed as well as habitat restoration relating to the delisting of the Concho water snake.

Bob Pine (U.S. Fish and Wildlife Service (USFWS)) provided a brief history of the listing of the Concho water snake and the requirements of the USFWS Biological Opinion for avoiding or minimizing impacts to the Concho water snake:

- September, 1986 – The Concho water snake was listed as a threatened species.
- December, 1986 – The original Biological Opinion was issued by the USFWS.
- June, 1989 – The critical habitat of the Concho water snake was identified.
- July, 2004 – The U.S. Army Corps of Engineers (USACE) reinstated consultation with the USFWS due to the emergency situation in the watershed caused by a limited water supply in the area. This limited water supply arose due to the 10-year drought and the implementation of the conditions in the original Biological Opinion.
- December, 2004 – The most recent Biological Opinion was issued which contained two requirements for avoiding or minimizing impacts to the Concho water snake while also taking into consideration the water supply crisis occurring in West Texas. One of these requirements is the development and implementation of a watershed restoration and management plan. “The Corps and the District shall seek funds to study a methodology for riparian rehabilitation/restoration following saltcedar spraying and then seek funds and subsequently utilize these funds (if acquired) to implement the recommendations of the study.” Additionally, the CRMWD committed to do the following as part of its ongoing project: “The District will participate in a cooperative effort with the Corps, the Service, the U.S. Bureau of Reclamation, City of San Angelo, Upper Colorado River Authority, and the Tom Green County Water Improvement and Control District No. 1 to consider ways that will possibly augment instream flows in the Concho River downstream of San Angelo. In a June 14, 2004 information sheet, the District indicated an interest in being the local sponsor for a watershed study and presented a list of potential partners.” Implementation of this effort should allow the Concho water snake to be delisted from the threatened species list.



Freese and Nichols, Inc. ◆ Engineers ◆ Environmental Scientists ◆ Architects
10814 Jollyville Rd., Bldg. 4 ◆ Suite 100 ◆ Austin, Texas 78759
(512) 451-7955 ◆ Fax (512) 451-7956

Randall Howard (FNI) informed the stakeholders that issues such as saltcedar removal, watershed restoration, and landowner participation/education were identified at the first Stakeholder Meeting held on June 28, 2005, and that the purpose of this meeting was to discuss funding and specific agency cooperation. Okla Thornton (CRMWD) updated the stakeholders on the progress of the Texas State Soil and Water Conservation Board (TSSWCB) saltcedar removal project. Spraying will begin on August 15, 2005, and the agency has received permission from landowners to spray approximately 90% of the affected acreage.

## Related Projects

The stakeholders were asked to discuss the progress of invasive brush control projects that have been undertaken in and around the watershed. Cindy Breiten (Upper Pecos Soil and Water Conservation District #213) discussed the status of the Pecos River saltcedar removal project. At this time, a grant proposal has been submitted for more funding. Originally, this project received funding due to a nomination by the Governor. Natural Resources Conservation Service (NRCS) EQIP money was utilized, and all qualified landowners were approved. Most of the landowners were not interested in participating if they had to pay a portion of the costs, and a small minority would not participate at all. The spraying has been completed in several areas, but the project needs more funding to remove the dead saltcedar. Many of the stakeholders mentioned the importance of looking ahead in these brush control projects because removal of the dead saltcedar requires planning and funding as well. Michael McColloch (Pecos County Water Improvement District #3) mentioned that the Texas Forest Service should possibly be involved in the removal of the dead saltcedar.

Becky Griffith (USACE) discussed the status of the O.C. Fisher Lake Ecosystem Restoration Project. The Detailed Project Report and Integrated Environmental Assessment was issued in June 2005, and if the report is given final approval and funding, the USACE hopes to begin the project in January. This project will treat 15,000 acres around O.C. Fisher Lake to remove invasive brush species, but it will focus on brush management as a component for ecosystem restoration. The land surrounding O.C. Fisher Lake is government-owned, however, so landowner buy-in is not an issue. The USACE has taken the approach of overlapping the water needs of the City of San Angelo with the USACE's needs of restoration to get funding from the City of San Angelo for this project. Okla Thornton (CRMWD) expressed that receiving funding from the member cities of Odessa, Big Spring, and Snyder will not be an option for the Upper Colorado River Watershed project because the cities will be very reluctant to pay an additional fee above what they are already paying for the water they purchase from the Water District.

## Landowner Awareness/Education and Funding Issues

Many stakeholders expressed the need to increase education and awareness to landowners about participation in saltcedar control, brush management, and riparian restoration; however, many government entities such as the NRCS are short-handed and/or legally unable to actively promote and solicit grant programs. It was mentioned that some planning and funding should be allocated for an individual to monitor the dissemination of information by entities such as the Texas Cooperative Extension (TCE) and the Texas Parks and Wildlife Department (TPWD). Stakeholders from the Pecos River Ecosystem Advisory Committee stated that for their project, they sent postcards to landowners offering a video which described the saltcedar spraying process. Many landowners sent the postcard back requesting the video. It was also mentioned that one important issue which should be stressed to landowners in the educational materials is that good rangeland practices utilizing terraces do not necessarily mean sufficient runoff to the reservoirs because terraces hold water on the land.

The idea was mentioned that even if the cities of Odessa, Big Spring, and Snyder could not be expected to provide funding, they could possibly assist the CRMWD with educational programs, which would show their support of the project. Okla Thornton (CRMWD) stated that this option could be pursued. Ideas presented by the stakeholders for disseminating educational information were the following:

- direct mail-outs to landowners;
- a website with consistently updated information;

- the TPWD could provide pamphlets or booklets regarding this project when they are talking to landowners about other issues;
- a participating landowner in this area, who is willing to volunteer, could be designated to lead the effort and encourage others to participate;
- a presentation could be organized for the local congressmen and senators, possibly leading to federal or state funding and/or a proclamation;
- a symposium could be organized to discuss the successes of the project and how they relate to the environmental health of the watershed as a whole;
- school programs, like the Major Rivers Program, stressing the importance of water conservation in local area schools;
- local environmental organizations sponsoring an exhibit about the importance of the project; and
- forming a task force, possibly led by one of the member cities or the Water District, to meet on a regular basis to discuss the progress of the project.

Alan McGinty (TCE) mentioned that the TCE typically uses groups such as the Texas and Southwestern Cattle Raisers Association to disseminate information to landowners. They have also had support for brush control and saltcedar programs from groups such as Environmental Defense, the Sierra Club, and The Nature Conservancy. Environmental Defense has also provided funding for brush control projects in the Leon River Watershed.

Several of the stakeholders mentioned that getting agency and landowner support is the first step towards acquiring funding for the implementation of the plan. If the public is educated on the importance of the plan, and successes of the initial saltcedar removal can be quantified, funding will follow. Alan McGinty (TCE) mentioned the importance of forming political partnerships for this project to receive additional funding, especially for the O.H. Ivie Reservoir. Bob Pine (USFWS) stated that because this project involves the delisting of a threatened species, it could possibly be benefited by receiving national attention.

Following lunch, the Stakeholder Meeting concluded with closing remarks from Randall Howard (FNI) and Okla Thornton (CRMWD). The stakeholders were encouraged to continually provide ideas and feedback regarding the development and implementation of the Upper Colorado River Watershed Restoration and Management Plan.

Colorado River Municipal Water District

# UPPER COLORADO RIVER WATERSHED RESTORATION AND MANAGEMENT PLAN STAKEHOLDER MEETING ATTENDEE LIST AUGUST 9, 2005

| | Name | Affiliation/Email/Phone |
|---|---|---|
| 1. | Allan McGinty | TCE/a-mcginty@tamu.edu/(325) 653-4576 |
| 2. | Bob Pine | FWS/robert_pine@fws.gov |
| 3. | Okla Thornton | CRMWD |
| 4. | Becky Griffith | COE |
| 5. | Mark Newman | TCEQ – Region 8 – San Angelo |
| 6. | Michael Edmiston | TCEQ – Region 7 – Midland |
| 7. | Michael McColloch | PWID #3 |
| 8. | Ronnie Cooper | Pecos County WID #3 – Imperial |
| 9. | Terri Blackshear | Congressman Randy Neugenbauer |
| 10. | Michael Miller | Texas Parks & Wildlife |
| 11. | Cindy Breiten | Upper Pecos SWCD #213 |
| 12. | Patrick Garnett | FNI/png@freese.com/(512) 617-3148 |
| 13. | Randall Howard | FNI/rh@freese.com/(512) 617-3159 |
| 14. | Makenzie Vessely | FNI/mmv@freese.com/(512) 617-3140 |
| 15. | Eddy Spurgin | NRCS – Big Spring |
| 16. | Charles Coffman | NRCS – Lubbock |
| 17. | Steve Shrode | NRCS – Colorado City |
| 18. | Tommy Morris | Colorado City, Texas |
| 19. | Wade Kress | USGS – San Angelo/(325) 944-4600 |
| 20. | David Brown | USGS – Fort Worth |
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## APPENDIX F

## GOVERNMENT FUNDING DETAIL SHEETS

# Natural Resources Conservation Service
# Wetland Reserve Program (WRP)

### Eligibility Requirements

- This program's eligibility is unrestricted. State governments, county governments, city or township governments, nonprofits other than institutions of higher education, individuals, for profit organizations other than small businesses, and small businesses may apply.

### Grant Objectives

- The goal of this program is to provide technical and financial assistance to eligible landowners to address wetlands, wildlife habitat, soil, water, and related natural resource concerns on private lands in an environmentally beneficial and cost-effective manner. The program provides an opportunity for landowners to receive financial incentives to restore, protect, and enhance wetlands in exchange for retiring marginal land from agriculture.

### Specifics of Grant

Partnership proposals must satisfy the following requirements:

- they must address wetland creation and enhancement efforts on easements enrolled in prior years;
- how partners will contribute significantly to WRP technical assistance costs; and
- how assistance with managing easement projects will be provided.

The NRCS estimates this request for proposals may result in addressing wetland restoration, creation, enhancement, and easement management on approximately 5,000 acres. Proposals are accepted from all 50 states. The NRCS State Conservationists will submit the top two priority proposals based on state resource concerns and technical resource needs to the NRCS national headquarters. Complete proposals will be evaluated by an agency review board at the national level.

### Types of Assistance

- NRCS contributions cannot exceed 75 percent; however, additional funds may be acquired from other sources, including federal contributions. Contributions cannot exceed 100 percent of the projected cost of the practice.
- Participants may receive incentive payments from other partners, such as state, private, or nonprofit sources.
- There is no payment limitation for WRP cost-share agreements.

### Contact Information

Name: Leslie Deavers leslie.deavers@usda.gov
Phone Number: 202-720-1062
Websites: http://fedgrants.gov/Applicants/USDA/NRCS/2890/USDA-GRANTS-051705-001/Grant.html
http://www.nrcs.usda.gov/programs/wrp/

# U.S. Fish and Wildlife Service
# Landowner Incentive Program (LIP)

## Eligibility Requirements

The following are requirements for eligibility in this program:

- The proposed action by the landowner must contribute to the enhancement of at least one rare species or its habitat. Rare species include those species that are federally or state listed as threatened or endangered, or Federal Candidate Species not currently on the federal list.
- The landowner's property must be able to provide suitable habitat for a rare species. The natural movement or reintroduction of individuals onto that property must be feasible and the property must be within the historic range of the targeted species.
- The results of the action must be measurable. Therefore, the landowner must agree to allow biologists onto their property for a pre-agreement survey and periodic progress checks to assess the success of the project objectives.
- The landowner must be willing to sign a project agreement or management plan. Each agreement or management plan will be designed to meet the landowner's individual conservation and land use needs and objectives. Name, address, and taxpayer ID or Social Security Number (SSN) will be required for accounting purposes, but any other recording of information specific to the property is confidential by state law and not released without written permission from the landowner. Inability to complete management actions due to weather or other conditions beyond the landowner's control will be considered individually and rescheduled.

## Grant Objectives

- This program is designed to assist states by providing grants to establish or supplement landowner incentive programs that protect and restore habitats on private lands, to benefit federally listed, proposed or candidate species, or other species determined to be at-risk, and provide technical and financial assistance to private landowners for habitat protection and restoration.

## Specifics of Grant

- It is the goal of Texas' program to provide financial incentives that encourage landowners to help conserve rare species. The program is flexible and is open to all private landowners who have a desire to voluntarily manage for rare species on their land.

## Types of Assistance

- Project funding varies according to availability of LIP funds and individual merit of projects.
- Although there are no project duration limitations, results of management actions that can be documented in three years or less are preferred.
- The applicant should expect to contribute at least 25 percent of total project cost in materials or in-kind services.
- Payment schedules will be negotiated with the landowner to meet the objectives of the management plan.
- Receipt of final payment will be contingent on the landowner's fulfillment of the agreement and completion of the project.
- Landowners are expected to work with their biologist to document final results of the project.

## Contact Information

| | |
|---|---|
| Name: Bob Anderson | bob_anderson@fws.gov |
| Phone Number: | 505-248-7459 |
| Federal Website: | http://federalaid.fws.gov/lip/lip.html |
| Texas Website: | http://www.tpwd.state.tx.us/conserve/lip/ |
| TPWD e-mail: | conserve@tpwd.state.tx.us |

# Natural Resources Conservation Service
# Wildlife Habitat Incentives Program (WHIP)

**Eligibility Requirements**

Eligible lands for this program are:

- privately owned land;
- federal land when the primary benefit is on private or tribal land;
- state and local government land on a limited basis; and
- tribal land.

If land is determined eligible, the NRCS places emphasis on enrolling:

- habitat areas for wildlife species experiencing declining or significantly reduced populations;
- practices beneficial to fish and wildlife that may not otherwise be funded; and
- wildlife and fishery habitats identified by local and state partners and Indian tribes in each state.

**Grant Objectives**

- This is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land.
- It provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat.

**Specifics of Grant**

- WHIP agreements between the NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed.

**Types of Assistance**

- Federal contributions shall not exceed 75 percent of the cost of installing a practice.
- Additional funds may be acquired from other non-federal sources.
- A land use payment is not provided.
- Participants may receive incentive payments from other partners, such as state, private, or nonprofit sources.
- WHIP agreements are limited to $10,000 per agreement. However, the State Conservationist has the authority to waive this limitation if the agreement offers significant wildlife benefits worthy of granting a waiver.
- In no instance can a cost-share agreement be modified to extend beyond the maximum 10-year agreement period.

**Contact Information**


Name: Albert Cerna    albert.cerna@usda.gov
Phone Number:    202-720-9358
Website:    http://www.nrcs.usda.gov/programs/whip/

# U.S. Fish and Wildlife Service
# North American Wetlands Conservation Act (NAWCA) Small Grants

**Eligibility Requirements**

- The eligibility for these grants is unrestricted.

**Grant Objectives**

- The Small Grants program is intended to promote long-term wetlands conservation activities through encouraging participation by new grantees and partners who may not otherwise be able to compete in the Standard Grants program.
- The purpose of this program is to promote long-term conservation of North American wetland ecosystems, and the waterfowl and other migratory birds, fish, and wildlife that depend upon such habitat.
- Principal conservation actions supported by the NAWCA are acquisition, establishment, enhancement, and restoration of wetlands and wetland-associated uplands.

**Specifics of Grant**

- All wetland conservation proposals that meet the requirements of the NAWCA will be accepted.
- Funding priority will be given to projects from new grant applicants (individuals or organizations who have never received a NAWCA grant) with new partners, where the project ensures long-term conservation benefits. However, this does not preclude former NAWCA grant recipients from receiving Small Grants funding.
- The anticipated magnitude of wetlands and wildlife resources benefits that will result from project execution are important factors to be considered in proposal evaluation, as may be reflected in whether or not the Small Grants project is part of another or broader initiative. If uplands are included, there should be a reasonable balance between wetland and wetland-associated upland acreage.
- NAWCA grant money may neither be used nor matched to meet federal mitigation requirements or used to meet match requirements of other federal programs.

**Types of Assistance**

- Proposals must have a grant request no greater than $50,000. Proposals requesting more than $50,000 are ineligible for Small Grants program funding and should be submitted to the Standard Grants program.
- There is a 1:1 or greater non-federal matching requirement.

**Contact Information**

E-mail Address: nawca_smallgrant@fws.gov.
Phone Number: 703-358-1784
Websites: http://www.fws.gov/birdhabitat/nawca/USsmallgrants.html
http://fedgrants.gov/Applicants/DOI/FWS/FA/NAWCASM-05/Grant.html

The administrative unit for this project is likely the Lower Mississippi Valley Joint Venture or the Playa Lakes Joint Venture: http://www.fws.gov/birdhabitat/nawca/images/jvadminmap1104.jpg.

LMVJV contact:
Charles Baxter charles_baxter@fws.gov 601-629-6600

PLJV contact:
Mike Carter mike.carter@pljv.org 303-659-8750

# Natural Resources Conservation Service
# Environmental Quality Incentive Program (EQIP)

### Eligibility Requirements

- This is a voluntary conservation program for farmers and ranchers.
- Persons who are engaged in livestock or agricultural production on eligible land are encouraged to apply.

### Grant Objectives

- This program promotes agricultural production and environmental quality as compatible national goals.

### Specifics of Grant

- The EQIP activities are carried out according to an environmental quality incentives program plan of operations developed in conjunction with the producer, which identifies the appropriate conservation practice or practices to address the resource concerns. The practices are subject to NRCS technical standards adapted for local conditions.
- The local conservation district must approve the plan.

### Types of Assistance

- The EQIP offers financial and technical help to assist eligible participants installing or implementing structural and management practices on eligible agricultural land.
- Contracts with a minimum term that ends one year after the implementation of the last scheduled practices and a maximum term of ten years are required. These contracts provide incentive payments and cost-shares to implement conservation practices.
- The EQIP may cost-share up to 75 percent of the costs of certain conservation practices. Incentive payments may be provided for up to three years to encourage producers to carry out management practices they may not otherwise use without the incentive.
- However, limited resource producers and beginning farmers and ranchers may be eligible for cost-shares up to 90 percent. Farmers and ranchers may elect to use a certified third-party provider for technical assistance.
- Incentive payments will be made in an amount and level necessary to encourage a participant to perform the land management practice that would not otherwise be initiated without government assistance. Incentive payments will be limited to a maximum of three years.

Maximum payments are:
- $10,000 per person for any fiscal year; and
- $50,000 per person for any multiyear contract.

### Contact Information

| | | | |
|---|---|---|---|
| Names/Phone Numbers: | David Webster | david.webster@usda.gov | 202-720-5742 |
| | Edward Brzostek | edward.brzostek@usda.gov | 202-720-1834 |

Websites: http://www.nrcs.usda.gov/programs/eqip/
http://www.nrcs.usda.gov/programs/salinity/

# Natural Resources Conservation Service
# Conservations Security Program (CSP)

### Eligibility Requirements

- Private working land (cropland, grassland, prairie land, improved pasture, range land, and forest land that is an incidental part of an agricultural operation) is eligible for this program.
- Tribal lands and land located in one of the selected watersheds (see list on the following page) are also eligible.
- Land enrolled in the Conservation Reserve Program, Wetlands Reserve Program, and Grassland Reserve Program, and land converted to cropland after the enactment of the CSP legislation are not eligible.

### Grant Objectives

- The objective of this program is to conserve and improve soil, water, air, energy, plant, and animal life.

### Specifics of Grant

All applicants must meet the following minimum tier contract requirements, plus any additional requirements in the sign-up announcement:

- for Tier I, the producer must have addressed soil quality and water quality to the described minimum level of treatment for eligible land uses on part of the agricultural operation prior to acceptance;
- for Tier II, the producer must have addressed soil quality and water quality to the described minimum level of treatment on all eligible land uses on the entire agricultural operation prior to acceptance and agree to address one additional resource by the end of the contract period;
- for Tier III, the producer must have addressed all applicable resource concerns to a resource management system level that meets the NRCS Field Office Technical Guide standards on all eligible land uses on the entire agricultural operation before acceptance into the program and have riparian zones adequately treated; soil quality practices include crop rotations, cover crops, tillage practices, prescribed grazing, and providing adequate wind barriers; water quality practices include conservation tillage, filter strips, terraces, grassed waterways, managed access to water courses, nutrient and pesticide management, prescribed grazing, and irrigation water management.

### Types of Assistance

Both technical and financial assistance are available through this program. CSP contract payments include one or more of the following:

- an annual stewardship component for the existing base level conservation treatment;
- an annual existing practice component for the maintenance of existing conservation practices;
- an enhancement component for exceptional conservation effort and additional conservation practices or activities that provide increased resource benefits beyond the prescribed level; and
- a one-time new practice component for additional needed practices.

Enhancements will be made for exceptional conservation effort and additional conservation practices or activities that provide increased resource benefits beyond the prescribed level. There are five types of enhancement activities:

- the improvement of a significant resource concern to a condition that exceeds the requirements for the participant's tier of participation and contract requirements;
- an improvement in a priority local resource condition, as determined by the NRCS, such as water quality and wildlife;
- participation in an on-farm conservation research, demonstration, or pilot project;
- cooperation with other producers to implement watershed or regional resource conservation plans that involve at least 75 percent of the producers in the targeted area; and

- implementation of assessment and evaluation activities relating to practices included in the conservation security plan, such as water quality sampling at field edges, drilling monitoring wells and collecting data, and gathering plant samples for specific analysis.

Total payments are determined by the tier of participation, conservation treatments completed, and the acres enrolled as follows:

- for Tier I, contracts are for 5 years and the maximum payment is $20,000 annually;
- for Tier II, contracts are for 5 to 10 years and the maximum payment is $35,000 annually; and
- for Tier III, contracts are for 5 to 10 years and the maximum payment is $45,000 annually.

**Contact Information**

Name: Craig Derickson craig.derickson@usda.gov
Phone Number: 202-720-3524
Website: http://www.nrcs.usda.gov/programs/csp/

**List of Watersheds**

| Watershed | Name | Number of Farms | Acreage |
|---|---|---|---|
| 12090110 | Brady | 393 | 411,958 |
| 12100304 | Cibolo | 1,901 | 399,363 |
| 12110107 | Hondo | 1,404 | 629,689 |
| 12060105 | Hubbard | 838 | 718,013 |
| 12070204 | Little | 1,938 | 496,640 |
| 11130209 | Little Wichita | 935 | 820,375 |
| 12070104 | Lower Brazos | 4,205 | 842,336 |
| 12090101 | Middle Colorado-Elm | 1,015 | 602,337 |
| 11120102 | Palo Duro | 488 | 543,822 |
| 13080002 | San Ambrosia-Santa Isabel | 296 | 913,469 |
| 11140301 | Sulphur Headwaters | 2,588 | 575,158 |
| 13070003 | Toyah | 504 | 486,003 |
| 12080008 | Upper Colorado | 600 | 718,717 |
| 12010001 | Upper Sabine | 4,115 | 604,710 |
| 11120201 | Upper Salt Fork Red | 319 | 420,374 |
| 11100202 | Upper Wolf | 287 | 455,848 |
| 12040204 | West Galveston Bay | 1,437 | 300,051 |
| 12100402 | West Matagorda Bay | 957 | 452,952 |
| | | | |
| Total: 18 Watersheds | | Total: 23,770 Farms | Total: 10,391,815 Acres |

# U.S. Fish and Wildlife Service
# Fisheries & Habitat Conservation
# Partners for Fish and Wildlife Program

### Eligibility Requirements

- Any privately-owned land is potentially eligible for this program, but most of the applicants are individual landowners. For the purposes of this program, "privately-owned" generally means lands not owned by a state or the federal government. Tribes, schools, local governments, businesses, and organizations are examples of eligible applicants.

### Grant Objectives

- The Partners for Fish and Wildlife Program provides technical and financial assistance to private landowners for habitat restoration on their lands.
- A variety of habitats can be restored to benefit federal trust species (for example, migratory birds and fish and threatened and endangered species).

### Specifics of Grant

The restoration projects may include, but are not limited to:

- restoring wetland hydrology by plugging drainage ditches, breaking tile drainage systems, installing water control structures, dike construction, and re-establishing old connections with waterways;
- planting native trees and shrubs in formerly forested wetlands and other habitats;
- planting native grasslands and other vegetation;
- installing fencing and off-stream livestock watering facilities to allow for restoration of stream and riparian areas;
- removal of exotic plants and animals that compete with native fish and wildlife and alter their natural habitats;
- prescribed burning as a method of removing exotic species and to restore natural disturbance regimes necessary for some species survival;
- reconstruction of in-stream aquatic habitat through bioengineering techniques; and
- re-establishing fish passage for migratory fish by removing barriers to movement.

The Partners for Fish and Wildlife Program provides financial assistance on a competitive basis to landowners interested in restoring wildlife habitat. Financial assistance is provided in the form of cooperative agreements. This program focuses its projects in watersheds where conservation efforts will provide the greatest benefits for federal trust species which include migratory birds, anadromous and catadromous (migratory) fish, and species federally-listed as threatened or endangered.

### Types of Assistance

- Normally the cost share is 50 percent (the USFWS and the landowner each pay half of the project costs), but the percentage is flexible. Services or labor can qualify for cost-sharing.

### Contact Information

Name: Don Wilhelm
Phone Number: 817-277-1100
Websites: http://fedgrants.gov/Applicants/DOI/FWS/FHC/Partners-05/Grant.html
http://www.fws.gov/partners/pdfs/05partnersgrants.gov.pdf

# U.S. Fish and Wildlife Service
# Private Stewardship Grants Program

### Eligibility Requirements

- Private lands exhibiting voluntary conservation efforts are eligible for this program.
- There are advantages for species listed or proposed or candidates for listing under the Endangered Species Act, or other at-risk species native to the U.S.

### Grant Objectives

- The Private Stewardship Grants Program provides grants and other assistance on a competitive basis to individuals and groups engaged in local, private, and voluntary conservation efforts that benefit federally listed, proposed, or candidate species, or other at-risk species.

### Specifics of Grant

Grant proposals require:

- landowner participation information;
- budget information; and
- measures to evaluate the project.

Diverse panels of representatives from state and federal governments, conservation organizations, agriculture and development interests, and the scientific community assess applications and make recommendations to the Secretary of the Interior, who awards the grants.

### Types of Assistance

- There must be a personal cost-share of at least 10 percent of the total project cost (may be met by in-kind contributions, including time, equipment, materials, operations, or maintenance costs).

### Contact Information

Name: Mike McCullum
Phone Number: 817/277-1108
Website: http://www.fws.gov/endangered/grants/private_stewardship/index.html

# U.S. Fish and Wildlife Service
# Cooperative Endangered Species Conservation Grants

### Eligibility Requirements

- State and territorial lands are eligible for these grants.

### Grant Objectives

- The objective of these grants is implementation of conservation projects to protect federally listed threatened or endangered species. The program provides funding to states and territories for species and habitat conservation actions on non-federal lands.
- A state or territory must currently have, or enter into, a cooperative agreement with the USFWS to receive grants. Most states and territories have entered into these agreements for both plant and animal species.

### Specifics of Grant

Four grant programs are available through the Cooperative Endangered Species Conservation Fund:

<u>Conservation Grants</u>

- These grants provide financial assistance to states and territories to implement conservation projects for listed species and species at risk. Funded activities include habitat restoration, species status surveys, public education and outreach, captive propagation and reintroduction, nesting surveys, genetic studies, and development of management plans.

<u>Habitat Conservation Planning Assistance Grants</u>

- These grants provide funds to states and territories to support the development of Habitat Conservation Plans (HCPs) through support of baseline surveys and inventories, document preparation, outreach, and similar planning activities.

<u>HCP Land Acquisition Grants</u>

- These grants provide funding to states and territories to acquire land associated with approved HCPs. Grants do not fund the mitigation required of an HCP permittee; instead, they support conservation actions by the state or local governments that complement mitigation.

<u>Recovery Land Acquisition Grants</u>

- These grants provide funds to states and territories for acquisition of habitat for endangered and threatened species in support of approved recovery plans. Acquisition of habitat to secure long-term protection is often an essential element of a comprehensive recovery effort for a listed species.

### Types of Assistance

- States and territories must contribute a minimum non-federal match of 25 percent of the estimated program costs of approved projects, or 10 percent when two or more states or territories implement a joint project.

### Contact Information

Name: Tracy Scheffler
Phone Number: 505-248-6665
Website: http://www.fws.gov/endangered/grants/section6/index.html

# U.S. Fish and Wildlife Service
# State and Tribal Wildlife Grant Program (SWG)

### Eligibility Requirements

- All state fish and wildlife agencies are eligible for this program.

### Grant Objectives

- The SWG program is designed to assist states by providing federal funds for the development and implementation of programs that benefit wildlife and their habitat, including species that are not hunted or fished. Both planning and implementation of the programs is permitted.

### Specifics of Grant

- No state, territory, or other jurisdiction shall receive a grant unless it has developed, or committed to develop by October 1, 2005, a comprehensive wildlife conservation plan consistent with criteria established by the Secretary of the Interior, that considers the broad range of the state, territory, or other jurisdiction's wildlife and associated habitats, with appropriate priority placed on those species with the greatest conservation need and taking into consideration the relative level of funding available for the conservation of those species.

### Types of Assistance

- For planning-related grant activities, the states must provide a minimum 25 percent match, and a 50 percent minimum match for all other types of eligible activities.
- Assistance will be provided for the development and implementation of programs for the benefit of wildlife and their habitat, including species that are not hunted or fished.
- The non-federal share of such projects may not be derived from federal grant programs.

### Contact Information


| | |
|---|---|
| Name: Bob Anderson | bob_anderson@fws.gov |
| Phone Number: | 505-248-7459 |
| Website: | http://federalaid.fws.gov/swg/swg.html |

# Department of Interior – Bureau of Reclamation
# Water Conservation Field Services Program (WCFSP)

### Eligibility Requirements

- Eligibility in the program is unrestricted.

### Grant Objectives

- The main objective is to develop a thorough water conservation plan as an opportunity for every water user to identify water management problems, evaluate options, highlight accomplishments, and plan for improvements.

### Specifics of Grant

- The WCFSP provides technical help for water agencies and users to begin implementing conservation measures.

### Types of Assistance

- Financial assistance is available for demonstration programs and pilot projects to promote and implement improved water management and conservation per the RFP.
- Financial assistance is also available for planning, designing, and constructing improvements that will conserve water, increase water use efficiency, or enhance water management through measurement or automation at existing water supply projects within the 17 western states.
- Local programs also provide cost-sharing, generally on a 50-50 basis, through cooperative agreements or grants.

### Contact Information

| | |
|---|---|
| Name: Brenton Johnson | bhjohnson@gp.usbr.gov |
| Phone Number: | (512) 899-4161 |
| Websites: | http://fedgrants.gov/Applicants/DOI/BOR/UC820/05-SF-40-2369/Grant.html |
| | http://www.usbr.gov/waterconservation/about.html |

# Natural Resources Conservation Service
# Farm and Ranch Lands Protection Program (FRPP)

### Eligibility Requirements

For land to be eligible, it must be all or part of a farm or ranch and:

- contain prime, unique, or other productive soil or historical or archaeological resources;
- be included in a pending offer from a state, tribal, or local government or nongovernmental organization's farmland protection program;
- be privately owned;
- be covered by a conservation plan for any highly erodible land;
- be large enough to sustain agricultural production;
- be accessible to markets for what the land produces;
- be surrounded by parcels of land that can support long-term agricultural production;
- be owned by an individual or entity that does not exceed the Adjusted Gross Income (AGI) limitation.

### Grant Objectives

- The main objective is to acquire conservation easements or other interests in land from landowners.

### Types of Assistance

- This program provides matching funds to help purchase development rights to keep productive farm and ranchland in agricultural uses.
- Federal contributions shall not exceed 50 percent.

### Contact Information


| | |
|---|---|
| Name: Denise C. Coleman | denise.coleman@usda.gov |
| Phone Number: | 202-720-0679 |
| Website: | http://www.nrcs.usda.gov/programs/frpp/ |

# Natural Resources Conservation Service
# Conservation Reserve Program (CRP)

### Eligibility Requirements

In order to be eligible for this program, land must be cropland that:

- has been planted or considered planted to an agricultural commodity four of the six years between 1996 through 2001;
- is physically and legally capable of being planted in a normal manner to an agricultural commodity; or
- is marginal pasture land.

This land must also:

- have a weighted average Erosion Index of eight or greater;
- be Water Bank Program acreage that expired in 2000, 2001, or 2002; or
- be located in a national or state CRP conservation priority area.

### Grant Objectives

- This program provides assistance to farmers and ranchers in complying with federal, state, and tribal environmental laws, and encourages environmental enhancement.
- It also strives to reduce soil erosion, protect the nation's ability to produce food and fiber, reduce sedimentation in streams and lakes, improve water quality, establish wildlife habitat, and enhance forest and wetland resources.
- This program encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as tame or native grasses, wildlife plantings, trees, filter strips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract, and cost-sharing is provided to establish the vegetative cover.

### Specifics of Grant

- This program is funded through the Commodity Credit Corporation (CCC), and is administered by the Farm Service Agency, with the NRCS providing technical land eligibility determinations, conservation planning, and practice implementation.

### Types of Assistance

- Annual rental payments based on the agriculture rental value of the land are provided.
- This program also provides cost-share assistance for up to 50 percent of the participant's costs in establishing approved conservation practices.
- Participants must enroll in CRP contracts for 10 to 15 years.

### Contact Information


| | |
|---|---|
| Name: Malcolm Henning | malcolm.henning@usda.gov |
| Phone Number: | 202-720-1872 |
| Website: | http://www.nrcs.usda.gov/programs/crp/ |

# Natural Resources Conservation Service
# Grassland Reserve Program (GRP)

### Eligibility Requirements

- Landowners who can provide clear title on privately owned lands are eligible to participate for either easement option. Landowners and others who have general control of the acreage may submit an application for a rental agreement.
- Eligible land includes privately-owned and tribal lands, such as grasslands, land that contains forbs (including improved rangeland and pastureland or shrubland), or land that is located in an area that historically has been dominated by grassland, forbs, or shrubland that has the potential to serve as wildlife habitat of significant ecological value.

### Grant Objectives

- This is a voluntary program offering landowners the opportunity to protect, restore, and enhance grasslands.
- It also helps landowners restore and protect grassland, rangeland, pastureland, shrubland, and certain other lands and provides assistance for rehabilitating grasslands.
- It will also conserve vulnerable grasslands from conversion to cropland or other uses and conserve valuable grasslands by helping maintain viable ranching operations.

### Specifics of Grant

Applications may be filed for an easement or rental agreement with NRCS or FSA at anytime. Participants voluntarily limit future use of the land while retaining the right to conduct common grazing practices, produce hay, mow, or harvest for seed production, conduct fire rehabilitation, and construct firebreaks and fences. GRP contracts and easements prohibit the production of crops (other than hay), fruit trees, and vineyards that require breaking the soil surface and any other activity that would disturb the surface of the land, except for appropriate land management activities included in a conservation plan.

- Permanent Easement – This is a conservation easement in perpetuity. Easement payments for this option equal the fair market value, less the grassland value of the land encumbered by the easement. These values will be determined using an appraisal.
- Thirty-year Easement – USDA will provide an easement payment equal to 30 percent of the fair market value of the land, less the grassland value of the land encumbered by the easement. For both easement options, the USDA will provide all administrative costs associated with recording the easement, including appraisal fees, survey costs, title insurance, and recording fees. Easement payments be provided, at the participant's request, in lump sum or annual payments (equal or unequal amounts) for up to 10 years.
- Rental Agreement – Participants may choose a 10-year, 15-year, 20-year, or 30-year contract. The USDA will provide annual payments in an amount that is not more than 75 percent of the grazing value of the land covered by the agreement for the life of the agreement. Payments will be disbursed on the agreement anniversary date each year.
- Restoration Agreement – An approved grassland resource management plan identifying required restoration activities will be incorporated within the rental agreement or easement. The CCC may provide up to 90 percent of the restoration costs on lands that have never been cultivated, and up to 75 percent of the cost on restored grasslands and shrub lands that were previously cropped. Participants will be paid upon certification of the completion of the approved practice(s) by NRCS or an approved third party. Participants may contribute to the application of a cost-share practice through in-kind contributions. The combined total cost-share provided by federal or state governments may not exceed 100 percent of the total actual cost of restoration.

### Contact Information


| | |
|---|---|
| Name: Floyd Wood | floyd.wood@usda.gov |
| Phone Number: | 202-720-0242 |
| Website: | http://www.nrcs.usda.gov/programs/GRP/ |

# Department of Agriculture
# CSREES National Integrated Water Quality Program (NIWQP)

### Eligibility Requirements

- Native American tribal organizations (other than federally recognized tribal governments), private institutions of higher education, and public and state controlled institutions of higher education are eligible.

### Grant Objectives

- The goal of the NIWQP is to contribute to the improvement of the quality of our nation's surface water and groundwater resources through research, education, and extension activities.

### Specifics of Grant

- Projects funded through this program will facilitate achieving this goal by advancing and disseminating the knowledge base available to agricultural and rural communities.
- Funded projects should lead to science-based decision-making and management practices that improve the quality of the nation's surface water and groundwater resources in agricultural and rural watersheds.

NIWQP applications are being solicited in the following program areas:
- National Facilitation Projects;
- Regional Water Quality Coordination Projects; and
- Integrated Research, Education, and Extension Projects.

Projects MUST address water quality issues at the watershed scale in agricultural and rural watersheds, including those watersheds where pressure from urban/suburban development is impacting water quality. Eight topical themes have been identified for the NIWQP:
- Animal Waste Management;
- Drinking Water and Human Health;
- Environmental Restoration;
- Nutrient and Pesticide Management;
- Pollution Assessment and Prevention;
- Watershed Management;
- Water Conservation and Agricultural Water Management; and
- Water Policy and Economics.

### Project Allowances

| Project Type | Maximum Funding | Project Length |
|---|---|---|
| National Facilitation Projects | $100,000 | 1 – 4 years |
| Regional Water Quality Coordination Projects (RWQCP) | $600,000 | 1 – 3 years |
| Integrated Research, Education, and Extension Projects | $200,000 | 1 – 3 years |

### Contact Information

Name: Dr. Michael P. O'Neill moneill@csrees.usda.gov
Phone Number: 202-205-5952
Websites: http://fedgrants.gov/Applicants/USDA/CSREES/OEP/USDA-GRANTS-011305-001/Grant.html
http://www.csrees.usda.gov/funding/rfas/pdfs/05_water_quality.pdf

# Farm Service Agency
# Conservation Reserve Enhancement Program (CREP)

### Eligibility Requirements

- A specific CREP project begins when a state, Indian tribe, local government, or local nongovernmental entity identifies an agriculture-related environmental issue of state or national significance. Then, these parties and FSA develop a project proposal to address particular environmental issues and goals.
- Enrollment in a state is limited to specific geographic areas and practices. To determine if a state and county are involved in CREP and if specific land qualifies, contact the local county FSA office.

  Note: Texas currently has no CREP projects.

### Grant Objectives

- This program is a voluntary land retirement program that helps agricultural producers protect environmentally sensitive land, decrease erosion, restore wildlife habitat, and safeguard ground and surface water.

### Specifics of Grant

- This program addresses high-priority conservation issues of both local and national significance, such as impacts to water supplies, loss of critical habitat for threatened and endangered wildlife species, soil erosion, and reduced habitat for fish populations such as salmon.
- Like the CRP, CREP contracts require a 10- to 15-year commitment to keep lands out of agricultural production. The FSA uses CRP funding to pay a percentage of the program's cost, while state, tribal governments or other non-federal sources provide the balance of the funds. States and private groups involved in the effort may also provide technical support and other in-kind services.
- This program is based on the familiar, highly successful CRP model. Land must be owned or leased for at least one year prior to enrollment to be eligible, and must be physically and legally capable of being cropped in a normal manner.
- Land must also meet cropping history and other eligibility requirements. Enrollment can be on a continuous basis, permitting farmers and ranchers to join the program at any time rather than waiting for specific sign-up periods.
- The CREP supports increased conservation practices such as filter strips and forested buffers. These conservation practices help protect streams, lakes, and rivers from sedimentation and agricultural runoff.
- The CREP also helps landowners develop and restore wetlands through the planting of appropriate groundcover.

### Types of Assistance

- The CREP provides payments to participants who offer eligible land. A federal annual rental rate, including an FSA state committee-determined maintenance incentive payment, is offered.
- Cost-shares of up to 50 percent of the eligible costs to install the practice are also offered.
- In addition, the program generally offers a sign-up incentive for participants to install specific practices.

### Contact Information

Name: N/A
Phone Number: N/A
Website: http://www.fsa.usda.gov/dafp/cepd/crep.htm

# Natural Resources Conservation Service
# Grazing Lands Conservation Initiative (GLCI)

### Eligibility Requirements

- In order to be eligible for this program, a person must own private grazing lands.

### Grant Objectives

- This program seeks to strengthen partnerships and promote voluntary assistance and participation, while respecting private property rights, encouraging diversification to achieve multiple benefits, and emphasizing training, education, and increased public awareness.

### Types of Assistance

- Congress has identified funds in the NRCS budget to be used directly for technical assistance and public awareness activities to support conservation activities on private grazing lands.

### Contact Information


| | |
|---|---|
| Name: Mitch Flanagan | mitch.flanagan@usda.gov |
| Phone Number: | 202-690-5988 |
| Website: | http://www.nrcs.usda.gov/programs/glci/ |

# Texas State Soil and Water Conservation Board
# Water Quality Management Plan (SB 503) Program (WQMP)

**Eligibility Requirements**

- Agricultural or silvicultural lands are eligible for this program.

**Grant Objectives**

- The WQMP is a site specific plan for agricultural or silvicultural lands developed through and approved by soil and water conservation districts. It includes appropriate land treatment practices, production practices, management measures, technologies, or combinations thereof. The plan is to achieve a level of pollution prevention or abatement determined by the TSSWCB in consultation with the local soil and water conservation district to be consistent with state water quality standards.

**Specifics of Grant**

- The purpose of this program is to provide the needed incentive to landowners or operators for the installation of soil and water conservation land improvement measures consistent with the purposes of controlling erosion, conserving water, and/or protecting water quality.

**Types of Assistance**

- It is the policy of the TSSWCB to cost-share on the basis of actual cost not to exceed the average cost.

**Contact Information**

| | |
|---|---|
| Name: Kendria Ray | kray@tsswcb.state.tx.us (Field Representative for the Travis County Office) |
| Phone Number: | 830-672-1899 |
| Website: | http://www.tsswcb.state.tx.us/swcd/resources.html |

# APPENDIX G

# NRCS PROGRAM DATA SHEETS

# EQIP 2004 State Resource Concern

## North Concho Brush Control

### Primary Resource Concern - Water Quantity

EQIP funds will be used to support brush control efforts in selected watersheds. Initial efforts will focus on cost share for initial and follow-up brush control by local cooperators who participate in the Texas Soil and Water Conservation Board's brush control program and other independent brush control efforts in the watersheds. EQIP funds will leverage state funds to increase available water through brush control and grazing management.

### Primary Area of Concern

- Coke
- Glasscock
- Howard
- Schleicher
- Tom Green

#### High Priority

- Initial and Follow-up Brush Management - All approved methods

#### Medium Priority

- Prickly Pear Control

#### Low Priority

- Facilitating practices (range planting, water development, fence, grazing land mechanical treatment)
- Initial Brush Management has been completed and prescribed burning is needed to treat juniper as a follow-up.

Cooperators in approved brush control project watersheds

| Watershed | Total Brush (Acres) |
|---|---|
| North Concho Watershed | 437,880 |

## Eligible Practices

- Brush Management (314)
- Range Planting (550)
- Fence (386)
- Watering Facility (614)
- Water Well (642)
- Grazing Land Mechanical Treatment (548)
- Prescribed Burning (338) - Juniper follow-up only
- Pipeline (516)

## Cost Share Rates

- Limited Resource Farmers or Ranchers = 60%
- Beginning Farmers or Ranchers = 50%
- All others = 50%

Practices will be cost shared based on the established county average cost of the practice.

## Ranking Criteria

### North Concho Brush Control Ranking Criteria

***Brush Management:***

Initial Brush Management or follow-up treatment - 100 points

Prickly pear control - 75 points

*Initial Brush Management has been completed*

*and prescribed burning is needed to treat juniper*

*as a follow-up. - 50 points*

***Facilitating practices:***

*Range planting - 10 points*

*Fencing - 10 points*

*Water development - 10 points*

*Grazing land mechanical treatment - 10 points*

*Total ___________*

***Instructions for Completing Ranking Worksheet:***

- *Only highest point item counts toward score*
- *Can have multiple item contracts*
- *75% of total contract dollars must address the High Priority Concern*
- *Mark all practices that producer wants cost shares on.*

***< Back to State Resource Concerns***

# EQIP 2004 Invasive Species

## Invasive Species - Salt Cedar

### Primary Resource Concern - Water Quantity

Salt Cedar is the most widely distributed phreatophyte in Texas. It has dominated the native vegetation, increased salinity of the soil and water, increased flooding, and increased water loss.

### Priority for Funding

**High Priority**

**Pecos River Basin**

- Crane
- Crockett
- Culberson
- Loving
- Pecos
- Reeves
- Terrell
- Val Verde
- Ward

| Priority Location | Description |
|---|---|
| 1 | New Mexico-Texas State Line to I-20 |
| 2 | I-20 to Highway 67 (near Girvin) |
| 3 | Highway 67 to I-10 (near Sheffield) |
| 4 | I-10 to Lake Amistad |

All applications will be accepted and ranked.

## Medium Priority

**Colorado River Basin**

- Andrews
- Borden
- Cochran
- Coke
- Dawson
- Ector
- Fisher
- Gaines
- Garza
- Glasscock
- Hockley
- Howard
- Lynn
- Martin
- Midland
- Mitchell
- Nolan
- Runnels
- Scurry
- Sterling
- Terry
- Upton
- Winkler
- Yoakum

| Priority Location | Description |
|---|---|
| 1 | Land is eligible if 8 digit Hydrologic Unit Code begins with 1208 and is North of I-20 in Colorado County |
| 2 | I-20 in Colorado City to Highway 67 in Ballinger |
| 3 | Highway 67 in Ballinger to Highway 377 in Winchell |
| 4 | Highway 377 in Winchell to Lake Buchanan |

All applications will be accepted but not ranked unless funds are available after funding all high priority applications.

## Low Priority

Other sites not in high or medium priority areas.

### Priority Location

- Zone 1 in watershed

- Zone 2 in watershed
- Zone 3 in watershed
- Zone 4 in watershed

## Proximity

Offered acres are adjacent to salt cedar areas previously treated or currently under contract to be treated.

## Eligible Practices

- Brush Management -chemical control only
- Brush Management - mechanical control
- Brush Management followed by range planting

## Cost Share Rates

| | Brush Management | Range Planting |
|---|---|---|
| • Limited Resource Farmers or Ranchers | 75% | 50% |
| • Beginning Farmers or Ranchers | 75% | 60% |
| • All Others | 75% | 50% |

Practices will be cost shared based on the established county average cost of the practice.

## Eligible Practices

- Brush Management (314)
- Range Planting (550) Limited to acres following brush management

## Incentive Payment Levels

Prescribed Grazing $ 0.50 per acre per year (maximum 3 years)

Applicable for all acres in the pasture where brush management is being applied.

## Ranking Criteria

Salt Cedar Ranking Criteria

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# Texas EQIP State Resource Concern

## Rolling Plains – Grassland Bird – Bobwhite Quail

### Primary Resource Concern - Wildlife

Reductions in grassland bird numbers due to an extended drought combined with overgrazing and brush encroachment. Priority counties are:

- Childress
- Cottle
- Hardeman
- Foard
- King
- Knox
- Stonewall
- Haskell
- Fisher
- Jones
- Nolan
- Taylor
- Runnels
- Wilbarger
- Baylor

- Throckmorton
- Wichita
- Shackelford
- Callahan
- Coleman
- Concho
- McCulloch
- San Saba
- Lampasas
- Mills,
- Brown
- Eastland
- Stephens
- Palo Pinto
- Erath

- Parker
- Young
- Jack
- Clay
- Wise
- Montague
- Archer
- Wheeler
- Donley
- Armstrong
- Collingsworth
- Randall
- Briscoe
- Hall

- Floyd
- Motley
- Lubbock
- Crosby
- Dickens
- Garza
- Kent
- Dawson
- Borden
- Scurry
- Howard
- Mitchell
- Coke
- Tom Green

### Priority for Funding

**Eligibility Criteria**

To be eligible for this state resource concern, applicants **must** meet all three criteria. If any criteria are not met, the application is not eligible.

- The offered acreage is contiguous and at least 51% of the acreage is located in MLRA 78B, 78C, 78D or 80B.
- The land use of the offered acreage is at least 90% native rangeland .
- The applicant must agree to implement an NRCS approved grazing program that is primarily beneficial to quail and other grassland birds.

### Priority Criteria

If applicant cannot agree to all three criteria below, the application will be ranked low priority. Applications not meeting these criteria, **will be accepted but not ranked** unless funds are available after all high priority application have been funded.

- Applicant agrees to follow Texas Parks and Wildlife Department ( TPWD) recommendations and implement a TPWD approved wildlife management plan that includes bobwhite quail before the end of the first full year of the contract.
- Offered acreage is adequately fenced and watered to carry out prescribed grazing
- Agree to restrict application of herbicides to IPT and forgo the use of Picloram on the offered acreage for the duration of the contract.

## Eligible Practices

- Prescribed Grazing (528A)
- Brush Management (314)
- Prescribed Burning (338)

- Range Planting (550)

## Cost Share

- Limited Resource Farmers or Ranchers = 60 %
- Beginning Farmers or Ranchers = 50 %
- All others = 50 %

## Incentives

Incentive cost share is flat rate.

Prescribed Grazing (528A) Payment is limited to a maximum of 2500 acres per contract.

• $5 per acre – Limited to a maximum of 2 years. Applicable only to acres requiring a planned **full growing season deferment** (such as planned rest, before and after a prescribed burn or following brush management). Payment to be made after each full growing season deferment is completed.

• $5 per acre – Year 5 (maximum 1 year). Must be actively implementing NRCS approved grazing management plan **and** TPWD approved wildlife management plan to receive this payment.

## Ranking Criteria

### Grazing System

The grazing system the applicant implements following the next full growing season of livestock deferment.

| | |
|---|---|
| Dormant season stockers or prescribed grazing that favors quail habitat | 50 points |
| All other systems | 0 points |

### Contiguous Acres Offered

| Contiguous Acres | Points |
|---|---|

| | |
|---|---|
| <1000 | 10 |
| 1000 to 2,499 | 50 |
| > 2500 | 50 |

**Percentage of Grazing Land**

The percentage of the grazing land in this operating unit will be operated under an active grazing management plan for the duration of the contract.

| Percent | Points |
|---|---|
| >75% | 25 |
| 25-74% | 15 |
| <25% | 0 |

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## APPENDIX H

## CCRP RIPARIAN BUFFERS DATA SHEET

# Controlling Salt Cedar and Restoring Healthy Creeks and Rivers
# With CCRP Riparian Buffers
## Coke, Mitchell, Howard Counties

**What is CCRP?** Continuous Conservation Reserve Program is a USDA program similar to regular CRP. Intended to protect and improve environmentally sensitive areas such as creeks and rivers. Enrollment period is 10 – 15 years. Enrollment is non competitive. All eligible applications are funded.

**What is a Riparian Buffer?** A band of dense native vegetation (grasses, forbs, shrubs and trees) adjacent to creeks, and rivers.

**What is the Purpose of a Riparian Buffer?** Protect creek banks, filter sediment, improve water quality, and enhance fish and wildlife habitat.

**What are the financial benefits to landowners?**

- Up front signing incentive of $100 to $150 per acre
- Annual rental payments of $28 to $31 per acre per year for seasonal creeks; and $43 to $46 per acre for perennial (running creeks)
- Rental payments include $7 to $10 per acre per year for maintenance
- 90% Reimbursement for fences and salt cedar control and alternate livestock water development

**What are the requirements?**

- Control salt cedar (if present)
- No grazing for life of contract
- Maintain fences
- Followup control of re-infestations of salt cedar

**What land is eligible?**

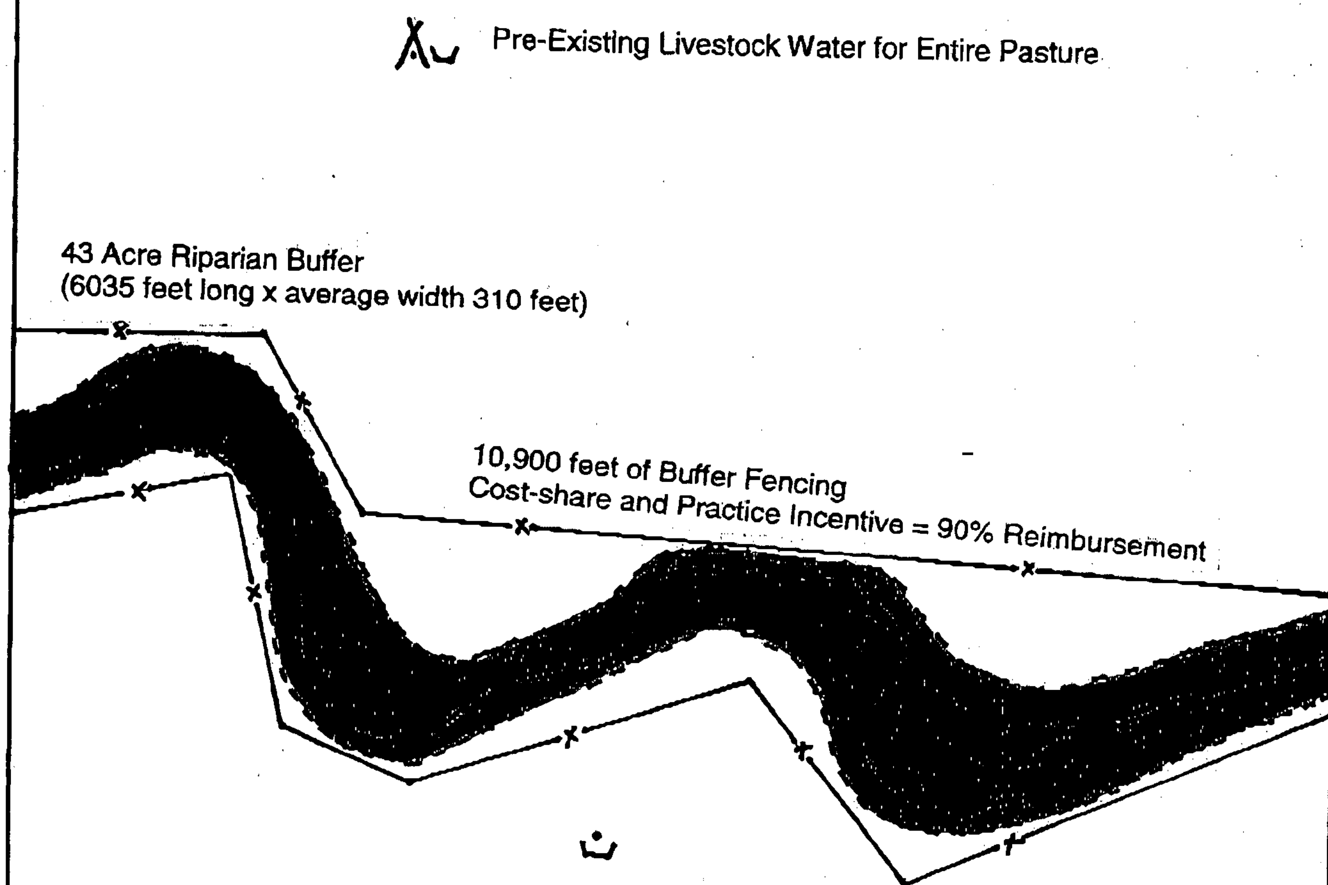
- 3rd Order Creeks (check with NRCS for determination)
- Creeks that have infestations of salt cedar
- Creeks that currently lack the proper kinds of native vegetation

**How is acreage determined?** Riparian Buffers will range from 35 feet to 180 feet wide on each side of the creek. A large creek will have a wider buffer and a small creek will have a narrower buffer. Acreage will be determined by on-site determination by NRCS.

**How is salt cedar controlled?** Initial treatment will normally be with helicopter application of Arsenal. Applicators <u>must</u> avoid areas of desirable trees such as willow, soapberry, pecan, hackberry and others. Arsenal is a non selective herbicide and will kill or damage desirable vegetation. Follow-up control to keep new salt cedar out of buffer will normally be with IPT methods (Individual Plant Treatment) with approved herbicides.

**CCRP and EQIP** – Both programs may NOT be used on the same acreage simultaneously. After the expiration of EQIP, land may be enrolled in CCRP Riparian Buffer.

# Example Riparian Buffer
# 630 Acre Pasture, Tom Green County




90% Reimbursement for Salt Cedar Control
90% Reimbursement for Buffer Fencing
90% Reimbursement for New Livestock Water Development

Up-Front, One-Time Signing Incentive = $150 for 15 full year enrollment
Signing Incentive = $6450

| | Perennial Stream | or | Seasonal Stream |
|---|---|---|---|
| Annual Rental Payment | = $36.00 per acre ; | or | $21.60 per acre |
| Maintenance Payment | = $10.00 per acre | | $10.00 per acre |
| Total Annual Payment | = $46.00 per acre | or | $31.60 per acre |

Annual Payment for 43 acres = $1,978 x 15 years = $29,670 (Perennial)
$1,358 x 15 years = $20,370 (Seasonal)

## APPENDIX I

## ORIGINAL COLORADO RIVER MUNICIPAL WATER DISTRICT (CRMWD) MONITORING SITES

# Original Colorado River Municipal Water District (CRMWD) Monitoring Sites

<u>Colorado River Above O.H. Ivie Reservoir</u>

1. Egan Dairy, 5.3 miles NNW of Rowena, Runnels County
2. Hwy 83, Colorado River at Hwy 83, Runnels County
3. Elm Creek, 3.2 miles N of Ballinger, Runnels County
4. Lake Moonen (Ballinger Municipal Lake), 6.0 miles WSW of Ballinger, Runnels County
5. Blair's, 6.0 miles SE of Ballinger, Runnels County

<u>Colorado River Below O.H. Ivie Reservoir</u>

1. Smith's, 2.5 miles E of FR 503, McCulloch County
2. Cox's, 5.8 miles ENE of Doole, McCulloch County
3. Harding's, 9.0 miles S of Gouldbusk, Coleman County
4. Cooper's, 3.5 miles SW of Rockwood, Coleman County
6. Theriot's, 5.0 miles SSE of Rockwood, Coleman County

<u>Concho River Above O.H. Ivie Reservoir</u>

1. Haechton's, Concho River at FR 381, Concho County
2. Vinson Dam, 3.6 miles W of Paint Rock, Concho County
3. Willberg's, 4.1 miles SE of Lowake, Concho County
4. Paint Rock Park, Concho River below Hwy 83, Concho County
7. Glasscock's, 3.2 miles NE of Paint Rock, Concho County

<u>Artificial Riffle Sites</u>

1. Colorado River at Hwy 208, Coke County
2. Rusk, 1.1 miles SE of Robert Lee, Coke County
3. Scott, 2.0 miles SE of Robert Lee, Coke County
4. Ivey, 6.4 miles ESE of Robert Lee, Coke County
5. Smith, 6.5 miles ESE of Robert Lee, Coke County
8. Lee, 2.8 miles SW of Bronte, Coke County